Deschutes Subbasin Plan
Table of Contents

Executive Summary

Subbasin Assessment

Inventory

Management Plan

List of Maps

Executive Summary

1. Purpose and Scope

The Deschutes Subbasin Plan shares the vision and cooperation of numerous people who are committed to restoring and/or sustaining healthy fish, wildlife and plant communities, water quality and instream flows in the Deschutes watershed. Many stakeholders took an active role in its formation including fish and wildlife managers, tribes, governmental agencies and citizens. This wide involvement reflects the foundation of the planning process — that the responsibility of subbasin planning ultimately lies with the people of the Deschutes Subbasin.

The Deschutes Subbasin Plan will ultimately be adopted as part of the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program. It and similar plans for other Columbia River subbasins that were prepared through the Council's Fish and Wildlife Program, will help direct Bonneville Power Administration funding of projects that protect, mitigate and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system. The Council, Bonneville, NOAA Fisheries, and U.S. Fish and Wildlife Service will use adopted subbasin plans to help meet the requirements of the 2000 Federal Columbia River Power System Biological Opinion. NOAA Fisheries and USFWS will also use the plans as building blocks for recovery planning for threatened and endangered species.

The foundation of the Deschutes Subbasin Plan is the belief that the physical and cultural environments of the Deschutes Subbasin — and larger Columbia River Basin — control the distribution, composition, and structure of fish and wildlife communities and populations in the watershed. These environments extend beyond the banks of the Deschutes River and tributaries, and reach from ridge top-to-ridge top. Consequently, strategies are designed to protect and restore the functions of natural processes within the subbasin. They include direction to protect, restore and expand core production areas for focal fish and wildlife species in the watershed. Strategies focus on restoring and reconnecting fragmented stream reaches; increasing instream flows and returning seasonal flows to more natural flow regimes; restoring overall watershed health to increase water infiltration, retention and permeability rates, and soil stability; and protecting existing critical habitats that currently provide high quality habitat conditions.

The Deschutes Subbasin Plan consists of three parts:

- The Assessment forms the scientific and technical foundation for development of the Deschutes Subbasin vision, objectives and strategies.

- The Inventory summarizes fish and wildlife protection, restoration and artificial production activities and programs that have already occurred in the subbasin or are currently being implemented.

- The Management Plan — the heart of the subbasin plan — defines the environmental and biological vision, objectives and strategies specific to fish and wildlife within the Deschutes Subbasin. The management plan has a 25-year planning horizon. It includes direction for research, monitoring and evaluation.

The development of the subbasin plan will be iterative. The plan is a living document and will be updated and refined through adaptive management, research and evaluation. It will be maintained to reflect new direction of other agencies and stakeholders. Information and direction in the subbasin plan will be revisited and updated through the Northwest Power and Conservation Council's Rolling Provincial Review Process once every three years.

2. Subbasin Planning Process

The Deschutes Coordinating Group (DCG) led the Deschutes Subbasin planning process. The DCG addresses natural resource issues from a subbasin-wide perspective. The group includes representatives from subbasin organizations, watershed councils, cities, counties, irrigation districts, hydropower operators, state agencies, and federal and resource management agencies. All meetings of the DCG have been open to the public and participation of others interested in the subbasin planning effort has been, and continues to be, encouraged.

The overall purpose of the DCG's planning efforts goes beyond the requirements of the Northwest Power and Conservation Council's subbasin planning process. The DCG seeks to develop a watershed restoration plan that identifies and prioritizes actions needed to:

- *Protect and enhance streamflows to meet water quality standards, instream water rights, fish and wildlife habitat objectives and existing water rights;*

- *Maintain the resource land base in the subbasin, consistent with acknowledged comprehensive land use plans, and the economic viability of the resource-based economy in the subbasin;*

- *Meet municipal and industrial water needs over the next 50 years; and*

- *Promote sustainability and conservation consistent with the custom, culture and quality of life in the subbasin.*

Fish and Wildlife technical teams with participants from ODFW, the Warm Springs Tribes, state and federal natural resource agencies, watershed councils and the public played an essential role during the planning process. These technical experts shared in-depth knowledge needed to characterize fish and wildlife populations and habitat attributes in diverse and widespread Deschutes River drainages. Their input was also critical in the development of management strategies to protect and restore focal populations.

Overall Planning Approach

Subbasin planners worked with the technical teams and DCG to make several key decisions that focused the scope and breadth of the planning effort. They selected focal fish and wildlife species that were then used to characterize the status, functions and management actions in the subbasin. They also divided the Deschutes watershed into eight different assessment units with similar climatic, hydrologic, biologic and geologic characteristics.

Focal Species

Five aquatic species and seven terrestrial species in the Deschutes River Subbasin were chosen as the focal species for the subbasin plan. The five aquatic focal species include Chinook salmon, steelhead/redband trout, bull trout, sockeye salmon and Pacific Lamprey. The seven terrestrial focal species include: American beaver, Columbia spotted frog, white-headed woodpecker, mule deer, Greater sage grouse, Columbian sharp-tailed grouse, and golden eagle. These five aquatic species and seven terrestrial species are all indigenous to the Deschutes Subbasin.

Focal species were selected based on their significance and ability to characterize the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species included a) designation as a federal threatened or endangered species, b) cultural significance, c) local significance, and d) ecological significance, or ability to serve as indicators of environmental health for other aquatic or terrestrial species.

Assessment Units

Because of the size and diversity of the Deschutes Subbasin, the planning team divided the watershed into eight smaller assessment units. The assessment units generally display unique physical characteristics, and often support different salmonid populations and life history characteristics because of their differing environmental conditions. The eight assessment units and their unique characteristics include

- **Lower Westside Deschutes Assessment Unit:** Lower Deschutes River from RM 0 to RM 100, the Warm Springs River and Shitike Creek, and all small tributaries entering the lower Deschutes River, except for Buck Hollow, Bakeoven, and Trout creeks. The assessment unit provides important spawning and rearing habitat for fall and spring Chinook, summer steelhead, redband trout, bull trout and Pacific lamprey.

- **White River Assessment Unit:** the White River watershed above White River Falls (RM 2). The assessment unit supports production of unique redband trout populations that are genetically and morphologically different from lower Deschutes redband trout. White River Falls prevents anadromous fish access to the assessment unit and isolates populations of redband trout and other resident fish above the falls from those downstream.

- **Lower Eastside Deschutes Assessment Unit:** Major Deschutes River tributaries draining the lower eastern portion of the Deschutes Subbasin, including Buck Hollow, Bakeoven, Trout and Willow creeks. Three of these systems —Buck Hollow, Bakeoven and Trout creeks — provide important spawning and rearing habitat for summer steelhead in the Deschutes Subbasin. All the tributaries also support redband trout.

- **Lower Crooked River Assessment Unit:** Lower Crooked River drainage below Bowman and Ochoco dams, including lower Ochoco Creek and McKay Creek. The assessment unit supports several resident indigenous fish populations, including redband trout. The Pelton Round Butte Complex blocks all anadromous fish access to the drainage.

- **Upper Crooked River Assessment Unit:** Upper Crooked River drainage above Bowman and Ochoco dams, including upper Ochoco Creek, north and south forks of the Crooked River and Beaver Creek. Redband trout are the only native game fish left in the upper basin and reside primarily in the headwaters of smaller tributaries located on forest lands.

- **Middle Deschutes Assessment Unit:** The 32-mile reach of the Deschutes River from the Pelton Round Butte Complex (RM 100) to Big Falls (RM 132) and its two major tributaries, Metolius River and Squaw Creek. The two major tributaries in the assessment unit once provided important salmonid spawning and rearing habitat, and continue to provide important habitats for bull trout and redband trout populations. The drainages will provide important habitat for reintroduced salmon and steelhead when fish passage is restored at the Pelton Round Butte Complex.

- **Upper Deschutes Assessment Unit:** The upper Deschutes River drainage from Big Falls (RM 132) to Wickiup Dam (RM 222), including Tumalo Creek, Spring River, the Little Deschutes River and Fall River. Big Falls was historically considered the upstream limit of anadromous fish passage. The assessment unit supports resident redband trout.

- **Cascade Highlands Assessment Unit:** The Deschutes River drainages above Wickiup Dam, including the Cascade Lakes. The assessment unit supports redband trout. In addition, the Odell Creek/Odell Lake complex, which is also part of this assessment unit, supports a remnant population of bull trout that is the only known resident, non-reservoir, adfluvial population remaining in Oregon.

Assessment Tools

Subbasin planners used three assessment tools to evaluate biological and physical characteristics of the subbasin, and bring information together for the development of biological objectives. The fish assessment employed the Ecosystem Diagnosis and Treatment (EDT) and Qualitative Habitat Assessment (QHA) analyses to compare focal fish species needs during different life stages with the conditions existing in various stream reaches. The analyses integrated knowledge of the environmental attributes critical to fish with species-specific environmental requirements, reproductive potential and life history strategies to predict the performance of a population subject to current, historic or hypothetical environmental conditions. The wildlife assessment relied heavily on information from the Northwest Habitat Institute Interactive Biological Information System (IBIS). Historic and current habitats from IBIS were examined and compared to identify focal habitats, and to assess habitat changes that have occurred throughout the subbasin.

3. Foundation of the Subbasin Plan

Vision for the Deschutes Subbasin

The Vision describes the desired future condition for the subbasin. Crafted by the Deschutes Coordinating Group, it incorporates the conditions, values and priorities of a wide spectrum of stakeholders in the Deschutes Subbasin. The vision for the Deschutes Subbasin also is consistent with and builds from the vision described in the Northwest Power and Conservation Council's Columbia River Basin 2000 Fish and Wildlife Program.

The Vision for the Deschutes Subbasin is:

> *To promote a healthy, productive watershed that sustains fish, wildlife and plant communities as well as provides economic stability for future generations of people. An inclusive consensus-based process will be used to create a plan for the achievement of sustainable management of water quality standards, instream flows, private water rights, fish and wildlife consistent with the customs and quality of life in this basin.*

This vision of the Deschutes Subbasin framed the development of the biological objectives and thereby the strategies that are incorporated to change conditions within the subbasin.

Conceptual Foundation

A conceptual foundation was also developed for the Deschutes Subbasin during the planning process. This foundation summarizes the underlying ecological conditions that define how salmonid and lamprey producing ecosystems in the Deschutes watershed function. It recognizes that fish and wildlife are part of the physical and cultural landscape, and that by understanding how ecosystem functions affect the vitality of fish and wildlife populations, we can better define steps needed to sustain a productive ecosystem that will support these populations.

The Conceptual Foundation includes several guiding principles:

- *Fish and wildlife populations in the Deschutes Subbasin have complex life histories that respond to the subbasin's considerable variation in habitat conditions. Such diversity promotes production and long-term persistence at the species level and must be protected.*

- *The Deschutes Subbasin is part of a coevolving natural—cultural system. Suitable ecosystem attributes can be achieved by managing human interference in the natural habitat forming processes.*

- *Productivity of focal fish species requires a network of complex interconnected habitats.*

- *There is a physical connection between the upper and lower Deschutes Subbasin. Changes in land and water uses in the upper watershed could affect the stability of the lower river environment, and thus the distribution and performance of native salmonids. Potential impacts must be understood and considered.*

- *Activities outside the Deschutes Subbasin can have tremendous influence on salmonid production and genetics. Potential impacts of out-of-subbasin programs must be considered and addressed.*

Strategies identified in the Management Plan describe actions needed to fulfill the vision for the Deschutes Subbasin. They are also consistent with, and based upon, the guiding principles. While the vision is a policy choice about how the subbasin will be managed, the guiding principles describe our current understanding of the biological realities that will ultimately determine the success of various resource management solutions.

4. Subbasin Description and Assessment

Physical and Human Landscape

The Deschutes Subbasin stretches over 10,700 square miles of land in central Oregon. Covering eleven percent of Oregon's land area, the Deschutes River subbasin is larger than other Oregon watersheds, except the Willamette. The subbasin extends west to the crest of the Cascade Mountains, south to lava plateaus, east into the Ochoco Mountains and to the plateau between the Deschutes and John Day Rivers, and north to its confluence with the Columbia River. Its length reaches 170 air miles from peaks in the Cascade Mountains to where it joins the Columbia River, 205 miles from the Pacific Ocean. In width, it extends up to 125 miles from the eastern slopes of the Cascades to the western slopes of the Ochoco Mountains, and over the high desert landscape that covers much of the subbasin's interior.

The headwaters of the Deschutes River and most major tributaries receive large amounts of precipitation, but much of the subbasin lies in the rain shadow of the Cascade Mountains and is sheltered from western Oregon's heavy rainfall. Average annual precipitation amounts to more than 100 inches on the eastern slopes of the Cascades, mostly as snow, but drops to only 40 inches in the Ochoco Mountains and 10 inches at lower central locations.

Land ownership in the Deschutes Subbasin is about 51 percent public, 7 percent Tribal, and 42 percent private. The federal government owns and manages most public land in the subbasin, including three national forests, one national grassland and one Bureau of Land Management District. Most of the public land lies in the upper watershed. Lands of the Warm Springs Tribal Reservation extend over approximately 641,000 acres and lie mostly in the lower Deschutes River subbasin. Lands in private ownership cover much of the lower and interior of the subbasin. Many of these private lands support agricultural, forest and range uses.

Population growth in the upper and middle Deschutes watershed continues at a tremendous rate. Deschutes County continues a 20-year trend of leading the state with the highest population growth. The county's population grew about 54 percent between

1990 and 2000 (Hough 2002) and growth is projected to continue. Crook and Jefferson counties, in the central and eastern Deschutes watershed, have also experienced higher levels of growth than other areas in the state. Population growth continues at a much slower rate in Wasco and Sherman counties in the lower Deschutes watershed.

Water Resources

In a natural state, the Deschutes River displayed a unique flow regime that sets it apart from other eastern Oregon rivers. The U.S. Reclamation Service recognized the river's unique character in 1914 and reported

> *"The flow of the river is one of the most uniform of all streams in the United States, not only from month to month, but also from year to year."*

The steady flows through the length of the Deschutes River were primarily due to the volcanic geology of the upper subbasin and substantial groundwater storage. Porous volcanic soils and lava formations absorb much of the snow and rain that falls on the Cascade Basin, creating a large underground aquifer. Much of this groundwater surfaces as springs in the upper and middle watershed. As a result of spring releases, the Deschutes River near its confluence with the Columbia River has a mean monthly flow ranging from 4,388 cfs in August to 7,511 cfs in February (Deschutes River at Moody). The highest monthly flows usually occur in early spring because of snowmelt in the Cascade Range. The lowest flows typically occur in late summer during July, August and September. The average annual discharge for the Deschutes River Subbasin is 4.2 million-acre feet, with the lower watershed contributing about 1.2 million-acre feet to this runoff (O'Connor et al. 2003).

Natural flows in tributaries are often more variable than those in the mainstem Deschutes River. Annual, and sometimes daily, stream flows are particularly changeable in eastside tributaries draining semi-arid lands in the Cascade rain shadow that do not receive abundant groundwater discharges. Stream flows in westside tributaries that drain the wetter, cooler slopes of the Cascades and benefit from groundwater and surface water are generally less variable. For example, flows in the Crooked River are highly variable, while those in the Metolius River fluctuate little.

Today, water regulation by upstream reservoirs and irrigation diversion systems alters the Deschutes River's stable natural flow pattern. Two main water projects on the upper Deschutes River, Crane Prairie and Wickiup Dam, regulate flows in the upper and middle Deschutes River. Water storage and releases create very low flows in the upper Deschutes River above the City of Bend during the winter, when reservoirs are being filled, and very high flows during the summer irrigation season, when water is being released from the reservoirs. Six irrigation diversion canals remove water from the Deschutes River near Bend. Consequently, water storage reduces flows in the middle Deschutes during winter months and irrigation withdrawals reduce flows during summer months. Natural flows in the Crooked River are altered through water storage and releases at Bowman and Ochoco Dams, and other smaller reservoirs, as are flows in the White River system. Flows in the Deschutes mainstem improve substantially near the Pelton Round Butte Complex with spring releases and tributary surface flow.

Water quality in the Deschutes Subbasin varies from pristine to degraded. Some changes in water quality occur naturally because of differences in geography, climate and vegetation. For example, because of their different environmental attributes, water temperatures in most streams on the lower eastside of the subbasin rise naturally to higher levels than those on the west side of the subbasin.

Focal Species and Habitats

The rich landscape and unique flow regime of the Deschutes River subbasin provide a wide variety of habitats for fish and wildlife. Stable flows and habitats in the lower Deschutes River produce healthy salmon, steelhead and resident fish populations. They also support the seasonal migration and rearing habitat for fish produced in tributaries — which often exhibit very different climates, geology and vegetative conditions, and produce fish populations that reflect these differences. Wildlife habitat conditions also vary throughout the watershed. These habitats range from alpine to semi-arid desert areas and support a wide number of big game and furbearing species, including elk, deer, antelope, black bear, beaver, mink, otter, and bobcat, as well as more than 100 species of birds.

Focal Fish Species

Anadromous fish historically ranged as far as Big Falls (RM 132) in the Deschutes Subbasin, but today are restricted to areas below the Pelton Round Butte Complex (RM 100). Spring Chinook and summer steelhead production in the subbasin may expand in the near future if passage is restored past the Pelton Round Butte Complex.

- **Chinook salmon** are an indigenous anadromous species in the Deschutes Subbasin with strong ecological and cultural value. Historically, they returned to the Deschutes Subbasin from spring until fall. Spring Chinook, usually the smallest of the Chinook, returned to the subbasin first. They spawned and reared in the mainstem Deschutes River below Big Falls and in the headwaters of several tributaries. The larger fall Chinook spawned in the lower Deschutes River mainstem. A summer Chinook run is believed to have also once returned to the Deschutes. However, this run was likely lost after construction of the Pelton Round Butte Complex.

  Today, spring Chinook spawning and rearing habitat is concentrated in several small geographic areas, though run information indicates that the stock is fairly healthy and productive (French and Pribyl 2003). Fall Chinook spawn and rear in the lower 100 miles of the Deschutes River mainstem. The size of this run varies considerably from year to year, but is now substantially larger than it was a decade ago.

- Redband trout are a hardy race of rainbow trout generally found in more arid regions east of the Cascade Mountains. Two distinct life forms of redband trout, **resident redband trout** and anadromous **summer steelhead**, are native to the Deschutes River subbasin. Redband trout remain a valued ecological and cultural resource in the Deschutes Subbasin and attract anglers from around the world.

  NOAA Fisheries has identified two demographically independent summer steelhead populations in the Deschutes Subbasin, which are included in the Mid-

Columbia ESU and have been designated as a threatened species under the federal Endangered Species Act. Rationale for this listing included the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead.

- **Bull Trout** in the Deschutes Subbasin are federally listed as threatened. They are part of the Deschutes Recovery Unit, which encompasses the Deschutes River and its tributaries and contains two core bull trout habitat areas separated by Big Falls on the mainstem Deschutes River. The Odell Lake Core Area in the Cascade Range also supports a small remnant bull trout population. Bull trout also have cultural and ecological value in the subbasin. Bull trout included in the Deschutes Recovery Unit are considered at an intermediate risk, while those in the Odell Lake – Davis Lake population are at an increased risk of extinction (USFWS 2002).

- The **Pacific Lamprey** is an indigenous, anadromous species in the Deschutes Subbasin with cultural significance. Historically this species likely had the widest distribution of any of the anadromous species in the subbasin. Today it is confined to the Deschutes River and select tributaries downstream of the Pelton Round Butte Complex.

- **Sockeye salmon** in Suttle Lake, part of the Metolius River system, were an indigenous species that used Link Creek for spawning and Suttle Lake for rearing. While now extirpated from the subbasin, they were selected as a focal species because of their historic ecological value, tribal significance and potential for re-introduction if remedial fish passage issues at the Pelton Round Butte Complex are successful.

Focal Wildlife Species and Habitats

The Deschutes Subbasin displays a large number of wildlife species and habitats. Because of this, the subbasin wildlife assessment identified focal species and habitats. Focal species were selected because of their status as threatened or endangered, cultural significance, and/or value as an indicator of overall habitat condition. Focal habitats were identified based on the amount of decline and sensitivity of the habitat to alteration or degradation.

- **American beaver** was chosen as a focal species because of its unique habitat-altering role in riparian habitats. This unique species alters the riparian habitat by constructing dams across streams to form still-water ponds, building stick lodges in the ponds, felling large trees into the water, and transporting smaller woody material into the aquatic environment.

- The **Columbia spotted frog** represents species that require a permanent-water habitat. Immediate opportunities also exist for habitat restoration in its former range.

- The **white-headed woodpecker** serves as a focal species due to the unique large ponderosa pine tree habitat required by this species, which was of some special concern in the subbasin, and its role as a primary excavator of tree cavities that are used by other species.

- **Mule deer** serve as an example of species that use aspen groves, oak groves, and ungulate winter ranges.

- **Greater sage grouse** represents species with unique habitat requirements within the steppe habitats.

- The **Columbian sharp-tailed grouse** has unique habitat requirements that require a mix of riparian and grassland habitat types within the steppe habitat.

- The **Golden eagle** is protected by the Bald Eagle Protection Act and serves as an example of species that require cliffs and rimrocks for habitat.

Focal habitats evaluated in the wildlife assessment include: riparian wetlands and herbaceous wetlands, interior grasslands, shrub-steppe, Ponderosa pine forest and oak woodlands, lodgepole pine forests, large juniper woodlands, and rimrock and cliff habitat.

5. Key Assessment Findings

The QHA and EDT models provided information on the quantity and quality of stream and riparian habitat. The wildlife habitat assessment provided information about upland watershed habitat changes over the past 150 years. When the QHA/EDT and wildlife habitat information was considered together, it provided good insight into how the ecosystem has changed from the mid-1800's and why.

Assessment findings showed that while many people are now more aware of how different land and water management actions influence stream habitats and overall watershed health, and are changing their management practices, anthropogenic influences since the mid-1850s have weakened the natural biophysical processes that create and maintain healthy fish and wildlife habitats. Watershed conditions began to change as trappers aggressively removed beaver from subbasin streams. Ranchers, farmers and other settlers of European background followed the trappers, and their practices further modified the landscape.

Information generated during the assessments showed that, as the ecosystems in the semi-arid segments of the subbasin unraveled from changes in land use and watershed health, some fish and wildlife populations became isolated, fragmented or extirpated. The important role that beaver played to maintain valley water tables, instream habitat and riparian and floodplain function grew more evident. It also became evident that as important upland habitat types were converted or lost a number of wildlife species were directly impacted, as were watershed characteristics that influence stream flow and water quality.

The QHA, EDT and the wildlife assessment processes helped to identify key factors that have limited, or are limiting, ecological function and biological performance. For example, a general reduction in summer stream flow combined with a general increase in summer water temperatures appreciably reduced fish and wildlife populations and numbers in some stream drainages. The development of extensive irrigation systems and hydroelectric projects placed seasonal and permanent barriers in a number of streams. Out-of-stream water use significantly diminished or altered the natural stream flow regimes. Watersheds degraded by western juniper and exotic plant invasions reduced capabilities to retain precipitation, and flashy stream flow regimes were often the result. These shorter duration, higher peak, stream flows contributed to the scouring or incision of a number of stream channels and loss of natural water storage features. The significant reduction, fragmentation or loss of some important upland habitat types associated with land management and development resulted in the extirpation of Columbia sharp-tailed grouse and the ESA-listing of the Greater sage grouse, as well as apparent reductions in numbers of other focal wildlife species.

Assessment results identified several key changes affecting production of the aquatic focal species in the Deschutes subbasin. Several of the changes also affected wildlife.

- Reduced fish distribution and connectivity from artificial obstructions has resulted in fish population fragmentation, isolation or extirpation.

- Conversion of native upland vegetation led to the introduction of exotic plant species and invasion of western juniper, and reduced the watershed’s ability to collect, store, and slowly release runoff and maintain soil stability.

- Stream flow extremes, especially seasonally low or intermittent flows, are probably the most significant factors limiting fish production in much of the Deschutes River subbasin today.

- Reduced water quality, including high summer water temperatures, limited focal fish species distribution and productivity. It also reduced connectivity between populations and, in some cases, fragmented populations.

- Loss of riparian and floodplain function reduced habitat complexity, contributed to water quality deficiencies, accelerated erosion, reduced water quantity, lowered water tables, and reduced beaver numbers and distribution.

- Loss of instream habitat diversity and complexity reduced focal fish species carrying capacity. Instream habitat, including large wood, boulders or emergent or aquatic vegetation is important for formation and maintenance of pools, braided channels and backwaters.

- Interactions with hatchery fish from the Upper Columbia River Basin pose potential serious genetic risk to wild summer steelhead in the Deschutes subbasin. These interactions could have a long-term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies.

- Indigenous focal fish species have been negatively impacted by the introductions of exotic fish species. Brook trout are of special concern where they have displaced indigenous focal fish species, including redband and bull trout.

In addition, comparisons of historic (1860s) and current vegetative types during the wildlife assessment showed a large-scale loss of interior grassland habitat in the subbasin. This estimated loss or conversion of over 600,000 acres of native grasslands since the mid-1800s created a major shift in wildlife habitat. In addition, large blocks of ponderosa pine, lodgepole pine and shrub-steppe habitats believed to have existed in 1860 have also been fragmented or converted to other habitat types of uses (IBIS 2004).

6. Management Strategies

During the assessment, it became apparent that it will take several decades to achieve the needed level of habitat recovery in many parts of the Deschutes Subbasin. Because the ecosystem's semi-arid nature, geology and vegetation restrict the pace of habitat restoration, remedial measures implemented to restore vegetative diversity and recovery of stream channel stability and diversity will require many years or decades to achieve the desired objective. Consequently, planners selected a twenty-five-year planning horizon for meeting subbasin objectives, instead of the ten to fifteen-year horizon suggested by the Council. This extended recovery period is particularly important for potential restoration of riparian and floodplain function, as well as channel aggradations. In some cases, earlier progress toward recovery of focal fish species will be made. Restoration of fish passage at manmade obstructions or unusual debris jams will frequently produce rapid response when fish begin to access historical fish habitat. The time required to implement these remedial fish passage projects could be substantially less than the time required for stream or upland habitat recovery to produce measurable increases in fish production.

Priority Reaches and Project Areas

During the subbasin assessment process, planners and resource managers concluded that for depressed, fragmented or isolated resident focal fish populations the most effective habitat and population restoration strategy would be to begin with recovery of core populations and core habitat. To provide needed direction, they identified key stream reaches that provide core habitat for focal fish species, including important spawning and rearing habitat, and important habitat for ESA-listed species. These stream reaches were earmarked as high priority reaches during the EDT and QHA analyses. The team determined that these stream reaches deserve high priority protection because of their importance in meeting desired biological objectives during the twenty-five-year planning horizon.

The fish technical team also identified stream reaches with high restoration value to focus future habitat restoration. Restoration of these reaches is needed to meet biological objectives within the planning horizon. These determinations reflected historical focal fish species use and potential for increasing focal fish production, distribution and re-establishing population connectivity. Further, the team identified ten high priority fish habitat restoration projects or scenarios that deserve immediate attention:

1. Trout Creek Fish Habitat Restoration Project
2. Squaw Creek Instream and Riparian Habitat Restoration Project
3. Middle and Upper Deschutes River Instream and Riparian Habitat Restoration Project
4. Lower Crooked River Instream and Riparian Habitat Restoration Project
5. Lake Creek and Link Creek Fish Passage Improvement Project

6. North Fork Crooked River Instream and Riparian Habitat Restoration Project
7. Beaver Creek Instream and Riparian Habitat Restoration Project
8. Tygh and Badger Creek Habitat Restoration Project
9. Lower Deschutes River Instream and Riparian Habitat Restoration Project
10. Pelton Round Butte Fish Passage Restoration Project

Overall Strategy for Habitat Restoration

Conclusions reached during the assessment formed the bases for an overall strategy to direct habitat restoration work in the subbasin. Under this strategy, habitat restoration will center on improving and expanding conditions for focal species in core habitats. The following direction will focus habitat restorations in the subbasin:

- Core habitats will be expanded downstream to build on the benefits of preceeding restoration work.
- In areas where headwater are degraded — or where the system is influenced by flashy or uncontrolled stream flows — habitat restoration for focal fish populations will take place progressively from the upper-most degraded reaches downstream, and restoration projects will include upland restoration work to maintain a ridge top-to-ridge top approach.
- Where headwater areas are in good condition, habitat restoration will begin in at the upper end of a degraded priority reach and work progressively downward.
- In areas where the system is hydrologically stable and habitat restoration is not at risk of loss from an uncontrolled flow situation, the most cost effective habitat restoration opportunities for restoring core fish populations may exist in lower watersheds. In such cases, these projects should be pursued, especially when opportunities become available to work with cooperating landowners.

7. Adaptive Management

The Deschutes Subbasin Plan is a living document. It reflects the current understanding of conditions in the Deschutes watershed. This understanding — as well as the biological objectives, management strategies and actions based on this understanding — will be updated through an adaptive management approach that includes research and evaluation. Under this approach, a structured process is activated to learn from ongoing management and research. Consequently, the subbasin plan contains direction for the development and implementation of a disciplined, and well coordinated, monitoring and evaluation program to help confirm scientific assumptions, resolve key uncertainties and provide the basis for performance tracking and adaptive management. Collecting monitoring data in a way that data can be “rolled-up” to larger scales is essential for information gathered at the scale of watersheds or subbasins to support evaluations at larger geographic scales, such as province or Evolutionarily Significant Unit. Information gained through this process will be used to refine biological objectives and develop new strategies to sustain fish, wildlife and plant communities, as well as provides economic stability for future generations of people in the Deschutes Subbasin.

Introduction — Section 1

Now as in the past, The Deschutes River binds the people of central Oregon together. As the river drops from mountain headwaters to the west, south and east, and through the high desert plateau in the middle and lower watershed, it collects the voices and stories of many people. These people share a love for the Deschutes, though they value the river in many different ways. Some, such as the people of the Warm Springs Reservation, value the river as part of their cultural heritage. For farmers and ranchers, people who make a living from the land and its natural resources, the river provides an important source of water needed for sustaining livestock, forage and cultivated crops. For loggers and mill and factory workers, forests in the basin supply the crop and raw material for income and employment. And for a growing number of people who reside in and outside the basin, the mountains, deserts, rivers of the Deschutes Subbasin provide valuable and diverse recreational opportunities.

The voices of many of people throughout the Deschutes subbasin were heard during the subbasin planning process, and this report reflects their thoughts and ideas. These people face a common challenge. This challenge is to restore and/or sustain healthy fish, wildlife and plant communities, water quality and instream flows in the Deschutes watershed while respecting cultural diversity, strengthening our communities, and providing economic stability for present and future generations.

This Introduction section identifies key participants in the planning process. It summarizes the key opportunities presented for stakeholder involvement and describes the process used to develop the plan with regards to organization and participation. It also identifies the process and schedule for revisiting and updating the subbasin plan after it is reviewed and adopted by the Northwest Power and Conservation Council.

1.1. Planning Entities and Participants

The foundation for this subbasin planning process is the belief that the responsibility for success of subbasin planning ultimately lies with the people of the Deschutes Subbasin. Developing a workable subbasin plan requires commitment and cooperation among various stakeholders: fish and wildlife managers, tribes, governmental agencies and citizens.

With this in mind, the Deschutes Coordinating Group (DCG) became the key coordinating entity in the subbasin planning process. The DCG formed in 2001 with the primary purpose of addressing issues from a subbasin-wide perspective. The group recognizes that fostering communication between people with varying interests in the watershed is key to this effort. The DCG includes representatives from subbasin organizations, watershed councils, cities, counties, irrigation districts, state agencies, and federal and resource management agencies. All meetings of the DCG are open to the public and participation of others interested in the subbasin planning effort is encouraged.

The overall purpose of the DCG's planning efforts goes beyond the requirements of the Northwest Power and Conservation Council's subbasin planning process. The DCG seeks to develop a watershed restoration plan that identifies and prioritizes actions needed to:

- Protect and enhance streamflows to meet water quality standards, instream water rights, fish and wildlife habitat objectives and existing water rights;
- Maintain the resource land base in the subbasin, consistent with acknowledged comprehensive land use plans, and the economic viability of the resource-based economy in the subbasin;
- Meet municipal and industrial water needs over the next 50 years; and
- Promote sustainability and conservation consistent with the custom, culture and quality of life in the subbasin.

The Deschutes Resource Conservancy (DRC) served as fiscal agent for the DCG during the subbasin planning process. The DRC managed the contract between the DCG and the NPCC, as well as other required contracts for services needed to prepare the plan. The DCG also contracted with Wy'East Resource Conservation and Development (Wy'East) to handle outreach and communication, including meetings of the DCG.

1.2. Stakeholder Involvement Process

The organizational structure of the DCG allowed coordination with all the groups actively working on watershed restoration in the Deschutes Subbasin. It is broadly representative of subbasin citizens and their varying interests in the Deschutes Subbasin.

The DCG held monthly meeting across the subbasin to discuss the plan. All those interested in watershed restoration in the subbasin were encouraged to attend and participate and comment. All DCG meetings were publicly notices and a website was set up specifically for the subbasin planning effort. DCG meetings held during the last six months of the subbasin planning process focused on the plan. Individuals serving on the DCG took responsibility to assure that their organizations received regular updates on the planning process so that as many people as possible could track developments as they occurred. DCG members also took a lead in reviewing various sections of the subbasin assessment and plan for accuracy, and in developing the vision, biological objectives, management strategies, and potential actions. The Outreach Coordinator also met with local elected officials, watershed councils and others to keep them informed about the subbasin planning process and receive comments.

The DCG held a series of open houses near the end of the planning process to introduce the plan and receive public comments and suggestions on how it could be improved to meet the needs of the residents in the subbasin. They also distributed 47,000 flyers in newspapers across the subbasin describing the importance of the planning activity and opportunities participate through the open houses and DCG meetings.

Technical teams with participants from ODFW, the Warm Springs Tribes, and other state and federal agencies and technical experts provided regular review and direction during the planning process. These technical experts and other interested individuals met for several work sessions around the subbasin. They provided key information to characterize fish, wildlife and habitat conditions in different Deschutes subbasin drainages. They also commented on draft material through personal communication with members of the subbasin planning team.

Many individuals provided key information, insight and suggestions during the planning process. Although it is impossible to name all of the individuals who contributed, some of the most active participants included Clair Kunkel, Steve Marx, Rod French, Brett Hodgson, Don Ratliff, Clay Penhollow, Chris Brun, Nancy Gilbert, Kyle Gorman, Bonnie Lamb, Roger Prowell, Jennifer Clark, Jason Dedrick, Mike Gauvin, Jeff Rola, Robert Marheine, Daniel Rife, Eric Schulz, Gustavo Bisbal, Rick Craiger, Merlin Berg, Michelle McSwain, Leslie Jones, Patrick Griffin, Ryan Huston, Ted Wise, Peter Lichwar, John Hurlocker, Steve Johnson, Jan Lee, Marc Thalacker, Jerry Cordova, Phil Roger, Jim Nartz, Jim Eisner, Randy Tweeten, Josh Moulton, Chris Rossel, Fara Currim, Marvin Davis, Bill McAllister, Jim Bussard, Dan VanVactor, Hal Lindell, Kolleen Yake, Ellen Hammond, Kimberley Priestley, Gene McMullen, Herb Blank, Jonathan La Marche, Clint Jacks, Bruce Aylward, Glen Ardt, Chris Carey, Russell Johnson, Nate Dachtler, Mike Weldon, Bob Spateholts, Tom Nelson, Amy Stuart, Larry Toll and Terry Luther.

1.3. Overall Planning Approach

Subbasin Assessment Units

To help expedite the subbasin planning process, the subbasin planning technical team broke the subbasin into eight smaller assessment units that generally had similar climatic, hydrologic, biologic and geologic characteristics. The DCG reviewed and approved the assessment units as appropriate areas for assessment and planning. The assessment units often support different salmonid populations and life history characteristics because of their differing environmental conditions. The eight assessment units and their unique characteristics include

- **Lower Westside Deschutes Assessment Unit:** Lower Deschutes River from RM 0 to RM 100, the Warm Springs River and Shitike Creek, and all small tributaries entering the lower Deschutes River, except for Buck Hollow, Bakeoven, and Trout creeks. The assessment unit provides important spawning and rearing habitat for fall and spring chinook, summer steelhead, redband trout, bull trout and Pacific lamprey.

- **White River Assessment Unit:** White River watershed above White River Falls (RM 2). The assessment unit supports production of unique redband trout populations that are genetically and morphologically different from lower Deschutes redband trout. White River Falls prevents anadromous fish access to the assessment unit and isolates populations of redband trout and other resident fish above the falls from those downstream.

- **Lower Eastside Deschutes Assessment Unit:** Major Deschutes River tributaries draining the lower eastern portion of the Deschutes Subbasin, including Buck Hollow, Bakeoven, Trout and Willow creeks. Three of these systems —Buck Hollow, Bakeoven and Trout creeks — provide important spawning and rearing habitat for summer steelhead in the Deschutes Subbasin. All the tributaries also support redband trout.

- **Lower Crooked River Assessment Unit:** Lower Crooked River drainage below Bowman and Ochoco dams, including lower Ochoco Creek and McKay Creek. The assessment unit supports several resident indigenous fish populations, including redband trout. The Pelton Round Butte Complex blocks all anadromous fish access to the drainage.

- **Upper Crooked River Assessment Unit:** Upper Crooked River drainage above Bowman and Ochoco dams, including upper Ochoco Creek, north and south forks of the Crooked River and Beaver Creek. Redband trout are the only native game fish left in the upper basin and reside primarily in the headwaters of smaller tributaries located on forestlands.

- **Middle Deschutes Assessment Unit:** The 32-mile reach of the Deschutes River from the Pelton Round Butte Complex (RM 100) to Big Falls (RM 132) and its two major tributaries, Metolius River and Squaw Creek. . The two major tributaries in the assessment unit once provided important salmonid spawning and rearing habitat, and continue to provide important habitats for bull trout and redband trout populations. The drainages will provide important habitat for reintroduced salmon and steelhead when fish passage is restored at the Pelton Round Butte Complex.

- **Upper Deschutes Assessment Unit:** The upper Deschutes River drainage from Big Falls (RM 132) to Wickiup Dam (RM 222), including Tumalo Creek, Spring River, the Little Deschutes River and Fall River. Big Falls was historically considered the upstream limit of anadromous fish passage. The assessment unit supports resident redband trout.

- **Cascade Highlands Assessment Unit:** The Deschutes River drainages above Wickiup Dam, including the Cascade Lakes. The assessment unit supports redband trout. In addition, the Odell Creek/Odell Lake complex, which is also part of this assessment unit, supports a remnant population of bull trout that is the only known resident, non-reservoir, adfluvial population remaining in Oregon.

Several assessment units used during the subbasin planning process overlap ESA-listed summer steelhead populations identified by the Interior Columbia Basin Technical Recovery Team (TRT). The TRT identified demographically independent summer steelhead populations and habitat areas, which included two populations in the lower subbasin and the historic habitat of an extirpated population in the upper subbasin (Interior Columbia Basin Technical Recovery Team, 2003). The TRT Deschutes River Westside Population occupies the southern end of the Lower Deschutes Westside Assessment Unit. The TRT Deschutes River Westside Population occupies the Deschutes River from the Trout Creek confluence to the Pelton Reregulating Dam and includes Shitike Creek and the Warm Springs River system. The TRT Deschutes River

Eastside Population occupies the Deschutes River and tributaries from the confluence with the Columbia River to the mouth of Trout Creek, except for Warm Springs River. The steelhead habitat the TRT identified above Pelton Dam includes the Metolius and Crooked River systems, as well as the Middle Deschutes River up to Big Falls and Squaw Creek. The subbasin plan breaks this historic steelhead habitat into three assessment units – the Middle Deschutes (Metolius River/ Squaw Creek/Middle Deschutes River), Lower Crooked River system (between Lake Billy Chinook and Ochoco and Bowman dams) and the Upper Crooked (upstream of Ochoco and Bowman dams).

Fish Assessments

Five of the thirty fish species in the Deschutes River Basin have been chosen as aquatic focal species for this subbasin plan: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead/redband trout (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), sockeye salmon (*Oncorhynchus nerka*) and Pacific Lamprey (*Lampetra tridentata*). The five species were selected by the Fish Technical Team, a group of fish and natural resource experts brought together to provide technical advice during the subbasin planning process. The team selected the focal species based on their significance and ability to characterize the health of the ecosystem and the effectiveness of management actions. The list of focal species was then adopted by the Deschutes Coordinating Group for use in subbasin planning. Criteria used in selecting the focal species included a) designation as a federal threatened or endangered species, b) cultural significance, c) local significance, and d) ecological significance, or ability to serve as indicators of environmental health for other aquatic species.

During the subbasin planning process, the technical team used the Ecosystem Diagnosis and Treatment (EDT) and Qualitative Habitat Assessment (QHA) analyses to compare focal fish species needs during different life stages with the conditions existing in various stream reaches. These tools helped to bridge the gap between descriptions of the environment and population performance. The analyses integrate knowledge of the environmental attributes critical to fish with species-specific environmental requirements, reproductive potential and life history strategies to predict the performance of a population subject to current, historic or hypothetical environmental conditions.

The EDT and QHA tools were used to rate stream reaches throughout the assessment units with current or historic anadromous fish habitat for restoration and protection values. Ratings denoted which stream reaches were in the most need for habitat restoration, or simply habitat preservation or protection. The EDT Diagnostic Reports provided finer resolution by noting the presence and severity of habitat limiting factors by summer steelhead or Chinook salmon life stage. These data provided direction for planners to develop draft management objectives, strategies and actions to restore production of focal fish species in these assessment units.

Wildlife Assessment

Focal wildlife species were selected by a team of wildlife biologists considering listed species, and by considering species of concern. Focal species were chosen to represent a “guild” of species whenever possible, for example, the sharp-tailed grouse could represent grassland species, and the sage grouse could represent shrub-steppe species. Seven species were selected: American beaver, Columbia spotted frog, white-headed woodpecker, mule deer, greater sage grouse, Columbia sharp-tailed grouse and golden eagle.

A short list of focal habitats was also selected to represent environmental conditions in the subbasin for focal wildlife species. Focal habitats were selected from the complete list of habitats in the subbasin by examining current habitats compared to historic (1860) habitats at the subbasin level, and selecting those habitats that were reduced significantly from historic acreages.

The wildlife assessment presents information at three different levels of detail for the subbasin: (1) subbasin, (2) assessment unit, of which there are 8 in the subbasin, and (3) hydrogic unit code (HUC) 6th level subwatersheds, at the 1:24,000 scale. There are 341 HUC6 fields in the Deschutes Subbasin (O'Neil p.c.). Focal habitat information for the subbasin was also compared to focal habitat information for the Columbia Plateau Ecoprovince, a larger study area that is made up of 11 subbasins including the Deschutes subbasin. Information from the Northwest Habitat Institute Interactive Biological Information System (IBIS) was used as the primary source of wildlife information for this assessment.

1.4. Process and Schedule for Revising and Updating the Plan

The completed subbasin plan will be reviewed and adopted as part of the Council's Columbia River Basin fish and Wildlife Program, and will help direct Bonneville Power Administration funding of projects that protect, mitigate and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system. The Council, Bonneville Power Administration, NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) intend to use the adopted subbasin plans to help meet requirements of the 2000 Federal Columbia River Power System Biological Opinion. The NOAA Fisheries and USFWS intend to use the subbasin plans as building blocks for recovery of threatened and endangered species.

Further, the Deschutes Subbasin Plan is a living document and plan development will be iterative. Information and direction in the subbasin plan will be revisited and updated through the Northwest Power and Conservation Council's Rolling Provincial Review Process once every three years.

Subbasin Overview
Section 2

The rich landscape and unique flow regime of the Deschutes River subbasin provide a wide variety of habitats for fish and wildlife. Stable flows and habitats in the lower Deschutes River produce healthy salmon, steelhead and resident fish populations. They also support the seasonal migration and rearing habitat for fish produced in connecting tributaries — which often exhibit very different climates, geology and vegetative conditions, and produce fish populations that reflect these differences. Wildlife habitat conditions also vary throughout the watershed. These habitats range from alpine to semi-arid desert areas and support a wide number of big game and furbearing species, including elk, deer, antelope, black bear, beaver, mink, otter, and bobcat, as well as more than 100 species of birds.

The unique landscape of the Deschutes subbasin also attracts large numbers of human residents and visitors to the area. It is highly valued for its quality of life — offering wide, open spaces, a distinct heritage and sense of community, and access to vast natural resources and recreational opportunities.

This overview section looks at the physical, natural and human landscapes of the Deschutes Subbasin. It summarizes how humans have influenced the subbasin's aquatic and terrestrial environments. It describes the subbasin's existing water resources, including its hydrologic regime, water quality and riparian conditions. Finally, it projects hydrologic and ecologic long-term trends that will shape the Deschutes River Subbasin over the next fifty years.

2.1. Physical, Natural and Human Landscape

2.1.1. Location and Size

The Deschutes Subbasin stretches over 10,700 square miles of land in central Oregon. Covering 11 percent of Oregon's land area, the Deschutes River subbasin is larger than other Oregon watersheds, except the Willamette. The subbasin extends west to the crest of the Cascade Mountains, south to lava plateaus, east into the Ochoco Mountains and to the plateau between the Deschutes and John Day Rivers, and north to its confluence with the Columbia River (Map 1). Its length reaches 170 air miles from peaks in the Cascade Mountains to where it joins the Columbia River, 205 miles from the Pacific Ocean. In width, it extends up to 125 miles from the eastern slopes of the Cascades to the western slopes of the Ochoco Mountains, and over the high desert landscape that covers much of the subbasin's interior.

All or portions of nine Oregon counties are situated in the Deschutes watershed. These counties include Crook, Deschutes, Harney, Hood River, Jefferson, Klamath, Lake, Sherman and Wasco. Five of these counties — Crook, Deschutes, Jefferson, Sherman and Wasco — comprise most of the watershed. Larger population centers in the subbasin include Bend, Redmond, Madras and Prineville.

2.1.2. Geology

The landscape of the Deschutes Subbasin — it's volcanoes, cinder cones, lava flows, sandy soils, spring-fed streams, and deep canyons — speaks of the turbulent natural events that shaped the subbasin. The sedimentary, igneous and metamorphic rocks that define its shape range from more than 250 million years old to as young as 1,300 years old (O'Connor et al. 2003). These past activities established the overall northern course of the Deschutes River about 12 million years ago, and carved the present canyon of the lower Deschutes 4 to 1 million years ago (O'Connor et al. 2003). Continuous geologic activity has refined the shape of the Deschutes hydrologic system many times. Periods of mountain building and river relocating volcanic activity across the landscape have been interspersed with periods of erosion and sedimentation associated with glacial activity and stream runoff. Evidence of geological events over millions of years can be traced in the lava fields of the upper Subbasin and in the deep gorge of the lower Deschutes River.

Today, a mosaic of geological footprints forms the Deschutes subbasin. To the west and south, the Cascade Range, an active volcanic arc, molds the high, rugged subbasin rim. Volcanic activity along the crest and volcanic centers along the eastern flanks create a topography of young volcanoes and lava flows. These porous volcanic soils and lava formations absorb most snow and rain that falls on the Cascade Basin and create the large underground aquifer that give the Deschutes and several tributaries naturally stable flows throughout the year.

The eastern rim of the watershed displays some of the Deschutes subbasin's oldest geological roots. These Mesozoic (250 to 65 million years old) and Paleozoic (more than 250 million years old) rocks lay within the headwaters of the Crooked River and Trout Creek drainages. Deposits from the John Day Formation cover most of the Crooked River watershed, including much of the Ochoco and Mutton Mountains. Areas in this ecological province are characterized by extensively geologically eroded, steeply dissected hills of thick, ancient sedimentary materials interspersed with buttes and basalt capped plateaus.

The Columbia River Basalt Group underlies much of the northern, central and eastern parts of the Deschutes watershed (O'Connor et al. 2003). This basalt group, which creates many of the major ridges in the subbasin, is between 1,000 and 2,000 feet thick. Sections of these basalts form the rim of the Deschutes River canyon. Deposits of loess, volcanic ash and pumice from more recent events often cover the basalt flows. This semiarid lava plateau defines much of the Deschutes subbasin landscape.

2.1.3. Climate and Weather

While the headwaters of the Deschutes River and most major tributaries receive large amounts of precipitation, much of the subbasin lies in the rain shadow of the Cascade Mountains and is sheltered from western Oregon's heavy rainfall. Average annual precipitation amounts to more than 100 inches on the eastern slopes of the Cascades, mostly as snow, but drops to only 40 inches in the Ochoco Mountains and 10 inches at lower central locations. Consequently, while the Metolius drainage receives up to 50 inches of precipitation annually, the Bakeoven drainage receives only 10-12 inches.

The climate in much of the subbasin is considered continental, with low precipitation and humidity, large daily temperature fluctuations throughout the year, and high evaporation rates. Cold winters and hot, dry summers are common. Temperatures in the Crooked River watershed, for example, can exceed 100^{o}F in summer and drop below -30^{o}F in winter. The City of The Dalles, located near the subbasin's mouth on the Columbia River, is often the warmest location in the state.

2.1.4. Land Cover

The geology and climate of the Deschutes Subbasin create a diverse landscape of mountain forests, juniper and sage rangelands, rugged outcroppings and deep river canyons. Wetlands and riparian areas account for only a small portion of the subbasin's total acreage. Higher elevations in the subbasin display ponderosa and lodgepole pine forests, wet meadows and savannah-like mountain grasslands. Peaks range from above 11,000 feet in elevation in the Cascades to about 6,500 feet in the Ochoco Mountains. At these highest elevations, where climatic conditions are often extreme, plant communities include hemlock, alpine and subalpine plants. Mid-elevation lands in the upper subbasin support mixed conifer and ponderosa pine forests. Along the upper river corridor, stands of old growth ponderosa pine and lodgepole are often mixed with lush wet marshes in the summer and large expanses of dry meadows.

Below Bend, the forest landscape merges with that of the high desert. Much of this semi-arid plateau is overlain with a blanket of pumice and volcanic ash, and covered by windblown sandy soils (BOR and OWRD 1997). Elevations across the central subbasin drop from 4,000 feet near Bend, to 2,300 feet near Madras, and 98 feet at the river's mouth. The central and lower subbasin is characterized by rolling sagebrush hills, juniper woodlands, scattered ranchlands, irrigated cropland and pastures, and urban and suburban communities. Native vegetation in the area includes sagebrush, bitterbrush, rabbitbrush, wheatgrass and bluegrass. Western yarrow, milk vetch, common woolly sunflower and lupine are common perennial forbs. Riparian communities consist of willow, alder, mock orange, juniper and sedges, with a wide variety of coniferous species at higher elevations. East and west side tributaries to the lower Deschutes often drain very different vegetation conditions, with tributaries on the west side of the subbasin draining lands with higher precipitation than those on the east.

Throughout the subbasin, noxious weeds are rapidly transforming vegetative communities. During the last 20 years, noxious weeds have become a problem along streamsides and on forest, agricultural and residential lands. These plants — including spotted and diffused knapweed; bull, Canada and Russian thistle; Dalmatian toadflax; and other unwelcome species — are quickly replacing native plant communities. The weeds contribute to higher soil erosion and runoff from agricultural and riparian lands.

2.1.5. Land Use and Population

The Deschutes Subbasin has long been a home to humans. American Indian groups — including ancestors to the Warm Springs and Wasco tribes — inhabited areas along the Columbia River and Cascade Mountains for at least 13,000 years before Europeans arrived. Evidence from Newberry Crater at the subbasin's south end indicates that humans inhabited that region at least 10,000 years ago, as did mastodons, camels and other now extinct species (USFS 1996). The middle watershed also supported humans, including the area where the Deschutes, Crooked and Metolius rivers converge. Archeological field inventories conducted for relicensing of the Pelton Round Butte Complex found the largest concentration of both prehistoric and historic sites and isolates near the confluence of these three rivers (CTWS 1999). These early residents probably also fished for salmon, steelhead, Pacific lamprey and other fish species at Sherars Falls.

Today, the Central Oregon region continues to be valued for its quality of life. The subbasin's picturesque landscape, productive natural resources, and outdoor recreational opportunities are essential to this quality of life.

Land Ownership

The Deschutes basin contains an estimated 6,850,700 acres, consisting of 6,797,300 acres of land and 53,400 acres of permanent water (NRCS 1997). The federal government owns about 50 percent of the subbasin, or about 3,380,900 acres. Most of this land, which includes three national forests, one national grassland and one Bureau of Land Management District, lies in the upper watershed. The U.S. Forest Service (31%) and Bureau of Land Management (18%) manage federal lands. State, county and city lands also cover a small percentage of the subbasin. (See Map 2.)

Lands of the Warm Springs Tribal Reservation extend over approximately 641,000 acres, or about 7 percent of the subbasin. Tribal lands lie mostly in the lower Deschutes River subbasin. Almost all land within the reservation boundaries is held in trust by the Bureau of Indian Affairs for the benefit of the Warm Springs Tribes or individual Tribal members. The reservation also includes a small amount of allotted land, which is mostly owned by individual Tribal members. In addition, the entire lower Deschutes River subbasin outside the reservation and most of the upper subbasin were ceded to the U.S. Government by the Tribes and Bands of Middle Oregon through the ratified treaty of 1855. This treaty reserves to the Indians exclusive rights of taking fish in streams running through and bordering the reservation.

Lands in private ownership comprise about 42 percent of the land area in the subbasin. Most of these lands support agricultural, forest and range uses.

Population: Past, Present and Future

The upper and middle Deschutes watershed is currently experiencing tremendous growth, and this trend is expected to continue. The growth rate in Deschutes County, particularly around the cities of Bend and Redmond, has been significantly higher than in most other rural areas. The county continues a 20-year trend of leading the state with the highest population growth. U.S. Census Bureau information indicates that the population of Deschutes County grew 53.9 percent between 1990 and 2000 (Table 2.1)(Hough 2002). This steady growth has continued for more than 30 years, with the county's population more than doubling in size between 1970 and 1990. In 1993, Portland State University's Center for Population Research and Census projected that Deschutes County's population would reach 128,868 people by the year 2010. However, by July 2002 the county had already reached 126,500 people (Hough 2002). The explosive growth in Deschutes County is also higher than most places in the United States. It was marked as the 74th fastest growing county in the nation between 2001 and 2002.

Crook and Jefferson counties have also experienced higher levels of growth than other areas in the state. U.S. Census Bureau statistics indicate that from 1990 to 2000 population growth was 39 percent in Jefferson County and 35.9 percent in Crook County (Hough 2002). Projections suggest these counties will continue to see above average growth for several years (COIC 2002).

Populations in the lower Deschutes watershed have also increased, but at much slower rates. According to U.S. Census information, Wasco County's population grew by 9.7 percent between 1990 and 2000, though less than half the people lived outside the City of The Dalles (Hough 2002). Sherman County remains the least populated county in the subbasin, with a population increase of only 0.8 percent since 1990 (Hough 2002).

Table 2.1. Population Changes for Counties in Deschutes River Subbasin: 1990 - 2000*.

Area	April 1990 Population	April 2000 Population	Population Change 1990-2000
State of Oregon	2,842,321	3,421,399	20.4 percent
Crook County	14,111	19,182	35.9 percent
Deschutes County	74,958	115,367	53.9 percent
Jefferson County	13,676	19,009	39.0 percent
Sherman County	1,918	1,934	0.8 percent
Wasco County	21,683	23,791	9.7 percent

* Census information produced by Population Research Center, Portland State University, 2002.

The influx of new residents has changed the character of some communities and rural areas. While agriculture, wood products, manufacturing, recreation and tourism continue to be primary land uses in the subbasin, some lands are being converted for new uses. Small agricultural towns and irrigation districts — particularly those around Bend — now have large residential development and hobby farms. There is also more demand for recreational areas, which has led to the development of at least seventeen 18-hole golf courses and/or destination resorts in Deschutes County alone.

2.1.6. Economy

The subbasin's economy has changed in pace with its population growth. While twenty years ago, the wood products industry was the leader in manufacturing jobs, many high-tech and cottage industries have appeared in recent years as the timber jobs declined. Today, manufacturing jobs continue to employ many residents, but jobs in construction, retail trade and social services employ a growing number of residents (Table 2.2). The agricultural and cattle industry continue to provide a significant number of jobs, particularly in Crook, Jefferson, Sherman and Wasco counties.

Information prepared by the Central Oregon Intergovernmental Council indicates that jobs in construction and mining led job growth in Central Oregon during the 1990s, with a 94.6 percent increase. This high growth rate reflected the region's expanding population, which led to fast growth in both residential and commercial construction. Jobs in the service industry and finance also grew, increasing 78 percent in Central Oregon from 1990 to 2000. Recent economic forecasts suggest that Central Oregon's economy will continue growing over the next six years, but will place greater emphasis on service-oriented businesses at the expense of manufacturing industries (COIC 2002).

Table 2.2. Percentage of Employment in Industries in 2000, by County (U.S. Census Bureau 2000).

Industry	Wasco	Sherman	Jefferson	Crook	Deschutes
Agriculture, forestry, fishing and hunting, and mining	6.6	19.8	10.3	10.3	2.5
Construction	6.4	6.9	5.4	8.3	11.7
Manufacturing	10.9	6.8	20.2	21.6	10.8
Wholesale trade	3.1	4.0	2.2	2.4	2.7
Retail trade	15.7	10.8	9.3	12.8	15.0
Transportation and warehousing, and utilities	5.6	9.1	3.0	4.0	3.7
Information	2.1	0.1	0.8	1.9	2.5
Finance, insurance, real estate, and rental and leasing	4.2	2.9	3.4	3.5	6.6
Professional, scientific, management, administrative, and waste management services	5.2	2.4	6.0	3.7	8.2
Educational, health and social services	20.6	17.5	16.5	17.6	17.4
Arts, entertainment, recreation, accommodation and food services	10.1	10.3	10.4	5.8	10.4
Other services (except public administration)	5.3	4.0	5.1	4.5	5.1
Public administration	4.3	5.4	7.5	3.6	3.4

2.1.7. Human Disturbances to Aquatic and Terrestrial Environments

Human influences on the hydrology and ecology of the Deschutes Basin extend back more than one hundred fifty years. Watershed conditions, particularly those in the lower Deschutes and Crooked River subbasins, began to change as trappers, ranchers, farmers and other settlers of European background moved into the area. The practices of these people differed from those of Native Americans who had lived in harmony with the watershed, and the water and fishery resources for thousands of years. Reports suggest that by the 1880s, the combination of beaver harvest, irrigation and cattle grazing had significantly affected streams and fish populations in the watershed, especially in the drier, east side tributaries and Crooked River (Lichatowich 1998). Oregon Fish Commissioners noted in their 1880 report to the governor that there were few salmon left in the Deschutes River, causing the Warm Springs Indians to travel to the Clackamas River to obtain their winter supply of fish (OSBFC 1888). Human activities throughout the 1900s continued to affect the river system.

Today, people are more aware of how different land and water management actions influence hydrology, habitat complexity and overall watershed health. As a result, many steps are being taken to correct watershed functions and improve land and water conditions in the watershed. These management changes and restoration measures are improving riparian areas, water quality and stream flows within the basin.

This section discusses past land and water management practices that have disturbed aquatic and terrestrial environments in the Deschutes Basin. It also describes some of the more recent practices that are having a positive influence on watershed conditions.

Beaver Trapping

Historically, beaver were plentiful throughout the Deschutes subbasin. Once scattered along the lengths of the tributary streams, beaver dams slowed high spring flows and recharged adjacent floodplains with water that was released slowly throughout the rest of the year. This natural storage helped produce good flows of high quality water and created habitat diversity, providing overhead and instream cover and a high quality and well distributed gravel substrate. These combined factors helped support salmonids throughout their life cycle, and were particularly important in arid river systems.

Beaver were targeted for their skins in the early 1800s and the Deschutes subbasin became well known for its beaver. Hudson Bay records comment on the large beaver in the Crooked River area, with hides that stretched five feet across instead of the usual three feet ( ). By 1839, the Hudson Bay's Company had harvested a significant number of beaver in the Columbia River Basin, including the Deschutes, and moved north. Loss of beaver greatly affected the ecosystem, particularly on the Crooked River and other eastside tributaries to the Deschutes. Without beaver, these systems became more susceptible to storm events, as well as the effects of livestock grazing and agricultural activities.

Today beaver populations are recognized for their great engineering abilities and contributions to watershed health. Their distribution in the subbasin is beginning to increase with the recovery of riparian vegetation along some stream reaches. Low fur prices during the last decade have also removed pressure on the animals and contributed to a rebounding population.

Livestock Grazing

Stockmen began driving cattle over the Cascades into the Deschutes country around 1857 (ODFW 1997) and continued into the early 1900s. By the late 1800s, grazing by high numbers of sheep, cows and horses was depleting grasslands in the subbasin. These native grasslands were replaced by encroaching sage and juniper communities, and more recently by noxious weeds, which contributed to higher soil erosion and runoff on uplands. The watershed's dry nature also caused livestock to concentrate near streams where they altered riparian vegetative communities. The interaction between high grazing pressure and variable climate (drought followed by intense summer and winter storms), as well as the loss of beaver and its associated habitat, caused streams to erode vertically and laterally, and contributed to the loss of riparian vegetation in the late 1800s to early 1900s (CRLAC 2003). Grazing pressure declined significantly after the early 1900s, but continued to contribute to stream corridor degradation. Stream channels generally continued to unravel, which resulted in a conversion of flow in some streams from perennial to intermittent or ephemeral, as natural water storage was reduced.

Today, livestock grazing in riparian zones of subbasin streams is less common than it was 100 years ago. Grazing practices are being revised to encourage early season use, better livestock distribution, and alter duration, timing, and intensity of use. Improved practices are allowing vegetation to reestablish and streambanks to stabilize. Trees and shrubs in these areas have re-colonized degraded streambanks.

Agricultural Practices

Farmers in the Deschutes Subbasin began converting valley bottoms and natural grasslands for agricultural use in the mid 1800s. This and other changes in land pattern accelerated runoff and natural erosion rates, and altered the timing and amount of water and sediment delivered to streams in some parts of the subbasin. Impacts from agricultural practices were particularly damaging to watershed conditions in some areas of the lower subbasin where soils are more susceptible to erosion — though the level of impact depended on soil type, location and management technique. For example, under some dry land farming methods, land has been left fallow every other year. This practice, though once believed to be state-of-the-art, reduced organic matter in the soil and vastly decreased infiltration rates. Erosion from these fallow fields has been severe, particularly during rain-on-snow events when the ground has been frozen. Natural Resource Conservation Service technicians have measured soil loss on steeper fields up to 300 tons per acre per year (Eddy 1996).

Today, agricultural practices in the Deschutes Subbasin are undergoing important changes. Farming and conservation practices on dry land grain fields have improved. Erosion has also been reduced through the Conservation Reserve Program and other efforts.

Forest Practices

Most forested lands in the subbasin have sustained some level of harvest and roading during the past 70 years. During the early 1900s, many stream systems (and their aquatic and terrestrial resources) in upper subbasin forests were seriously damaged by timber harvest and the transport of logs downstream. Harvesting of trees in sensitive areas, including riparian areas, was a common practice until the early 1990s when forest practice laws were implemented. Merchantable timber was repeatedly removed from streams bottom forests in the Cascade and Ochoco mountains. Woody debris in and near the stream channel was commonly removed.

Such practices affected aquatic and terrestrial species in several ways. Riparian harvest reduced stream shade and led to higher water temperatures. Riparian harvest also depleted future large woody debris that would enhance the stream. Loss of large woody debris led to loss of pools, channel complexity, and channel alteration. Timber harvest also increased sedimentation due to soil disturbance, and altered the timing and quantity of peak flow events (USDA 1989b). Road building associated with timber harvest caused further habitat degradation and sedimentation by increasing the "hydrologic net" of a watershed, increasing peak runoff and sedimentation. In addition, impassable culverts placed at stream and river crossing delayed or prevented upstream fish movement. Soil compaction from timber harvest and roading also contributed to reduced infiltration and the problems mentioned above.

In addition, years of aggressive fire suppression on forestland has produced an unnatural accumulation of explosive fuels and the invasion of fire intolerant tree species. There have been several subbasin examples of the catastrophic impacts of wild fire in recent years. These fires can burn with enough heat to sterilize the remaining soil and substantially increase the time required for watershed recovery, while increasing the risk of soil erosion and stream habitat degradation. Some parallel conditions are also found on historic grassland habitat that has been converted to sagebrush/juniper communities because of land management and fire suppression. Some of these stand replacement fires have also consumed portions of communities and subdivisions during the past two decades.

Positive steps taken in recent years on public and some private forestlands are helping reverse the impacts of timber harvest on fish and wildlife habitat. Efforts are allowing stream recovery and providing shade, streambank stability, and future large woody debris. Inadequate road culverts for fish passage are also being replaced with bridges or open arch culverts where possible, and reconstructed to pass 50-year flood events.

Recreational Use

Concentrated recreational use, commonly associated with campgrounds or day use sites has resulted in the loss or some reduction in riparian vegetation and stream bank stability. Dispersed camping and recreation in localized areas also has contributed to loss of riparian vegetation and trampling and compaction of streamside soils.

Residential and Municipal Development

A recent land use activity affecting aquatic and terrestrial habitats has been the subdividing of land and construction of homes, golf courses and resorts on private lands. This land use began to expand tremendously in the late 1970's and continues today. Since the 1980s, more farmlands have been subdivided to smaller acreages, or converted into hobby farms. Development has also occurred near rivers and stream courses. Results of this growth have been loss and fragmentation of wildlife habitats, loss of riparian structure and habitat vegetation, loss of instream structure from construction of retaining walls and boat docks (such as along the upper Deschutes River), and degradation of water quality from fertilizers, pesticides, and failed septic systems.

Today, efforts are being made to reduce residential and municipal impacts on the environment. For example, while experiencing heavy growth, the City of Bend has become a leader in water conservation and stewardship. Through an aggressive program of water metering, conservation incentives and partnerships, and public education, the city maintained the same peak summer demand in 2003 as compared to 2002 despite 1,000 new service connections (Prowell 2004). Other municipalities in the subbasin are also adopting water conservation programs to use available water supplies more efficiently.

Transportation Network

Transportation corridor development in the lower Deschutes River subbasin began in earnest in the 1850's, efforts began to develop a railroad line into Central Oregon to reach and harvest the basin’s vast ponderosa pine forests. Subsequent railroad construction from 1906 to 1911 along the Deschutes River from the mouth to Warm Springs affected riparian and aquatic habitat. Blasting basalt outcroppings, slope excavation, and side casting excavated material eliminated areas of riparian vegetation and filled sections of river. In addition, culverts installed at tributary stream crossings eventually formed barriers that now preclude upstream fish migration.

Development of a road transportation network in the basin also had some negative impacts on the watershed and water quality. Road construction commonly occurred in stream bottoms and frequently resulted in the loss of riparian vegetation, changes in the channel configuration, filling of the stream channel, and constriction of flow at bridge sites. Road corridors frequently are a source of erosion that culminates in turbidity and sedimentation in adjacent streams. This can be a significant problem when the road is located in close proximity to the stream. Road surfaces have also reduced natural infiltration of water into the soil, which is important for ground water and spring recharge. Roads have acted to divert and concentrate surface water flow, which can exacerbate erosion and stream sedimentation problems.

Irrigation

Settlement of the lower White River country began in the 1850's and orchards were planted in the Tygh Valley area by 1858 (Clark and Lamson, 2003). Water in the Deschutes subbasin was first diverted in 1866 when settlers took water from the South Fork Crooked River (BOR 1980). Water diversions from Squaw Creek began in 1871. In the early 1900s several ditch companies, irrigation districts and municipal improvement districts formed to supply water to farms via storage reservoirs and canals. Soon water rights on several streams were over-appropriated. By 1914, filings for water rights to the Deschutes River above the City of Bend amounted to 40 times the river's flow (Nehlsen 1995). The need for summer irrigation water prompted the construction of irrigation storage reservoirs in the White River drainage, beginning in 1928, to supplement the natural stream flow.

Today, irrigation water is supplied by three large reservoirs in the upper Deschutes subbasin and two large reservoirs in the Crooked River drainage. Water management operations have replaced the stable natural flows in the upper Deschutes River with very low flows during the winter when the reservoirs are being filled, and very high flows during the summer irrigation season, when water is being released from the reservoirs. Below Bend, where most of the water is diverted to meet irrigation needs, summer flows in the middle Deschutes River drop to about 60 cfs. On the Crooked River, Bowman and Ochoco dams also altered natural flow cycles, reversing the size and timing of peak flows.

Smaller storage reservoirs and irrigation diversions also exist on many tributary streams. The White River drainage, for example, contains four reservoirs, including Clear and Badger lakes and Rock Creek and Pine Hollow reservoirs that supply much of the irrigation water to irrigated cropland. Diversion of water for irrigation and storage in Rock Creek and Pine Hollow reservoirs converted the lower reaches of Gate, Rock and Threemile creeks from perennial to intermittent streams for much of the year.

Many early irrigation diversions were unscreened or equipped with inefficient louvers that allowed juvenile fish to become stranded in the canals — particularly before the 1930s when federal screening programs were initiated. In addition, some irrigation structures lacked proper upstream fish passage facilities, which limited adult salmonid access to spawning areas. This contributed to the extirpation of bull trout in the upper subbasin. Fish passage was also restricted in some streams by the annual construction of temporary gravel dams to divert water into irrigation canals or ditches. Water could filter through these gravel dams, but there was no overflow to permit either upstream or downstream fish passage.

Irrigation withdrawals affect anadromous salmonids in several ways. Low summer flows and high water temperatures in diverted stream reaches limit habitat for rearing juveniles. They also restrict fish passage to other areas and connectivity between fish populations. The effects of reduced streamflows are particularly damaging to salmonid populations in degraded stream reaches, which may be wider than they were historically and lack deep pools and other structure that could provide refuge for fish during low flow periods.

The altering of the natural stream flow cycles also affect riparian communities, leaving streambanks and channels unstable, reducing aquatic vegetation and habitat, and seasonally displacing or eliminating some vertebrates and invertebrates. Flow restrictions also contribute to stream channel constriction and simplification. In addition, storage projects interrupt some gravel and large woody material recruitment to lower stream reaches. Inundation of lands for reservoir development affects terrestrial populations.

Today, irrigation districts and other water users in the Deschutes River Subbasin are allocating significant energy and funds toward water conservation and efficiency. With help from organizations such as the Deschutes Resource Conservancy, subbasin irrigation districts are implementing water conservation projects that are putting water back into streams where summer flows have been severely depleted for many years. Recent projects include canal lining and piping, source switches, instream transfers, instream deliveries and water leasing. Such projects are already improving instream flows in the Deschutes River below Bend, where summer flows have increased from as low as 30 cfs during the irrigation season to 60 cfs. In Squaw Creek, water conservation through piping, water leasing, source switching and other projects is expected to provide a permanent flow of 7 cfs in the creek near the town of Sisters, which has largely been dry during summer months since the late 1800s.

Hydroelectric Development

Dams were also constructed on Deschutes Subbasin streams to generate power. Early hydroelectric dams include the Cline Falls Power Company and Cove Power Plant, which were operating by 1901 and 1910, respectively. These early dams did not provide fish passage.

Construction of the largest dam complex in the Deschutes Subbasin began in the late 1950s. The Pelton Round Butte Complex, built on the Deschutes River near RM 100, had a significant effect on fish production in the basin. The complex was constructed with fish passage facilities, but attempts to pass juvenile anadromous fish through the project failed. Consequently, the dam complex blocked anadromous fish from part of their historic spawning and rearing habitat, particularly in the Squaw Creek, Metolius River and Crooked River systems. The dam complex also reduced peak flows in the lower Deschutes River and interrupted some gravel and large woody material recruitment.

The project also altered terrestrial habitats. Much of the upland area inundated by Lake Billy Chinook served as winter range for migratory mule deer. Filling of the reservoirs also inundated a small amount of wetland vegetation. The loss of riparian vegetation reduced cover, breeding and foraging habitat and undoubtedly affected some wildlife species.

Efforts are underway to reestablish anadromous fish passage at the Pelton Round Butte Complex as part of the hydro relicensing process. If successful, these efforts will restore salmon and steelhead to habitats in the Deschutes River between Round Butte Dam and Big Falls, and to available habitats in the lower Crooked River, Metolius River, and Squaw Creek drainages. In addition, project operators are reducing flow fluctuations by keeping the reservoir near full pool. Generally, the reservoir level only fluctuates 6 inches to 1 foot per day from late spring to early fall.

2.2. Water Resources

2.2.1. Watershed Hydrography

In a natural state, the Deschutes River displays a unique flow regime that sets it apart from other eastern Oregon rivers. The U.S. Reclamation Service recognized the river's unique character in 1914 and reported

> *"The flow of the river is one of the most uniform of all streams in the United States, not only from month to month, but also from year to year."*

Historic flows in the Deschutes River were especially uniform in the reach between Benham Falls (RM 180.9) and the mouth of the Crooked River (RM 113.7) (USGS 1914).

The steady flows through the length of the Deschutes River were primarily due to the volcanic geology of the upper subbasin and substantial groundwater storage. Porous volcanic soils and lava formations absorb much of the snow and rain that falls on the Cascade Basin, creating a large underground aquifer. Most of this groundwater discharges into streams in three areas: the southern part of the subbasin in and near the margin of the Cascade Range, the Metolius Basin adjacent to the Cascade Range, and the area surrounding the confluence of the Deschutes, Metolius and Crooked rivers extending downstream to about Pelton Dam (Gannett et al. 2001). Other parts of the subbasin receive lesser amounts of groundwater discharge. Subbasin-wide, the average annual rate of groundwater recharge from precipitation is about 3,800 cfs, with recharge in the low-elevation areas of the central and lower subbasin contributing little to this amount (USGS 2001).

While natural flows in the mainstem are fairly stable, those in tributaries are often more variable. Annual, and sometimes daily, stream flows are particularly changeable in eastside tributaries draining semiarid lands in the Cascade rain shadow that do not receive abundant groundwater discharges. Stream flows in westside tributaries, that drain the wetter, cooler slopes of the Cascades and benefit from groundwater and surface water are generally less variable. For example, flows in the Crooked River are highly variable, while those in the Metolius River fluctuate little. Further, while the Crooked River drains 40 percent of the Deschutes Subbasin, it contributes only 27 percent of the total flow to Lake Billy Chinook and the Metolius River, which only drains 3 percent of the Deschutes Subbasin, contributes 26 percent of the total flow to Lake Billy Chinook (O'Connor et al. 1999).

The Deschutes River near its confluence with the Columbia River has a mean monthly flow ranging from 4,388 cfs in August to 7,511 cfs in February (Deschutes River at Moody). The highest monthly flows usually occur in early spring as a result of snowmelt in the Cascade Range. The lowest flows typically occur in late summer during July, August and September. The average annual discharge for the Deschutes River Subbasin is 4.2 million-acre feet, with the lower watershed contributing about 1.2 million-acre feet to this runoff (O'Connor et al. 2003).

2.2.2. Current Hydrologic Regime

Regulation of the Deschutes River by upstream reservoirs and irrigation diversion systems alters the river's stable natural flow pattern. Two main water projects on the upper Deschutes River, Crane Prairie (1922) and Wickiup Dam (1945) regulate flows in the upper and middle Deschutes River. Water storage and releases create very low flows in the upper Deschutes River above the City of Bend during the winter, when reservoirs are being filled, and very high flows during the summer irrigation season, when water is being released from the reservoirs (Figure 2.1). Flow fluctuations in this upper reach are most significant between Wickiup Dam and the mouth of Fall River, and lessen as tributaries and springs augment flows of the mainstem between Fall River and Sunriver. Water storage and releases in the Little Deschutes River system also alter flow patterns —though the change is less significant than in the Deschutes River. Flow storage in the Little Deschutes system at Crescent Lake and drawdowns for irrigation create an artificial flow cycle in the four-mile reach of the Little Deschutes River below the Crescent Creek confluence, with low flows during winter months and high flows during spring and summer months.

Six irrigation diversion canals remove water from the Deschutes River near Bend (Table 2.3). Consequently, natural flows in the middle Deschutes River below Bend are altered by water storage in upper river projects and by withdrawals for irrigation. Reservoir storage reduces flows during winter months and irrigation withdrawals reduce flows during summer months (Figure 2.2). The median ratio of summer to winter flows from 1961 through 1999 below Bend is roughly 30/600 cfs (OWRD 2001). Irrigators currently release approximately 60 cfs below Bend during the irrigation season, but there is no legally established minimum flow for instream use in the Deschutes River below North Canal Dam. Other irrigation diversions remove water from Deschutes River tributaries, including the Crooked River, Tumalo Creek and Squaw Creek. These diversions also alter natural flow regimes.

Low summer flows between Bend and Lake Billy Chinook are slowly supplemented by flows from Tumalo Creek, Squaw Creek, and natural springs. By the time the river reaches the Pelton Round Butte Complex average summer flows in the Deschutes River increase from 30 cfs to 550 cfs (ODFW 1996).

Natural flows in the Crooked River are altered through water storage and releases at Bowman and Ochoco Dams, and other smaller reservoirs. While natural flows in the Crooked River follow a cycle of spring runoff, with flows peaking in March and April, operations at Bowman and Ochoco dams have altered the flow regime in the streams below the dams. These reservoirs are designed to control flooding and have successfully reduced damaging floods through Prineville for more than 40 years. One exceptional flood in May 1998 occurred outside of the flood control season on Ochoco Dam and did cause substantial damage through Prineville, but this was a highly unusual event and could not have been prevented. The reservoirs provide irrigation water during the summer and as a consequence, the flows below Ochoco Reservoir and, more significantly, below Bowman Dam have benefited by having exceptionally cool water flow at levels near optimum throughout the hot summer months until diversions substantially reduce the flow near Prineville.

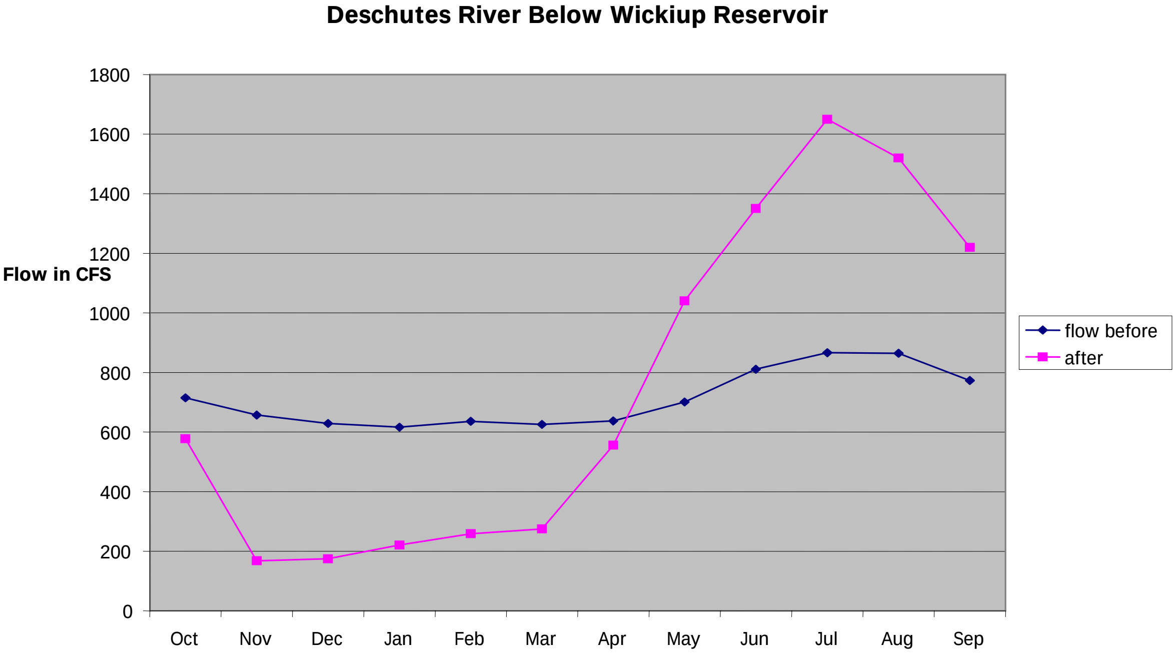


Figure 2.1. Comparison of average monthly flow in the Deschutes River below Wickiup Reservoir before and after construction of Wickiup Dam.

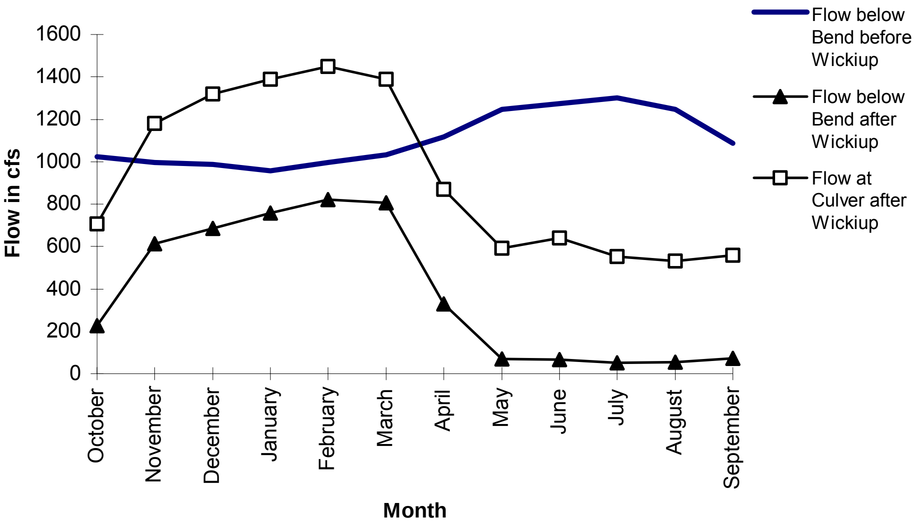


Figure 2.2. Comparison of average monthly flow in the Deschutes River below North Canal Dam in Bend and above Lake Billy Chinook (Culver) before and after construction of Wickiup Dam (Pre-Wickiup Dam data is not available for the Lake Billy Chinook site).

Together, water storage projects in the upper Deschutes and Crooked River systems provide a total of 532,100 acre-feet of storage capacity. The stored water is primarily used for irrigation.

Table 2.3. Storage and Diversion Facilities in the Upper Deschutes River Subbasin.

Name	River mile	Maximum storage/diversion	Irrigation District
Crane Prairie Reservoir	239.0	55,000 acre feet of storage	Lone Pine, Arnold, and Central Oregon Irrigation District (COID)
Wickiup Reservoir	227.0	200,000 acre feet storage	North Unit Irrigation District
Crescent Lake	*	86,050 acre feet storage	Tumalo Irrigation District
Arnold Canal	174.6	135 cfs	Arnold Irrigation District
Central Oregon Canal	171.0	650 cfs	COID
PP&L Hydroelectric (Bend)	166.2	1,325 cfs	
Bend Feed Canal	165.8	150 cfs	Tumalo Irrigation District
North Unit Main Canal	164.8	1,100 cfs	North Unit Irrigation District
North Canal	164.8	600 cfs	COID and Lone Pine Irrigation Districts
Swalley Canal	164.8	120 cfs,	Swalley Irrigation District
PP&L Hydroelectric (Cline Falls)	145.0	90 cfs	
Tumalo Creek (City of Bend)	n/a	21 cfs	
Tumalo Creek (Tumalo Feed Canal)	n/a	180 cfs	Tumalo Irrigation District
Squaw Creek Canal	n/a	150 cfs	Squaw Creek Irrigation District

* Located at head of Crescent Creek

Several smaller reservoirs also store and release water for irrigation. The White River drainage contains four reservoirs, including Clear and Badger lakes and Rock Creek and Pine Hollow reservoirs that supply much of the irrigation water to the 8,640 acres of irrigated cropland. There are up to eighteen irrigation diversions that supply irrigation canals or ditches that in turn convey the water from streams in the drainage to the specific points of use. Most of these diversion structures lack provisions for fish passage or protective screening (ODFW 1985).

Diversion of water for irrigation and storage in Rock Creek and Pine Hollow reservoirs converted the lower reaches of Gate, Rock and Threemile creeks from perennial to intermittent streams for much of the year. The lower reaches of other streams, including Badger, Tygh, and Boulder creeks, have also seen substantial reductions in summer flow because of upstream irrigation water withdrawals. The irrigation water delivery system that carries water to storage impoundments and individual landowners in the Juniper Flat and Wamic areas is comprised of many miles of open, earthen ditches and canals. These ditches and canals are believed to be relatively inefficient due to the potential for significant water loss through leakage and evaporation between the source and the eventual destination (ODFW 1997).

Flows improve substantially in the Deschutes River below the Pelton Round Butte Complex. The total average annual flow past the USGS gage below Round Butte Dam is 3,279,000 acre-feet, or 4,519 cfs. Much of the flow can be attributed to large amounts of groundwater entering the system through springs within the Metolius drainage, and into the Deschutes and Crooked canyons shortly above the Pelton Round Butte

Complex. Because of groundwater releases and surface flows from tributaries, flows in the lower Deschutes River are more stable than those above the dam. Flows in the lower Deschutes River have exceeded 3,200 cfs 99 percent of the time, but have only exceeded 9,040 cfs 1 percent of the time since 1965 (Huntington 1985, O'Connor et al. 2003a).

Since the early 1980s, most fish bearing streams in the Deschutes River Basin have received instream water rights. Table 2.4 shows some of these instream flow water rights. Because instream water rights generally have more recent filing or priority dates, they tend to be the most junior water right on a particular stream. For instream water rights that are most junior in priority date, there are no junior users to be regulated in order to achieve target instream flows. There are, however, two instream water rights in the lower Deschutes River Subbasin that are the result of conversion of minimum perennial stream flows. These instream water rights have older priority dates and water rights with junior dates could be regulates in times of shortage.

2.2.3. Water Quality

Water quality in the Deschutes Subbasin varies from pristine to degraded. Some changes in water quality occur naturally because of differences in geography, climate and vegetation. For example, because of their different environmental attributes, water temperatures in most streams on the lower eastside of the subbasin rise naturally to higher levels than those on the west side of the subbasin. In addition, sediment levels in the White River, which drains glaciers on Mt. Hood, are naturally much higher than in other nearby rivers.

Water quality in several parts of the subbasin, however, is affected by human practices. A number of stream segments in the Deschutes Subbasin have been declared water quality limited by the Oregon Department of Environmental Quality under Section 303(d) of the Clean Water Act (Map 3). Water quality standards are violated on some streams for temperature, sedimentation, pH, dissolved oxygen, flow modification and habitat modification. Of these, temperature, flow and pH are primarily summer concerns. Dissolved oxygen is primarily a summer/fall concern. Exceeding these standards indicates potential problems for fish populations. Water quality concerns in the different assessment units and in different stream reaches within the subbasin are discussed in Section 4, Environmental Conditions and in Appendix II of this document.

Table 2.4. Selected Instream Flow Water Rights in the Deschutes Subbasin (Gorman 2004).

Stream	Priority Date	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Deschutes R., Pelton Dam to Mouth	10/2/1989	3000	3000	3500	3500	3500	3500	3000	3000	3000	3000	300	3000
Deschutes R. Pelton Dam to Mouth	1/16/1991	4500	4500	4500/ 4000	4000	4000	4000	4000/ 3500	3500	3500/ 3800	3800	3800	3800/ 4500
Deschutes R., Wickiup to Little Deschutes	11/3/1983	300	300	300	300	300	300	300	300	300	300	300	300
Deschutes R., L. Deschutes to Spring R.	11/3/1983	400	400	400	400	400	400	400	400	400	400	400	400
Deschutes R., Spring R. to North Canal D.	9/24/1990	660	660	660	660	660	660	660	660	660	660	660	660
Deschutes R., North Canal D. to LBC	3/21/1990	250	250	250	250	250	250	250	250	250	250	250	250
Trout Cr., Antelope C. to Mouth	5/9/1990	25	67/73	73	73	73	33.5	6.19	1.94	1.94	2.83	9.67	25
Trout Cr., Clover C. to Antelope C.	10/11/1990	25	67/ 72.9	73	73	54.5	16.4	2.98	0.93	0.93	1.3	4.09	15.8
Tumalo Cr.	10/11/1990	47	47	68.7	76.6	82	47	32	32	32/47	65.3	47	47
Squaw Cr., Indian Ford Cr. To Mouth	10/11/1990	33	33	50	50	50	33	33	33	33	33	33	33
Squaw Cr., SF Squaw Cr. To IFC	10/11/1990	30	20	20	20	20	20	10	20	20/30	50	30	30
L. Deschutes R., Crescent Cr. To Mouth	10/11/1990	200	200	236	240	240	200	126	74.5	92.2	116	164	196
L. Deschutes R., RM 72 to Crescent Cr.	10/11/1990	52.7	60	61.6	75	75	60	40	37.4	34.6	35.1	36.8	39.9
L. Deschutes R., Headwaters to RM 72	10/11/1990	34	34	44.8	62.1	68	34	34	34	32.8	33.3	35.3	37.8
Ochoco Cr., Ochoco Dam to Mouth	8/30/1990	23	23/35	45	45	45	35	14.7	6.27	6.5	6.89	8.62	23
Crooked R., NF Crooked to Prineville Res.	5/11/1990	50	50/75	113	113	113	75	50	47.8	50	50	50	50
Crooked R., Prineville Res to mouth	5/11/1990	75	75/ 150	255	255	255	150	75	75	75	75	75	75
Metolius R., Canyion Cr. To LBC	9/19/1990	200	200	335	335	335	200	200	0/335	335	335	335	335
Metolius R., springs to Canyon Cr.	9/19/1990	110	110	185	185	185	110	110	0/185	185	185	185	185
White R.	10/2/1989	60	100	145	145	145	100	60	60	60	60	60	60

2.3. Hydrologic and Ecologic Trends

2.3.1. Macro-climate and Influence on Hydrology and Ecology

Over the last century, the region has seen natural multi-decade swings in climate. Generally, the region experienced warming from the 1920s to 1940s, cooling in the 1950s and 60s, and more warming from the 1970s through 1990s. These changes affected temperature ranges and snow accumulations that influenced hydrology and ecology throughout the Northwest, including the Deschutes Subbasin. Such natural multi-decadal cycles will continue to influence hydrologic and ecologic trends in coming years.

Some scientific studies indicate that natural climatic trends will be further affected by human-induced actions, including global warming (Mote et al. 2003). For example, studies by climatologist Phil Mote (2003) indicate that snowpack levels have dropped considerably throughout the west in response to a 0.8°C warming since the 1950s. They also reveal that if moderate regional warming predictions for the next fifty years come true, western snowpacks will be reduced by up to 60 percent in some areas, including in Oregon's Cascade Mountains. This would in turn reduce summer stream flows in some areas by 20 to 50 percent (Mote et al. 2003). Other climatologists, however, believe future trends will be less severe. According to George Taylor, state of Oregon climatologist, the effects of human induced global warming will be small compared to effects from multi-decadal cycles.

In the Deschutes Subbasin, impacts from possible climatic changes will likely be mixed. Warmer temperatures will mean precipitation falls more as rain instead of snow, particularly at lower elevations. This will have little influence on flows in the Deschutes River and other streams that receive large contributions from groundwater. However, it may alter flow cycles in systems that respond primarily to surface runoff. Less snow will mean earlier and lower spring runoff, with possible increases in winter flooding, and less water available for summer use. Streams with warmer temperatures and reduced summer flow will affect focal fish production, water quality and water availability for different water users.

Temperature changes may also reduce the amount of water stored naturally in upland areas for later use. Warmer temperatures could increase that rate at which plants use water and some plants would be weakened by drought conditions (Mote et al. 2003).

2.3.2. Human Influence on Hydrologic and Ecologic Trends

In recent years, people across the subbasin have initiated strong actions to improve flows and watershed health in the Deschutes ecosystem. Together, these actions will have a significant impact on future hydrologic and ecologic conditions in the Deschutes watershed.

Recent studies show that water use in the subbasin is already changing. Because of the conversion of traditional farmland to hobby farms or uses that are less water-intensive, and because of added improvements in water conservation and conveyance, water demand in most irrigation districts has decreased over time. Over the last 36 years, diversions for irrigation on the Deschutes River and Tumalo, Squaw, Crescent and Ochoco creeks have declined from about 870,000 acre-feet to about 640,000 acre-feet, a reduction of 230,000 acre-feet. They have averaged 640,000 over the last five years (Gorman 2004). These water savings, however, have not been seen instream. Water rights in many streams are over-allocated and saved water goes to junior water uses. Water saved from out-of-stream use often only stays instream when protected through Transfers or the Conserved Water Statute.

Steps are also being taken to restore watershed health, and these efforts are expected to increase in the future. Soil and water conservation districts, watershed councils and others are working with landowners to improve farming and conservation practices on upland watersheds. Restoration efforts include terracing fields and/or constructing water and sediment control basins to reduce erosion and the amount of sediment that enters the water. Erosion has also been reduced through placement of lands in the Conservation Reserve Program. Along the riparian corridors, restoration takes the form of planting native vegetation to increase habitat, or fencing streams to exclude livestock. At home, subbasin residents are beginning to reduce water use by watering their lawns efficiently, planting vegetation that require smaller amounts of water, buying water and energy smart appliances, and generally using water wisely.

With implementation of these and other steps to improve water use and restore watershed lands, many streams and rivers of the Deschutes Subbasin will take on a new look in fifty years. Fortunately, the river environment is very resilient. For example, riparian fencing in the Trout Creek and Warm Springs River systems and along the lower Deschutes River has allowed vegetation to reestablish and stabilize stream banks. Alders are now common along sections of the lower Deschutes River where few stood before riparian exclosure fencing. Instream habitat projects on the Warm Springs River and Trout Creek have increased both quantity and quality of fish habitat.

Control of flows and sediment from the uplands and improvements in riparian areas will allow stream systems to regain natural functions. Drainages will release rain and snowmelt to streams more slowly, improving summer stream flows and keeping water temperatures from reaching levels that are lethal to fish populations. Well-developed riparian areas will also act to reduce the extremes of flow. Well-developed stream channels and associated higher water tables will hold more water during the wet season and release water slowly during the dry season allowing streams to flow year-round. However, these increased flows not be available to improve habitat conditions for fish and wildlife if diverted out-of-stream by junior water uses.

Improvement of conditions within riparian corridors will also increase the amount of large woody debris within streams where the cover is now lacking. Generally, the more instream habitat diversity created by large woody material, the greater the rearing potential for fish.

If current efforts are successful to provide anadromous fish passage around the Pelton Round Butte Complex, salmon and steelhead will regain habitat in the upper Deschutes River Subbasin. The productivity of these returning anadromous fish will depend greatly on the amount and quality of habitat they find in tributary habitats. While conditions in the Metolius River remain good, conditions in Squaw Creek, the Crooked River and many other tributaries beg for improvement.

In addition, with projected growth in the Bend/Redmond area, meeting this demand will require that new water rights issued from groundwater mitigate their use. Projections suggest that there is ample water to meet current and future demands. However, to meet present and future water needs in the subbasin, residents need to accelerate actions to modify inefficient water policies and water delivery. To meet increasing future water demands — while at the same time protecting water quality and restoring critical fish and wildlife habitat — steps must be taken to re-allocate water to increase stream flows in critical areas. At the same time, new approaches must be created for developing or transferring groundwater and surface water to places where it is needed. The Oregon Department of Water Resources had enacted the Deschutes Basin Groundwater Mitigation Program, which requires any new water right issued in the basin within the USGS Groundwater Study Area to mitigate the consumptive use of the new water right (Gorman 2004). To meet the mitigation requirements, an applicant will have to provide an equal amount of water instream whether by a temporary instream lease or permanent transfer. Already, this mitigation water is being provided in Squaw Creek and the Middle Deschutes River (Gorman 2004).

Further, some irrigation water storage will be lost over the next 50 years as reservoir capacity declines. There are efforts underway to provide increased minimum flow releases below the reservoirs in the Upper Deschutes Subbasin, including the Crooked River drainage. The U.S. Bureau of Reclamation has a target of 75 cfs outflow from Prineville Reservoir in the winter when water is available, which is above 10 cfs (Gorman 2004). The local Watermaster's office has implemented the ramping rates for the outflow from Wickiup Reservoir as outlined in the Upper Deschutes River Wild and Scenic River Management Plan (USFS 1996). In addition, the Tumalo Irrigation District has voluntarily released a minimum of 5 cfs from Crescent Lake to protect instream flow values. There is no minimum from this impoundment (Gorman 2004).

2.4. Regional Context

2.4.1. Relation to the Columbia River Basin

The Deschutes Subbasin is a major subbasin of the Columbia River and the second largest river drainage system in Oregon. The annual average subbasin runoff to the Columbia River is 4.2 million acre feet. There are only five other, within-Oregon, watersheds that have greater annual runoff (Aney 1967).

Historically the subbasin was an important Columbia River contributor of spring, summer and fall Chinook salmon, sockeye salmon, summer steelhead and Pacific lamprey. In addition, the historic Deschutes meta bull trout population had cohorts that intermingled in the Columbia River with bull trout from other meta populations.

Today, The Deschutes Subbasin, which lies above two Columbia mainstem dams, continues to be an important contributor to salmon and steelhead runs in the Columbia River Basin. In addition, the cool water plume at the mouth of the Deschutes River provides temporary refuge for salmon and steelhead migrating to upriver tributaries.

2.4.2. Relation to the Ecological Province

The subbasin is part of the Columbia Plateau Province. This province, or eco-region, is one of eleven eco-regions that make up the Columbia River Basin. The provinces are groups of adjoining subbasins with similar climates and geology. The Columbia Plateau Province covers approximately 45,275 square miles and extends over much of north central and northeast Oregon, southeast and south-central Washington, and a small part of western Idaho.

2.4.3. NMFS Evolutionary Significant Units (ESUs)

Deschutes River summer steelhead are included in the Mid-Columbia ESU. This ESU includes the portion of the Columbia River Basin from the Wind and Hood rivers on the west, and extends up to and includes the Yakima River in Washington. Summer steelhead within this ESU were federally listed as threatened on March 25, 1999 (NMFS 1999).

2.4.4. USFWS Designated Bull Trout Planning Units

The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout, including the Deschutes subbasin populations, as a threatened species under the Endangered Species Act on June 10, 1998 (63 FR 31647) (USFWS 2002). Bull trout are currently listed on the Oregon Sensitive Species List (OAR 635-100-040) as Critical.

The Deschutes subbasin contains two designated Bull Trout Planning Units, the Deschutes Recovery Unit and the Odell Lake Recovery Unit. Bull trout are distributed among five or more local populations in the Deschutes Recovery Unit, with five or more local populations in the lower Deschutes Core Area. In the Odell Lake Recovery Unit, bull trout are distributed among one or more local populations, depending on whether fish are found to exhibit homing fidelity to individual streams.

2.4.5. National Wild and Scenic Rivers and Oregon State Scenic Waterways

Several sections of the Deschutes River and its tributaries have also received special protection through designation as national wild and scenic rivers and/or state scenic waterways (tables 2.5 and 2.6). (See Map 4.)

The Wild and Scenic Rivers Act of 1968 provides for the protection and enhancement of Outstandingly Remarkable Values of free-flowing and other natural river sections. Under the Act, rivers are designated as recreational, scenic or wild. Recreational rivers are defined as *“Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.”* Scenic rives are defined as *“Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.”* Wild rivers are defined as *“Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.”*

The Oregon Scenic Waterways Act, adopted in 1970 and amended in 1988 under the Oregon Rivers Initiative, provides further protection for Deschutes subbasin rivers. The program are designed to protect and enhance the scenic, aesthetic, natural, recreation, and fish and wildlife values along selected rivers.

Table 2.5. National Wild and Scenic Rivers in the Deschutes Subbasin.

Section	Description	Designation
Deschutes R.	Mouth to Pelton Rereg. Dam (RM 0-100)	Recreation
Deschutes R.	Lake Billy Chinook to Odin Falls (120-140)	
Deschutes R.	Bend UGB to Lava Island Camp (172-175)	Recreational
Deschutes R.	Lava Island Camp to Sunriver (RM 175-186.2)	Scenic
Deschutes R.	Sunriver to Wickiup Dam (RM186.2 to 226.7)	Recreational
White R.	Mouth to forest boundary	Scenic: 24.3 miles Recreational: 22.5
Metolius R.	Lake Billy Chinook to Bridge 99 (RM 12-29.1)	Scenic
Metolius R.	Bridge 99 to Metolius Springs (RM 29.1-41)	Recreational
Squaw Cr.	Gauging station to wilderness boundary (8.8 m)	Scenic
Squaw Cr.	Wilderness boundary to source (6.6 miles)	Wild
Crooked R.	National Grasslands boundary to Dry Creek	Recreational
NF Crooked R.	One mile above mouth to source (RM 1-33.3)	Wild: 11.1 miles Scenic: 9.5 miles Recreational: 11.7
L. Deschutes R.	Hemlock Cr. To headwaters (RM 84-97)	
Crescent Cr.	County Rd. to Crescent Lake Dam (RM 18.5-30)	Recreational
Marsh Cr.	Mouth to headwaters (RM 0-15)	Recreational

Table 2.6. Deschutes Subbasin Scenic Waterways.

DESCHUTES SUBBASIN SCENIC WATERWAYS		
Section	**Description**	**Data/Method of Designation**
Lower Deschutes	Pelton Rereg-dam to mouth, except City of Maupin	1970 initiative
Below Bend	Sawyer Park to Tumalo Park, Deschutes Market Road to Lake Billy Chinook	1988 initiative 1987 legislation and 1988 initiative
Below Harper Bridge	Harper Bridge to Bend Urban Growth Boundary (RM 171)	1987 legislation and 1988 initiative
Below Wickiup Dam	Gage to General Patch Bridge	1987 legislature
Below Lava Lake	Lava Lake to Crane Prairie Res.	1988 initiative
Metolius River	Headwaters to Candle Creek	1988 initiative

Focal Species Characterization
Section 3

This section summarizes key characteristics of focal fish and wildlife species selected to evaluate the health of the Deschutes Subbasin ecosystem and the effectiveness of management actions in the subbasin. Each focal species is described in terms of its special ecological, cultural and/or legal value, abundance and distribution, key life history strategies and habitats, genetic integrity, and population trends. More detailed discussions of the focal species can be found in Appendices I and III.

3.1. Focal Species Selection

Five aquatic species and seven terrestrial species in the Deschutes River Subbasin have been chosen as the focal species for this subbasin plan. The five aquatic focal species include: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead/redband trout (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), sockeye salmon (*Oncorhynchus nerka*) and Pacific Lamprey (*Lampetra tridentata*). The seven terrestrial focal species include: American beaver, Columbia spotted frog, white-headed woodpecker, mule deer, Greater sage grouse, Columbian sharp-tailed grouse, and golden eagle. These five aquatic species and seven terrestrial species are all indigenous to the Deschutes Subbasin.

Focal species were selected based on their significance and ability to characterize the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species included a) designation as a federal threatened or endangered species, b) cultural significance, c) local significance, and d) ecological significance, or ability to serve as indicators of environmental health for other aquatic or terrestrial species.

The focal species are characterized below. Section 3.2 summaries characteristics of the aquatic focal species. These characteristics are discussed in more detail in Appendix I. Section 3.3 summarizes characteristics of the terrestrial focal species in the Deschutes Subbasin. These characteristics are further described in Appendix III. In addition to the focal species, the Deschutes River Subbasin supports more than thirty species of indigenous and introduced fish (Appendix I) and numerous amphibians, reptiles, birds and mammals (Appendix III).

3.2. Aquatic Focal Species

3.2.1. Chinook Salmon

Historically Chinook salmon returned to the Deschutes Subbasin from spring until fall. Spring Chinook, usually the smallest of the Chinook, returned to the subbasin first and spawned primarily in the headwaters of major tributaries, including the Metolius and Crooked rivers. The larger fall Chinook spawned in the lower Deschutes River mainstem. A summer Chinook run is thought to have also once returned to the Deschutes. However, this run is believed to have been lost after construction of the Pelton Round Butte Project. Today, research suggests that only two indigenous races of Chinook salmon — spring Chinook and summer/fall Chinook — spawn and rear in the Deschutes Subbasin. During the past 30 years, fish managers have not found any temporal or spatial separation during spawning in the lower Deschutes River that could verify distinct populations of summer and fall Chinook salmon within the subbasin. Both segments of the run appear to spawn in the same areas during the same time period and interbreeding between the two has been suspected for many years, suggesting that only one run exists. For simplicity, this plan will consider this protracted Chinook salmon run as the Deschutes River fall Chinook salmon population.

Importance

Chinook salmon are an indigenous anadromous species in the Deschutes Subbasin with strong ecological and cultural value (Table 3.1).

Table 3.1. Rationale for Selection of Chinook as a Focal Species.

Species Designation	Species Recognition	Special Ecological Importance	Tribal Recognition
Spring Chinook salmon are not an ESA-listed species in the Deschutes River subbasin or the Mid-Columbia ESU. The Mid-Columbia ESU fall Chinook populations, including the Deschutes River population, were proposed for ESA listing, but it was determined that a listing was not warranted.	Deschutes River Chinook have provided an important food source for Native Americans over hundreds, if not thousands of years. Once harvested at many sites within the subbasin, including Sherars Falls on the lower Deschutes River. Fall Chinook were generally preferred for drying since their flesh contained less oil than the spring Chinook. Today Chinook continue to provide important recreational and traditional fisheries, also near Sherars Falls.	An important food source for a variety of wildlife. Chinook die shortly after spawning and their carcasses provide marine derived nutrients that have wide-reaching benefits to the biota of the subbasin, including aquatic insects, aquatic and semi-aquatic plants and, indirectly, terrestrial plants. Chinook also till the gravel substrate during spawning. This helps prevent cementing or embeddedness and benefits production of macro invertebrates and other aquatic species.	Strong cultural, religious and subsistence values for Native Americans throughout the Pacific Northwest, including the Warm Springs Tribes. Salmon are considered part of the spiritual and cultural identity of the Indian people. They also have commercial value, and historically were the center of an important trade economy between various tribes. Fishing is still the preferred livelihood of some tribal members.

Characteristics that define spring and fall Chinook salmon populations in the Deschutes Subbasin are summarized in the following section. The runs are described in more detail in Appendix I.

Spring Chinook

Population Abundance

Historically, the Deschutes River system may have supported four times as many spring Chinook salmon as it does today. A robust meta population once spawned and reared in the mainstem Deschutes River below Big Falls and in several tributaries including

Shitike and Squaw creeks, and the Warm Springs, Crooked and Metolius river systems (Map 5). Population abundance dropped after the early 1800s — particularly in the Crooked River and Squaw Creek systems — due to watershed alterations and water withdrawals. The spring Chinook population faced further declines in the early and mid-1900s. The Cove Power Plant, built around 1910 on the lower Crooked River, barred upstream spring Chinook spawners at low flows and Ochoco Dam, built 10 miles above the mouth of Ochoco Creek in 1922, further blocked fish passage (Nehlsen 1995). All spring Chinook production in tributaries and mainstem reaches of the Deschutes River above RM 100 was lost in the late 1960s when anadromous fish passage failed at Pelton and Round Butte dams. The Pelton Round Butte hydro project operator and fishery managers at the time estimated the average pre-dam spring Chinook run past the dam sites at approximately 1,200 adults. This number reflected fish counts made before and during construction of the project.

Today, both wild and hatchery spring Chinook return to the Deschutes Subbasin. The wild spring Chinook run averages 1,780 adults and returns to spawning grounds in the Warm Springs River and Shitike Creek drainages on the Warm Springs Reservation. Fish managers have no evidence that wild spring Chinook spawn in the mainstem lower Deschutes River or other tributaries. Run size varies considerably from year to year, with annual wild spring Chinook numbers since 1977 ranging from 241 to 3,460 fish (French and Pribyl 2004). These numbers could increase in the near future if passage past the Pelton Round Butte Project is restored.

Currently, the Warm Springs system produces most wild spring Chinook in the Deschutes River Subbasin. The natural smolt production capacity of the Warm Springs River system is estimated to be 132,000 smolts (ODFW 1977). The number of juvenile spring Chinook migrants averaged 78,736 for brood years 1978 through 1998. The total number of fall and spring migrants (age-0 and age-1+ spring Chinook) from the Warm Springs River ranged from 3,784 fish to 155,225 fish for the 1975 through 1998 broods (CTWS unpublished data). Tribal spring Chinook redd counts in the Warm Springs system since 1982 show an average of 341 redds counted per year, with a range from 62 in 1995 to 752 redds in 2001. A smaller wild spring Chinook run returns to Shitike Creek. Spawning ground counts show that an average of 49 adult spring Chinook escaped annually to Shitike Creek between 1982 and 1995 (ODFW 1997). This population is believed to be composed entirely of wild spring Chinook. All 17 spring Chinook carcasses sampled in Shitike Creek from 1986 through 1995 were wild fish (CTWS, unpublished data).

The subbasin also supports a run of hatchery spring Chinook. From 1993 to 2002, an average of 4,778 hatchery spring Chinook (4,103 adults and 675 jacks) returned to the Deschutes Subbasin. Spring Chinook salmon smolts are reared and released from two hatcheries in the subbasin: Round Butte Hatchery, operated by ODFW since 1973, and Warm Springs Hatchery, operated by USFWS since 1980 (ODFW 1997). Round Butte Hatchery raises about 300,000 spring Chinook yearling smolts annually for release into the Deschutes River. Annual releases from this hatchery include 230,000 yearling spring Chinook smolts immediately below Pelton Reregulating Dam to meet adult mitigation requirements, and 65,000 to 70,000 yearling smolts at the same site as part of a study to evaluate innovative fish rearing cells in the Pelton Fish Ladder (ODFW 1997). Warm Springs Hatchery currently raises up to 750,000 juvenile spring Chinook for release in the Warm Springs River. Approximately 10% of the juvenile Chinook produced annually at Warm Springs Hatchery voluntarily migrate from the hatchery in the fall as age-0 fish. The remaining juveniles are released as age-1 smolts the following spring. Since 2000, adult hatchery spring Chinook have also been outplanted in Shitike Creek below Peters Pasture (RM 23). These releases included 159 fish in 2000, 200 fish in 2001 and 80 fish in 2002. The program is scheduled to continue when there are adequate numbers of hatchery adults available at Warm Springs Hatchery (Gauvin 2003).

Key Life History Strategies

Wild spring Chinook adults return to the Deschutes River from March through June. Generally, the first spring Chinook reach Sherars Falls in early to mid-April and the run peaks at Sherars Falls in early to mid-May. Most spring Chinook pass above Sherars Falls by mid-June. About 80% of the spring Chinook run returns to the Deschutes after two years in the ocean (age-4 at spawning). Roughly 5% of the run returns as 3-year old jacks and 15% returns as age-5 adults (PGE 1999).

For several months before spawning, adult fish seek secure holding areas with good water quality in the mid-reaches of Shitike Creek and the Warm Springs River. They move upstream to spawning areas shortly before spawning during August and September. Spawning generally occurs in smaller headwater stream reaches with abundant clean gravel substrate and good instream and overhead cover. Fry emerge from the gravel in February and March. Fry and juvenile Chinook prefer to remain in or close to areas with lower water velocity near good escape and hiding cover, which is usually associated with emergent and aquatic plants and riparian vegetation along the stream margins. Juvenile spring Chinook rear in freshwater for a year and smolt as age 1+ fish.

Juvenile spring Chinook leave the Warm Springs River in two peaks, a fall migration from September through December and a spring migration from February through May (Lindsay et al. 1989). Fall migrants are age-0, ranging in size from 3.1 inches to 4.3 inches fork length, and do not have a smolt appearance. They likely rear over winter in the Deschutes or Columbia rivers before entering the ocean the following spring at age-1+. Most spring migrants are age-1+ fish, ranging from 3.5 inches to 5.1 inches fork length, and have the bright silver coloration characteristic of smolts (ODFW 1997). Spring Chinook in Shitike Creek are believed to follow a similar life history pattern.

Life history patterns for spring Chinook salmon have probably not changed in the last one hundred years. Former production areas located upstream of the Pelton Round Butte Project were lost, but it is likely that Deschutes spring Chinook have always migrated as 1+ smolts. It is possible that past ocean harvest of Chinook salmon may have accounted for the low percentage of five-year old spawners in this population, but there has not been a marked increase in the numbers of five-year old spawners since the U.S./Canada Salmon Treaty was implemented.

Genetic Integrity

Oregon’s Wild Fish Population List recognizes natural production of spring Chinook from two separate Deschutes Subbasin populations, one in the Warm Springs River and one in Shitike Creek. Currently information is insufficient to determine if the two groups have enough genetic differences to qualify as separate populations.

Effects of hatchery releases: ODFW, USFWS and the Warm Springs Tribes have worked conscientiously to maintain the wild characteristics of spring Chinook produced at Warm Springs and Round Butte hatcheries. The 2003 Warm Springs Hatchery and Genetic Management Plan directs that all hatchery brood stock be collected from spring Chinook indigenous to the Warm Springs River. To maintain genetic diversity in the hatchery stock, a minimum of 10% wild brood stock is incorporated into each hatchery brood if wild fish returns are sufficient to meet escapement goals above Warm Springs Hatchery (passage of 1,000 wild spring Chinook above the hatchery to spawn). A maximum of 630 adult salmon are collected for brood stock annually, though actual production varies with brood stock availability (USFWS 2003). Brood fish are collected throughout the run in proportion to their time of return.

Round Butte Hatchery has only used spring Chinook originating from the hatchery (verified from coded wire tags) as brood stock since 1995 (French 2003). Brood stock is collected throughout the run, proportional to their abundance, to maintain diversity in the time of return. Before 1995, most brood stock was collected from fish returning to the Pelton Fish Trap, though some wild fish were also used. From 1985 to 1994, unmarked spring Chinook made up 5.1% to 39.4% of the spring Chinook brood stock at Round Butte Hatchery. Wild spring Chinook passing Sherars Falls were also used as brood stock during the low hatchery run years of 1977 through 1980.

Hatchery spring Chinook releases in the subbasin are generally timed to coincide with smolting so the fish migrate quickly out of the Deschutes River and into the ocean. This rapid migration minimizes interactions with naturally produced salmon. The exception is the small volitional release of fall migrants from Warm Springs Hatchery. Most of these fish over-winter in the Deschutes or Columbia Rivers where they may compete with some naturally produced spring Chinook juveniles. Possible effects from outplanting adult hatchery produced spring Chinook in Shitike Creek have not yet been determined.

Effects of harvest: Spring Chinook harvest data at Sherars Falls from 1977 through 1993 shows that harvest of hatchery and wild spring Chinook averaged 1,002 and 737 fish, respectively. Harvest rates of wild and hatchery spring Chinook salmon were similar, averaging 32% for the wild stock and 36% for the hatchery stock (ODFW 1997). Since the 1980s, recreational and tribal fisheries for spring Chinook have been closed or restricted in some years to help insure adequate wild spring Chinook spawner escapement. Harvest rates on wild Deschutes River spring Chinook in Columbia River and ocean fisheries have also dropped. Coded wire tags recovered from tagged wild spring Chinook juveniles from the 1977-79 brood years (the only lower Deschutes River wild spring Chinook to be coded wire tagged) showed that 33% of total harvest for those brood years was in the ocean, 24% in the Columbia River, and 43% in the lower Deschutes River (ODFW 1997). Today's out-of-subbasin harvest rates on Deschutes spring Chinook are likely significantly lower because of stock protection received under international harvest agreements and from the Endangered Species Act (French 2004, personal communication).

Relationship with Other Key and/or Sensitive Species

Since spring Chinook spawn in small headwater streams, they are reproductively isolated from fall Chinook but often share spawning and early rearing habitat with redband, summer steelhead and/or bull trout. Adult and sub-adult bull trout likely prey on rearing or migrating juvenile spring Chinook, particularly in areas where hiding and escape cover have been degraded. There is probably little interaction between spring Chinook and redband trout juveniles since redband spawn in late spring/early summer, though redband juveniles may compete with spring Chinook for food and space.

Population Trend and Risk Assessment

The Deschutes spring Chinook populations are small and, as such, are at greater risk from a number of factors, including environmental catastrophe, loss of genetic variability, environmental change, poor migration and ocean-rearing conditions and over-harvest. In addition, the population's freshwater spawning and rearing habitat is concentrated in several small geographic areas. The two populations have had a number of brood years that were too small to withstand in-subbasin tribal and/or recreational harvest and still meet spawner escapement goals. In most years, the number of wild spring Chinook returning to the Deschutes River has exceeded 1,300 adults, the replacement level suggested by the stock-recruitment model to maintain the stock. However, poor returns were observed from the 1989 through 1995 brood years, except in 1992. Returns in 1989 and 1990 exceeded 1,300 adults (ODFW 1997). Spring Chinook returns in 2000 and 2001 exceeded 2,000 adults, indicating that the stock is fairly healthy and productive (French and Pribyl 2003).

Fall Chinook

Population Abundance

Little is known about historic fall Chinook production in the Deschutes Subbasin. While Big Falls on the Deschutes River historically blocked all upstream migration of anadromous salmonids, it is unclear whether fall Chinook distribution extended past Steelhead Falls, or even much above the present site of the Pelton Round Butte Project. The large Chinook may have been able to pass above Sherars Falls before development of the large irrigation systems in Central Oregon, but low flows after the irrigation systems were in place may have impeded fish passage above the falls until 1940 when a fishway was built. Fall Chinook distribution to possible historic spawning grounds was blocked in the 1960s by construction of Pelton Dam (Map 6).

Historically, the subbasin probably also supported a summer Chinook run. Galbreath (1966) reported several instances where Chinook tagged at Bonneville Dam during the summer Chinook migration were recovered later in the Deschutes Subbasin — including recovery of three tags in the Metolius River before anadromous runs were blocked by dams on the Deschutes River. Further, data collected before construction of Pelton and Round Butte dams shows a number of Chinook captures at the Pelton Fish Trap before September 1, excluding spring Chinook (Jonasson and Lindsay 1988). Two peaks in the Chinook run also occurred at Sherars Falls, a July peak and a September peak. Based on the timing of Chinook passing Sherars Falls and those trapped at the Pelton, Jonasson and Lindsay (1988) concluded that the summer run probably spawned above the dam site at a higher rate than those that migrated in the fall (Nehlsen 1995).
Today, all production of fall Chinook salmon in the subbasin is from wild stock. Fall Chinook spawn and rear in the lower 100 miles of the Deschutes River mainstem. ODFW and the Warm Springs Tribes have recorded fall Chinook salmon redds from RM 1 upstream of Moody Rapids to the area of the Pelton Fish Trap at RM 99.8. Following completion of the Pelton Round Butte Project, most spawning occurred in the six miles of the lower Deschutes River from Dry Creek to Pelton Reregulating Dam (Jonasson and

Lindsay 1988; Huntington 1985). However, most fall Chinook have spawned downstream from Sherars Falls since the 1980s. Fall Chinook spawning has not been documented in any Deschutes River tributaries.

The size of the fall Chinook run varies considerably from year to year, but is now substantially larger than in the past. This rise is primarily due to increased fall Chinook escapement to spawning areas in the Lower Deschutes below Sherars Falls, as fish escapement above Sherars Falls has stayed relatively constant. Annual estimated escapement of fall Chinook spawners averaged 7,146 fish from 1977 to 2003, and ranged from a low of 2,205 fish in 1984 to a high of 20,678 in 1997. Annual escapement of adult fall Chinook upstream from Sherars Falls averaged 2,438 fish for the period 1977 through 2003 and 2,597 fish from 1993 through 2003. Annual spawning escapement of adult fall Chinook from the mouth of the Deschutes River up to Sherars Falls averaged 3,708 fish for the period 1977 through 2003, and 7,237 fish for the period 1993 through 2003 (French and Pribyl 2004).

Key Life History Strategies

Fall Chinook spawners return to the Deschutes River from July through November. They hold in deep pools and runs before spawning in the Deschutes mainstem. Spawning begins in late September, peaks in November, and is completed in December. Fall Chinook incubation and growth occurs much faster than for spring-run Chinook because they spend their freshwater life in the warmer mainstem river instead of cool, westside tributary streams (CTWS 1999a). Emergence of fall Chinook fry from the gravel begins in January or February and is completed in April or May. The juveniles begin their ocean migration the same spring, from May to July, at age-0. The downstream migration through the Columbia River occurs from April to August, with the median passage in June and July. A small percentage of the juvenile fall Chinook remains in the lower Deschutes River over winter and emigrates in spring at age-1.

Genetic Integrity

It is uncertain if one or two fall Chinook populations currently return to the lower Deschutes River — though the adult run timing of this population(s) overlaps the accepted summer and fall Chinook run timing in the Columbia River. Speculation also remains about whether one population spawns throughout the lower 100 miles of the Deschutes River or if there are two populations; one spawning above Sherars Falls and one spawning below Sherars Falls. Existing evidence supports both the one population concept and the two populations concept (ODFW 1997).

Effects of hatchery releases: Interactions between wild Deschutes fall Chinook and other stray, hatchery origin summer or fall Chinook appear to have increased substantially within the lower reaches of the Deschutes River during the last few years. Recent radio telemetry data and an ongoing Tribal fall Chinook study support this conclusion. Few stray, out-of-subbasin fall Chinook were observed in the Deschutes River before this, though it was difficult to identify stray fish since they often lacked external markings. A Columbia Basin adult fall Chinook radio telemetry study provides some insight into the straying of fish into the Deschutes River. During the 2001 through 2003 brood years, approximately 42%, 30% and 54% (respectively) of the adult fall Chinook tagged at Bonneville Dam that then entered the Deschutes River did not remain to spawn in the Deschutes River. This suggests that upriver bright fall Chinook use the Deschutes for temporary holding during migration to spawning areas in the upper

Columbia and Snake systems (Brun 2004). Further, during 2001 and 2002 tribal biologists recovering fall Chinook spawner carcasses estimated that only about 1% of the carcasses examined were fin-marked, out-of-subbasin stray salmon. Most coded wire tags recovered from these fin-clipped carcasses were from Klickitat River and Lyons Ferry fish hatcheries (Brun 2003). Nevertheless, it will be impossible to accurately estimate the number of stray hatchery salmon spawning in the river, or estimate their effect on the Deschutes River population, until all Columbia Basin hatchery-origin fall Chinook are distinctively marked.

Effects of harvest: Harvest of fall Chinook salmon in the lower Deschutes River occurs primarily in a three-mile section from Sherars Falls downstream to the first railroad trestle (RM 41–44). Recreational harvest averaged 320 adult fall Chinook and tribal harvest averaged 1,297 adult fall Chinook from 1977 to 1990, years when season length and harvest restrictions were not in place (ODFW 1997). In recent years, recreational and tribal harvests have been restricted to increase fall Chinook production in the subbasin. Recreational harvest averaged 168 adult fall Chinook and tribal harvest averaged 438 adult fall Chinook from 1998 through 2003, years when season lengths and harvest restrictions were in place (French 2004).

Relationship with Other Key and/or Sensitive Species

Juvenile fall Chinook rear in the lower Deschutes River for four to six months before migrating. Their rearing along the river's margin may overlap that of spring Chinook juveniles and redband/steelhead fry for a short period, but the effects are unknown. Adult Chinook may share holding waters with adult steelhead for several months prior to spawning. The small bull trout population rearing in the lower Deschutes River likely preys upon Chinook juveniles when the opportunity arises.

Population Trend and Risk Assessment

The fall Chinook population has experienced some of its largest runs to the Deschutes River in the past ten years. This increase coincides with years of good ocean productivity and may be directly associated with reduced ocean harvest following implementation of the U.S./Canada Salmon Treaty.

Risks to this population range from water quality to environmental catastrophe. Elevated river temperatures before the smolt migration could produce appreciable losses from *Ceratomyxosis.* Lower Deschutes River fall Chinook are susceptible to *Ceratomyxosis*, the disease caused by the myxosporidian parasite Ceratomyxa shasta (*C. shasta*). Most juvenile fall Chinook salmon may avoid contracting *Ceratomyxosis* by migrating to the ocean before July when high numbers of infective units of *C. shasta* are present in the river. An ongoing juvenile fall Chinook tagging project shows many fall Chinook juveniles are present in the river upstream of Sherars Falls during July (Brun 2002). The cooler water temperatures above Sherars Falls may delay juvenile outmigration, forcing these late migrants to migrate through the warmer water below Sherars Falls during June and July. In contrast, juveniles rearing in the river downstream from Sherars Falls appear to leave the river by early June when water temperatures begin to rise (Brun 2002). Fall Chinook are also susceptible to environmental catastrophe. An accidental derailment and spill of hazardous material along the rail line that closely borders the lower 86 miles of the Deschutes River could devastate all aquatic life from that point downstream, though the population's complex life history patterns allow some built-in population protection from such a catastrophic scenario.

3.2.2. Redband Trout

Redband trout are a hardy race of rainbow trout generally found in more arid regions east of the Cascade Mountains. Two distinct life forms of redband trout, resident redband trout and anadromous summer steelhead, are native to the Deschutes River subbasin.

Importance

Large numbers of anadromous and resident redband trout once spawned and reared throughout the Deschutes Subbasin. Today, redband trout remain a valued ecological and cultural resource in the Deschutes Subbasin and attract anglers from around the world (Table 3.2). Summer steelhead in the subbasin are listed as threatened.

Table 3.2. Rationale for Selection of Redband Trout as a Focal Species.

Species Designation	Species Recognition	Special Ecological Importance	Tribal Recognition
Two demographically independent Summer steelhead populations and one unoccupied habitat were identified by the TRT as part of the Mid-Columbia ESU, which extends from the Wind and Hood rivers on the west, and up to and including the Yakima River. Summer steelhead within this ESU were federally listed as threatened in March 1999. Later in 1999, NOAA Fisheries removed the Deschutes River hatchery steelhead stock from the ESU as it was not essential for the recovery of the wild steelhead population. The resident redband trout were proposed for ESA listing throughout its range, but a listing was determined not warranted at that time.	Redband trout, especially summer steelhead, have provided an important food source for Native Americans over thousands of years. They have also provided an important recreational fishery for other non-tribal fishers. The fishery is now generally confined to the more robust populations. The lower Deschutes subbasin supports at least three distinct populations of resident redband trout. Some populations in the White River system may represent remnants of an ancestral population and an evolutionary line originating from a primitive race of redband trout.	Redband trout serve as an important food source for a variety of wildlife and contribute nutrients that have wide-reaching benefits to the biota of the subbasin. Steelhead and redband trout spawners till portions of the gravel substrate, in different areas than Chinook. This benefits macroinvertebrates and other aquatic species. Historically, steelhead may have had one of the widest distributions of any of the anadromous fish species found within the subbasin, possibly exceeded only by the Pacific lamprey.	Native Americans throughout the Pacific Northwest, including the Confederated Tribes of the Warm Springs, maintain strong cultural and religious values for summer steelhead and Chinook salmon. These fish have long had important tribal subsistence, ceremonial and commercial value.

The following discussions briefly describe the summer steelhead and resident redband trout populations in the Deschutes Subbasin. More information on these species is provided in Appendix I.

Summary Steelhead

Population Abundance

Historically, the Deschutes summer steelhead population was robust and widely distributed. Summer steelhead occurred throughout the mainstem lower Deschutes River below Steelhead Falls and in many of the larger tributaries, including the Crooked River and Squaw Creek systems (Nehlsen 1995). Borovicka (1953) observed steelhead passing Steelhead Falls in the 1950's, though there was no known passage over Big Falls (OSGC 1953). Seven adult steelhead were captured in a trap at the ladder on Steelhead Falls. Borovicka also observed that it was possible for steelhead to go over the falls and bypass the ladder under period of high flow. After construction of the Steelhead Falls fish ladder in 1922, fish could move upstream, regardless of flow conditions, to access some excellent gravel areas and cool spring-fed flows between Steelhead and Big falls (Nehlsen 1995). Steelhead natural distribution was restricted in the Crooked River system by construction of Ochoco Dam (Ochoco Creek, RM 10) and Bowman Dam (Crooked River, RM 70) in 1921 and 1961, respectively. Borovicka (1956) reported *"a concentration of steelhead in undetermined numbers was found below the dam of the Ochoco Lumber Co. on Ochoco Creek in the town of Prineville* (OSGC 1956). Borovicka (1956) also reported *that "steelhead were observed jumping at the Stearns Dam above Prineville on the mainstem of Crooked River". "Steelhead are able to pass the Stearns Dam during flood stages of the Crooked River"* (OSGC 1956). Access to habitat above RM 100 on the Deschutes River was blocked by Pelton and Round Butte dams (Map 7).

Today, wild summer steelhead spawn in the lower Deschutes River, Warm Springs River system, White River, Shitike Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and a lack of barriers to fish migration. Only about 5-10% of the steelhead/redband spawning in the Deschutes occurs below the confluence of White River. Most of the spawning below Sherars Falls is likely associated with the tributaries. Juvenile rearing also occurs in the mainstem below Sherars Falls and may be more important because of the general upward trend in the condition of the riparian community.

The Interior Columbia Basin Technical Recovery Team (TRT) identified two demographically independent steelhead populations, and one extirpated population in the Deschutes Subbasin. The Deschutes River Eastside Tributaries (DREST) population encompasses the mainstem Deschutes River from its mouth to the confluence of Trout Creek, and the tributaries entering the Deschutes from the east: Buck Hollow, Bakeoven, and Trout Creeks. The Deschutes River Westside Tributaries (DRWST) population are mainstem spawners from the mouth of Trout Creek upstream to Pelton Reregulating Dam (current upstream barrier to anadromous fish), and in the Warm Springs River and Shitike Creek. The Deschutes River above Pelton Dam historically supported a third population that was extirpated by the Pelton Round Butte dam complex. The population structure of steelhead in the area now blocked by Pelton Dam is ambiguous. The population may have included multiple life histories, including spring-run fish (Nehlsen 1995). Historically, steelhead were found in the Deschutes River upstream to Big Falls (RM 132), in Squaw Creek and the Crooked River, and possibly in the Metolius River, with Squaw Creek and the Crooked River being particularly productive (TRT 2003).

Estimates of wild summer steelhead migrants over Sherars Falls have ranged from a low of 482 fish in the 1994/95 run year to a high of 9,624 in the 1985/86 run year, averaging 5,005 fish annually for the period of record (1977/78 – 2002/03). However, actual wild steelhead escapement in 1985/86 may have been lower, as the escapement estimate likely included unmarked stray hatchery-origin fish that were indistinguishable from wild fish (French and Pribyl 2003).

In recent years, wild adult steelhead returns to the Deschutes Subbasin have exceeded the NOAA Fisheries interim spawner escapement objective for the subbasin of 6,300 wild steelhead. The run, however, remains below the ODFW goal for the Deschutes, which calls for a spawning escapement of 6,575 wild steelhead upstream from Sherars Falls to sustain maximum natural production potential during years of good juvenile and adult survival conditions. During years of outstanding fresh water and ocean rearing conditions and high smolt-to-adult survival, spawning escapement could be considerably larger (ODFW 1997). Steelhead production in the subbasin may expand in the near future if passage is restored past the Pelton Round Butte Project.

The subbasin also supports a run of hatchery-produced steelhead from Round Butte Hatchery. The hatchery was completed in 1973 and is the only hatchery releasing summer steelhead in the Deschutes River subbasin. As mitigation for effects of the Pelton Round Butte Project, the project operator is required to return 1,800 Deschutes stock summer steelhead adults annually to the Pelton Fish Trap from hatchery smolt releases.

Life History Strategies and Habitats

Counts of adult steelhead at Pelton Dam from 1957 through 1965 show adults migrating throughout of the year, with peaks in July, late fall, and early spring (Nehlsen 1995; King 1966). Steelhead passing the Pelton site appeared to form three size groups: a group in late spring averaging 8-12 pounds, a group in the summer averaging 3-5 pounds, and a group in the fall weighing 8-12 pounds (Gunsolus and Eichler 1962). This data suggests that the steelhead run comprised multiple life histories (Nehlsen 1995).

Adult summer steelhead generally return to the Deschutes River from June through October and pass Sherars Falls from June through March, with peak movement in September or early October. Wild female steelhead consistently outnumber males in a run year. The relative proportion of mainstem and tributary spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30 to 60% of the natural production (ODFW 1997). The Warm Springs River system, the main spring Chinook producer, does not appear to produce large numbers of wild summer steelhead. Shitike Creek is a major producer of steelhead and spring Chinook.

Steelhead spawning in eastside tributaries occurs earlier than in the mainstem and westside tributaries. Steelhead usually spawn in Bakeoven, Buck Hollow and Trout creeks from January through mid-April. Some opportunistic steelhead move into small tributaries during short periods of high water to spawn in late January or February. Spawning in eastside tributaries may have evolved to an earlier time than westside tributaries or the mainstem Deschutes River because stream flow tends to decrease earlier in the more arid eastside watersheds (Olsen et al. 1991). Spawning in the lower Deschutes River and westside tributaries usually begins in March and continues through

May (Zimmerman and Reeves, 1999). Steelhead begin their spawning migration into the Warm Springs River in mid-February.

Steelhead fry emerge in spring or early summer depending on time of spawning and water temperature during egg incubation. Zimmerman and Reeves (1999) documented Deschutes River summer steelhead emergence in late May through June. Juvenile summer steelhead emigrate from the tributaries in spring from age-0 to age-3. Steelhead fry from small or intermittent tributary streams experience greater growth than those in the mainstem Deschutes River, and may have a competitive advantage as they move from tributary environments to the river (Zimmerman and Reeves, 1999). Many juvenile migrants continue to rear in the mainstem lower Deschutes River before smolting. Scale patterns from wild adult steelhead indicate that smolts enter the ocean at age-1 to age-4 (Olsen et al. 1991). Specific information on time of emigration through the Columbia River is not available, but researchers believe that smolts leave the Deschutes River from March through June.

Lower Deschutes River origin wild summer steelhead typically return to the Deschutes after one or two years in the Pacific Ocean (termed 1-salt or 2-salt steelhead). Typical of other summer steelhead stocks located east of the Cascade Mountains, very few steelhead return to spawn a second time in the lower Deschutes River. Egg-to-smolt and smolt-to-adult survival rates are not known for wild summer steelhead in the lower Deschutes River.

Genetic Integrity

Effects of hatchery releases: Hatchery releases, especially from out-of-subbasin hatcheries, pose a significant threat to wild summer steelhead populations in the Deschutes Subbasin. If numbers of hatchery origin summer steelhead captured at the Pelton Fish Trap and Warm Springs Hatchery trap and estimated in angler harvest upstream from Sherars Falls are subtracted from the estimated number of hatchery summer steelhead passing Sherars Falls, many hatchery fish remain unaccounted for. Steelhead spawning surveys on Buckhollow and Bakeoven creeks indicate that many of these fish remain in the wild each year, potentially spawning with wild steelhead. From 1984 to 1991, estimated hatchery origin summer steelhead adults migrating upstream from Sherars Falls exceeded estimated numbers of wild summer steelhead adults six of those ten years. From 1992 to 2002, the estimated number of hatchery origin summer steelhead adults escaping upstream from Sherars Falls exceeded the number of wild steelhead every year. In the 1997/98 run year, stray hatchery origin steelhead were nearly 10 times as abundant as wild steelhead (French 2004).

These out-of-subbasin strays may be contributing significant amounts of maladapted genetic material to the wild summer steelhead population in the lower Deschutes River subbasin. Round Butte Hatchery summer steelhead contribute to this problem, but their impact is small, numerically and genetically, compared to the impact of large numbers of out-of-subbasin stray hatchery steelhead that are also present in the spawning population. Round Butte Hatchery does not release any non-indigenous summer steelhead stocks in the subbasin. The cumulative effect of this genetic introgression from hatchery fish may contribute to lowered productive capacity of the wild population as evidenced by low run strength of wild summer steelhead through time.

The component of the Deschutes steelhead population spawning in the Warm Springs River system upstream of Warm Springs Hatchery may be at less genetic risk. The Warm Springs system is of particular value as a refuge for wild summer steelhead since hatchery marked or suspected hatchery origin summer steelhead are not allowed to pass the barrier dam at the hatchery (WSNFH Operational Plan 1992-1996). This effectively excludes all non-Deschutes River origin summer steelhead except stray wild summer steelhead or stray, unmarked, hatchery origin fish.

Effects of harvest: Since 1979, recreational angling regulations have stipulated that all wild fish be released unharmed. Tribal harvest of wild steelhead since 1998 has also been restricted at Sherars Falls, where most tribal summer steelhead harvest occurs. From 1993 to 2003, the annual harvest of wild steelhead in this subsistence fishery averaged 34 fish, with a range from 0 to 135 per year (French and Pribyl 2004). Significant tribal harvest of steelhead continues to occur in the mainstem Columbia, however the number of Deschutes origin fish harvested in this fishery is unknown (French 2004).

Relationship with Other Key and/or Sensitive Species

Summer steelhead and resident redband trout are reproductively isolated in the Deschutes River by a combination of spatial and temporal mechanisms (Zimmerman and Reeves 1999). Steelhead usually spawn as much as 10 weeks before redband spawn, and they also select spawning sites in deeper water with larger substrate than those selected by redband trout.

Population Trend and Risk Assessment

The TRT has identified two demographically independent summer steelhead populations in the subbasin, which are included in the Mid-Columbia ESU and have been designated as a threatened species under the federal Endangered Species Act. Rationale for this listing included the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead. The incorporation of genetic material from large numbers of stray steelhead could have a long term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-subbasin strays also pose a threat to steelhead population health. About 5% of the hatchery stray steelhead have tested positive for whirling disease (Engleking 2002).

Resident Redband Trout

Redband trout are a large group of inland native rainbow trout endemic to basins of the Pacific Northwest east of the Cascade Mountains. They are often called the desert trout because they show a greater tolerance for high water temperatures, low dissolved oxygen levels, and extremes in stream flows that frequently occur in desert climates.

Population Abundance

The lower Deschutes River drainage is capable of producing large populations of wild redband trout. In fact, the lower mainstem Deschutes River has the strongest population of resident redband trout in Oregon (Kostow 1995). ODFW currently recognizes 46 wild populations of resident/fluvial redband trout in the Deschutes Subbasin up to Big Falls, with the strongest populations located in the lower mainstem. Wild redband trout are present throughout the lower Deschutes River, though are more abundant above Sherars Fall and most abundant in the 50-mile stretch between the Reregulating Dam and Maupin (ODFW 1997). Densities of redband trout greater than 8 inches in the 1980's averaged 1,630 fish/mile in the North Junction area (river mile 69.8 to 72.8) and 1,830 fish/mile in the Nena Creek area (river mile 56.5 to 59.5) of the lower Deschutes River. Redband trout may be less abundant below Sherars Falls because of high water temperatures, increased competition for food and habitat, and lack of high quality spawning gravel below the confluence of White River. Glacial sediments from White River may also decrease egg to fry survival and decrease aquatic insect production in the lower Deschutes (ODFW 1997). Several lower river tributaries also support redband trout populations. However, trout production capacity in many lower subbasin streams, such as White River and Trout, Bakeoven and Buck Hollow creeks, is depressed by degraded habitat, predation and competition.

Principal redband trout production areas above Lake Billy Chinook include the mainstem Deschutes up to Big Falls, Squaw Creek, the Metolius River, and the Deschutes River above Crane Prairie Reservoir, Crooked River below Bowman Dam, and the North Fork Crooked River and tributaries. During snorkeling and raft electrofishing surveys conducted from 1989 to 1991, biologists counted 1,261 redband trout in 0.42 miles surveyed between Big Falls and Lake Billy Chinook. In comparison, they counted only 68 redband trout in 0.88 miles surveyed between Big Falls and Bend. Low summer stream flow and elevated water temperature are believed to be a primary cause for the decline in fish production in this section of river (ODFW 1996). Redband trout production in the Deschutes River between Bend and Crane Prairie Reservoir varies by reach and is directly associated with winter flow conditions and available spawning and rearing habitat. Brown trout are the dominant species between Benham Falls and Wickiup Reservoir.

The Crooked River system once supported large numbers of redband trout, but production potential is currently limited by habitat degradation. Historically the system is believed to have contained two contiguous redband trout populations that were separated by a geologic barrier in the North Fork Crooked River. Today most redband populations in the Crooked River system are fragmented and isolated due to physical and water temperature barriers. As a result, the drainage contains as many as 28 isolated redband trout populations (Stuart and Thiesfeld 1994). Many of these isolated populations are thought to be depressed. Redband trout populations in the Crooked River watershed are generally healthy in streams with year around flow, instream cover, suitable water temperatures, clean spawning gravel and an intact riparian zone.

Key Life History Strategies and Habitats

Redband trout spawn in the lower Deschutes River drainage during spring and early summer, with most spawning occurring from April to June. Colder water temperatures may delay spawning in some streams. Zimmerman and Reeves (1999) observed redband spawning in the lower Deschutes River from mid-March through August. Most suitable trout spawning gravel in the lower Deschutes River is in the area from White River to Pelton Reregulating Dam (Huntington 1985).

Studies indicate that most redband trout migration is associated with spawning activity (Schroeder and Smith 1989). During studies by ODFW in the lower Deschutes River, about 75% of the tagged trout greater than 8 inches in length that were caught one to five years after tagging and were recaptured within the same 3-mile study area. Median distance of upstream and downstream migration for tagged fish that did leave the tagging area was about 9 miles and 6 miles, respectively (ODFW 1997).

Redband trout spawn in the Crooked River system from late April through early June. Fry emergence has been observed in early July to mid August. Redband trout in most streams reach about 3 inches at age one, 4.5 inches at age two, and 5-6 inches at age three. Very few redband trout exceed 10 inches. Redband trout in the Crooked River below Bowman Dam, benefiting from cold water reservoir releases, have considerably faster growth rates. Maturing Crooked River redband trout migrate up their respective spawning tributary, probably during March, April, or May, while others spawn in the same general area where they rear and little or no migration is associated with spawning.

Above the Pelton Round Butte Project, redband trout spawn in rivers and streams with cool, clean, well-oxygenated water from March through May. Redband in the Metolius spawn from November through May. Above Crane Prairie spawning occurs from January through May (Marx,2004). Fry emerge from the gravel in June and July and generally live near where they were spawned. They mature at age-3, and size varies with productivity of individual waters. Few redband trout in the upper subbasin exceed 10 inches in length (ODFW 1996).

Genetic Integrity

Redband trout isolated in the White River system above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin of south-central Oregon — both genetically and morphologically — than they are to lower Deschutes River redband trout (Currens et al. 1990). A possible explanation is that the Deschutes River drained the Fort Rock Basin until lava flows separated the drainages in the late Pleistocene epoch (Allison 1979). Ancestral redband trout probably invaded White River and the Fort Rock Basin when they were connected to the Deschutes River. Subsequent isolation of White River and Fort Rock subbasins prevented these populations from acquiring genetic traits that evolved in the Deschutes River population during the last glacial period. Thus, some populations in the White River system may represent remnants of the ancestral population and an evolutionary line originating from a primitive race of redband trout.

Effects of hatchery releases: Differences between populations in the White and lower Deschutes rivers are probably not attributable to the influence of past hatchery rainbow trout releases in the White River system. However, evidence suggests that genetic introgression between indigenous redband trout and hatchery populations may have occurred in the lower White River, lower Tygh Creek, Jordan Creek, and Rock Creek (Currens et al. 1990). Redband trout in Deep Creek (North Fork Crooked River tributary) also exhibited a moderate level of hatchery introgression from legal rainbow trout released from 1963 to 1990 (ODFW 1995). Some populations in the Ochoco Creek system and lower Crooked River areas show low to moderate levels of hatchery introgression, probably due to a combination of high levels of past hatchery stocking and chemical treatment projects.

Effects of harvest: The lower Deschutes River supports a popular redband trout fishery. The character of this fishery has changed over the years as angling regulations have become more restrictive and the stocking of hatchery rainbow trout has been discontinued. Angling regulations and management strategies have changed to protect juvenile steelhead and to potentially increase certain size groups of wild redband trout (ODFW 1997). Current trout bag limit and tackle restrictions encourage catch and release angling. Similar angling regulation restrictions have limited redband trout harvest on the Crooked and Metolius rivers and promoted catch and release angling. Angling on the Metolius is restricted to catch and release only.

Relationship with Other Key and/or Sensitive Species

Redband appear to be reproductively isolated from steelhead. There is likely some overlap in juvenile rearing habitat between redband, Chinook salmon and steelhead.

Population Trends and Risk Assessment

The redband trout populations in the lower Deschutes River and White River are robust. The biggest risk to these populations is a catastrophic environmental incident. The lower Deschutes population may be vulnerable to the effects of a hazardous substance spill that could result from a train derailment on the rail line closely bordering the lower river. The White River population could be particularly vulnerable to catastrophic flooding associated with volcanic activity on Mount Hood. Habitat deficiencies in some small tributaries — including low flow, temperature extremes and lack of cover — put trout populations at risk.

Natural mortality of trout in the lower Deschutes River, particularly associated with spawning, is high (45% to 69%) for fish about 12 inches or more in length. This high natural mortality, and not harvest, is likely the limiting factor controlling recruitment of trout into size ranges over about 16 inches (Schroeder and Smith 1989).

Lower Deschutes River redband trout are resistant to *Ceratomyxosis*, a parasitic infection in the intestinal tract that spreads to other tissues and ultimately resulting in mortality. This disease was first detected in the lower Deschutes River immediately below the Pelton Reregulating Dam in 1965. Its presence has been detected every time tests have been conducted since 1965 (ODFW 1997). Studies done by ODFW in 1984 indicate that redband trout in the White River system are susceptible to infection by *C. shasta*.

In the Crooked River drainage, small fragmented and isolated redband trout populations reside in tributary streams, while in the mainstem of Crooked River vast reaches — with the exception of the 19 km reach below Bowman Dam — have severely reduced redband trout abundance. Only 7% of the Crooked River drainage supports strong populations of redband trout. Fragmentation and isolation of populations may eliminate life history forms and reduce survival, growth and resilience. Populations with extremely low abundance, in streams with marginal habitats, and with little or no exchange of genetic material, have a high risk of extinction (Rieman and McIntyre 1993).

Redband populations in the upper Deschutes subbasin are smaller than those in the lower subbasin and often fragmented. These populations may have been genetically impacted by past stocking of hatchery rainbow trout or are at genetic risk because of the small remaining population size. Environmental conditions associated with diminishing stream flows, degraded stream habitat, and passage barriers have placed a number of populations at risk. Upper subbasin redband populations are also at risk from disease. Metolius redband trout, for example, are much more susceptible to *C. shasta* than redband trout from the Deschutes River, which have genetic resistance to the lethal disease. Data indicates that genetic introgression with non-native hatchery rainbow trout has made the Metolius River redband more susceptible to *Ceratomyxosis* when conditions for infection occur (Currens, et al. 1997).

Introduced brown trout have proven to be a formidable competitor for redband trout in the subbasin upstream of Lake Billy Chinook, however this is mostly related to habitat modification. Brown trout are more tolerant of warm water temperatures that occur between Bend and Lake Billy Chinook in the summer and low water conditions below Wickiup in the winter. When flows below Wickiup drop in the winter (during irrigation storage months) much of the riffle habitat utilized by redband trout for feedng and rearing is lost. Brown trout tend to occupy the limited pool habitat that remains (Marx 2004). Brook trout have also become well established in a number of headwater streams and may aggressively compete with or displace redband trout.

Depressed redband trout populations are capable of rapid recovery if habitat conditions are favorable and other limiting factors are not oppressive. Redband trout production is increasing in some areas because of changes in fish management and habitat enhancement. Redband trout populations in the Metolius River have shown indications from annual redd counts that this population is on the increase due to management changes that resulted in elimination of stocking of hatchery trout and habitat protection and enhancement measures. Record high redd numbers were observed in the Metolius River in 2001-2002. ODFW biologists have also documented rebounds in the redband population below Wickiup Reservoir following several years of good winter flows. Redband populations were very depressed during the low water years in the early 1990's and increased dramatically in the late 1990's when higher flows were maintained below Wickiup Reservoir due to a series of good water years. Numbers of redband have dropped again in recent years due to poor water conditions.

3.2.3. Bull Trout

Bull Trout in the Deschutes Subbasin are part of the Deschutes Recovery Unit, which encompasses the Deschutes River and its tributaries and contains two core bull trout habitat areas. The lower Deschutes Core Area and upper Deschutes Core Area are separated by Big Falls on the mainstem Deschutes River at RM 132. In addition, the Odell Lake Core Area supports a small remnant bull trout population in a portion of the extreme southern end of the subbasin that was cut-off from the Upper Deschutes River system by a lava flow. The lower Deschutes Core Area is generally described as the mainstem Deschutes River and its tributaries from Big Falls downstream to the Columbia River. The upper Deschutes core habitat is generally described as the upper Deschutes River, Little Deschutes River, and other tributaries upstream from Big Falls at about River Kilometer 212 (River Mile 132). Current subbasin bull trout distribution is limited to the lower Deschutes Core Area, which includes the five local populations in Shitike Creek, the Warm Springs River, and the three Metolius River population complexes and the Odell Lake population (USFWS 2002). The upper Deschutes core habitat does not currently support bull trout populations, but had bull trout historically (Map 8).

Importance

Bull trout were selected as a focal species based on an evaluation of the legal, cultural and ecological status (Table 3.3).

Table 3.3. Rationale for Selection of Bull Trout as a Focal Species.

Species Designation	Species Recognition	Special Ecological Importance	Tribal Recognition
The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout, including the Deschutes subbasin populations, as a threatened species under the Endangered Species Act in June 1998. Bull trout are also currently listed on the Oregon Sensitive Species List as Critical.	Until about 1960, bull trout were not highly regarded by tribal or non-tribal fishers or fishery managers. Instead they were trapped and removed [killed] from the Metolius and Warm Springs rivers because of perceived predation on spring Chinook eggs and juveniles	Historically bull trout were an important component of the subbasin's aggregate fish population. The fish were an important predator that co-existed with other fish species and helped to keep the ecosystem in balance. Today bull trout are recognized as indicators of high quality fish habitat and cold water. Their presence is associated with an intact aquatic ecosystem.	Historically, the tribes utilized bull trout as food fish. Bull trout were generally perceived to be a predatory fish that harmed more desirable fish species. This tribal image of the fish was fostered by the negative image given by ODFW and the USFWS. Today, the tribes view bull trout as being an important part of healthy, functioning ecosystems, which is consistent with their traditional beliefs.

Characteristics that define bull trout populations in the Deschutes Subbasin are summarized in the following section. Appendix I describes the populations in more detail.

Population Abundance

Historically the Deschutes Subbasin supported a number of bull trout populations that included the lower Deschutes River population in the mainstem and tributaries upstream to Big Falls, the upper Deschutes River population above Big Falls and tributaries, and the Odell Lake – Davis Lake population. Anecdotal information suggests that bull trout in the lower Deschutes River subbasin were more abundant historically than at present. Workers at a Pelton Reregulating Dam fish trap, in place before 1968, recalled annually passing up to several hundred large bull trout upstream for a number of years, indicating that bull trout were much more abundant historically (Ratliff et al. 1996). Today, Deschutes River bull trout populations are listed as threatened under the Endangered Species Act.

The Metolius River system supports the largest complex of bull trout populations in the Deschutes Subbasin and contains both resident and adfluvial bull trout. Bull trout currently inhabit most riverine habitats of the Metolius drainage (USFWS 2002). The drainage also supports a migratory bull trout population that uses the Metolius River and Lake Billy Chinook as seasonal foraging habitat and as a migratory corridor (Buchanan et al. 1997). The local population has exhibited a positive trend in spawning numbers, possibly in response to angling restrictions. The number of redds observed increased from 27 in 1987 to 330 in 1994 (Ratliff et al. 1996), and more recently to a high of 760 redds in 2001 and 643 in 2002 (Wise 2003). The 2002 count was a decrease of 15.4% from 2001, but still the second highest count on record. Based on an estimate of 2.3 adult fish per redd, 1,479 bull trout moved into Metolius Basin streams to spawn during the 2002 year (Wise 2003).

Bull trout in the lower Deschutes subbasin reside in the mainstem above Sherars Falls, Shitike Creek and the Warm Springs River (USFWS 2002). The draft bull trout recovery plan estimates there are 1,500 to 3,000 adult bull trout in the recovery unit, which are distributed in the lower Deschutes Core Area (USFWS 2002). In 2001, Brun (2001) estimated there were approximately 260 and 470 bull trout spawners in the Warm Springs River and Shitike Creek, respectively. The Shitike Creek population may be comparable to the Metolius River populations in juvenile bull trout densities, but the Warm Springs River population is much smaller. In a 1997 study, ODFW estimated that the lower Deschutes River reach near North Junction (RM 68.5 to 71.5) contained an estimated 7 fish per mile over 25 cm in length (Newton and Nelson 1997).

The Odell Lake subpopulation contains the last extant native lake migratory (adfluvial) bull trout in Oregon (Ratliff and Howell 1992; Buchanan et al. 1997). Bull trout redd numbers in Trapper Creek, the only known spawning area in the Odell/Davis complex, have ranged from 12 to 24 redds in recent years. Juvenile bull trout were documented in Odell Creek by USFS personnel in 2003, the first observations of bull trout in Odell Creek since the early 1970's (Marx 2004).

Key Life History Strategies

The Warm Springs River and Shitike Creek bull trout populations are thought to be fluvial, but contain a resident component as well. These systems provide the only known suitable bull trout spawning areas in the lower Deschutes Subbasin. The fluvial life history pattern is dominant in the lower Deschutes River, with bull trout migrating from their smaller natal streams to a larger river (the Deschutes) to rear, and then back to their natal stream to spawn. Adults return from the Deschutes River to headwater spawning areas in the Warm Springs River and Shitike Creek from April to June (Brun and Dodson 2000). Fish generally reach spawning habitat by September and complete spawning by the end of October. Spawning in Shitike Creek has been observed from August 20 through early November when water temperature averaged 6.2°C (43°F) between RM 18 to 27; this was the mean 7-day average from thermographs. In the Warm Springs River, temperatures averaged 6.6°C (44°F) between RM 31 to 35 during the late-August to early November spawning period (Brun 1999).

At age-2 and age-3, some juvenile bull trout from the Warm Springs River and Shitike Creek migrate to the mainstem lower Deschutes River to rear. Brun (1999) found that juvenile bull trout migrants from Shitike Creek averaged 131mm and 183.9mm in the spring and fall, respectively. At age-5, fluvial and adfluvial fish migrate back to their natal tributary to spawn (USFWS 2002). Bull trout are very piscivorous allowing them to reach up to 20 lbs in size depending on food availability.

The Metolius River complex populations have a life history similar to the Shitike Creek and Warm Springs River populations. However, the Metolius populations contain an adfluvial component that spends a portion of its life rearing in Lake Billy Chinook. Most bull trout in the Metolius system spawn from August 15 to October 1, though spawning has been observed as early as July 13 and as late as mid-October (Ratliff et al. 1996).

Genetic Integrity

Research conducted on the genetics of bull trout in Oregon established the genetic baseline for bull trout and confirmed Oregon Department of Fish and Wildlife's designation of Deschutes bull trout as a separate gene conservation group (Spruell and Allendorf 1997). Fluvial subpopulations in Shitike Creek and the Warm Springs River contribute bull trout into the lower Deschutes River. The Metolius River system populations were historically a component of the lower Deschutes populations. The Pelton/Round Butte Project isolated some of these populations. The Odell Lake population has been isolated from other subbasin populations for approximately 6,000 years.

Effects of hatchery releases: Bull trout have not been artificially produced in the subbasin and there are no records of artificially produced bull trout being released anywhere in the subbasin. In addition, there are no documented instances of bull trout from other subbasins straying into the Deschutes subbasin.

Releases of other hatchery-reared salmonids within the subbasin may mimic or potentially be more harmful than the potential effects of straying. Hybridization with brook trout is a concern for the Warm Springs River and Shitike Creek populations. A low level of hybridization has been documented in the lower Deschutes River subbasin. Brook trout are present in high lakes and the upper reaches of Shitike Creek and the Warm Springs River. Competition between juvenile brook trout and bull trout for available resources may exist where both are present (Brun and Dodson 2000). Introduced brook and brown trout may also be limiting some bull trout populations in the Metolius River basin due to their potential for interaction. Brown trout in Suttle Lake may have been partially responsible for the demise of that bull trout population.

Effects of harvest: In the past 20 years, size and bag limit regulations on the lower Deschutes River have likely precluded a target bull trout fishery and limited exploitation rates to very low levels. The taking of bull trout was banned by rule in the lower Deschutes River starting in 1994 (ODFW 1997). Today, the only legal harvest of bull trout within the Deschutes Subbasin is a very restrictive fishery within Lake Billy Chinook. Protective bull trout angling regulations in the Metolius River have been implemented since 1980, which culminated in the closure of the tributaries below Lake Creek to angling in 1994 (USFWS 2002). Overharvest of bull trout may be a factor in a mixed fishery with brown trout because of angler confusion about species identification (Ratliff et al*.* 1996).

The Warm Springs River and Shitike Creek are closed to tribal angling to protect spring Chinook salmon, except for the occasional opening of the Warm Springs River from the mouth to the hatchery for spring Chinook when the salmon are abundant. Tribal angling is generally very light during these special seasons. A small tribal harvest of bull trout may occur from the lower Deschutes River bordering the reservation (Brun 2003).

Relationship with Other Key and/or Sensitive Species

Bull trout share spawning and early rearing habitat with spring Chinook and redband trout. They may prey on spring and fall Chinook juveniles in the Deschutes River.

Population Trends and Risk Assessment

Bull trout core areas with fewer than five local populations are at increased risk, core areas with between five and ten local populations are at intermediate risk, and core areas with more than ten interconnected local populations are at diminished risk. In the lower Deschutes Core Area, there are currently five known local populations. Based on the above guidance, bull trout in the Deschutes Recovery Unit is at an intermediate threat category (USFWS 2002). Bull trout in the Odell Lake – Davis Lake population are at an increased risk of extinction.

The bull trout populations in the Metolius River system appear to have rebounded from extremely low levels as recently as the 1980s (Fies et al. 1996). The recent trend in Metolius River system bull trout redd counts also appears to indicate an upward population trend. Bull trout spawning surveys in Shitike Creek and the Warm Springs River indicate that the annual spawner numbers are stable in the Warm Springs River system and on an upward trend in Shitike Creek.

Small bull trout populations risk extinction through excessive rates of inbreeding and chronic or catastrophic natural processes. It is unknown if lower Deschutes River subbasin bull trout populations are large enough to escape these risks (ODFW 1997). The limited quantitative measures of bull trout numbers in the lower Deschutes suggest several small populations exist. Tribal fishery managers have been closely monitoring bull trout populations in recent years at the weirs in Shitike Creek and the Warm Springs River, so any unusually population characteristics should be promptly noted.

3.2.4. Pacific Lamprey

Importance

The Pacific Lamprey is an indigenous, anadromous species in the Deschutes Subbasin. It was selected as a focal species based on its cultural significance (Table 3.4).

Table 3.4. Rationale for Selection of Pacific Lamprey as a Focal Species.

Species Designation	Species Recognition	Special Ecological Importance	Tribal recognition
Pacific lamprey were listed as a state sensitive species in 1993. In 1997 they were given further legal protected status by the state. They are not listed as a federally threatened or endangered species. Conservation groups in several western states petitioned to give lamprey federal protection under the Endangered Species Act in January 2003. Budget limitations forced the USFWS to defer formal consideration of the petition.	Historically lampreys provided an important local tribal fishery for subsistence, ceremonial and medicinal purposes. However, people have commonly viewed lampreys as a threat even where they are native and live in harmony with their ecosystem. Some people seem to find their parasitic behavior repulsive, a view that is perhaps also sustained by their sliminess and snake-like appearance (Kostow 2002).	Historically this species likely had the widest distribution of any of the anadromous species in the subbasin. Lamprey can often negotiate barriers that effectively interrupted migration of other fish. Historically pristine conditions in the subbasin likely supported lampreys. Most adult lampreys die shortly after spawning, feeding various scavenger species and contributing rich nutrients throughout their freshwater habitat (Kostow 2002).	The species is culturally significant for Native Americans, including the Warm Springs Tribes. They have religious and ceremonial importance. They are also important in the annual tribal subsistence fishery in the Deschutes River at Sherars Falls. Fatty and highly nutritious, they are a traditional food for some Native Americans (Kostow 2002). They have also been used for medicinal purposes, including as hair oil and to cure tuberculosis.

Characteristics that define Pacific lamprey populations in the Deschutes Subbasin are summarized in the following section. The populations are described in more detail in Appendix I.

Population Abundance

Historically, Pacific lamprey were widely distributed throughout the Deschutes Subbasin. Pacific lamprey distribution in the Deschutes subbasin is currently confined to the Deschutes River and select tributaries downstream of the Pelton Round Butte Project. Most, if not all, spawning is believed to occur within the boundaries of the Warm Springs Reservation, likely only in the Shitike Creek and Warm Springs River systems. ODFW personnel have conducted numerous steelhead surveys on the tributaries entering the lower Deschutes River from the east. No adult or juvenile lampreys have been observed during these surveys. Tribal biologists are currently mapping the known larval distribution of lamprey within reservation waters (BPA Project 200201600) (Brun 2003).

Historic lamprey counts at Bonneville and The Dalles dams suggest that lamprey production swung between tens of thousands and hundreds of thousands in just a few years (Kostow 2002). In recent years, pacific lamprey abundance throughout the Columbia River Basin has decreased significantly (ODFW 1997). Pacific lamprey abundance in the Deschutes Subbasin has not been estimated, but appears to be low. The current carrying capacity for pacific lamprey in the Deschutes Subbasin is unknown, however, because of their high fecundity rate, lamprey populations may be able to quickly rebound if freshwater and ocean survival conditions are favorable.

Key Life History Strategies

Life history information for the Deschutes River subbasin lamprey population is generally lacking. The following description of the Pacific lamprey life cycle is generally based on observations and data from other Columbia River Basin or Pacific Northwest lamprey populations.

Pacific lampreys are an anadromous species that is parasitic during their life in the ocean. Adult lampreys return to the Deschutes River during the summer months. It is assumed that they over-winter in subbasin streams before spawning the following spring or early summer. Willamette River subbasin lampreys spawn from February through May (Kostow 2002). Colder water temperatures in the westside Deschutes River tributaries may result in a slightly later spawning time in the Deschutes River subbasin.

Spawning generally occurs just upstream of stream riffles and often near silty pools and banks. Lampreys' fecundity is thought to be highly variable, possibly ranging from 15,500 to 240,000 eggs/female (Kostow 2002). This may suggest a variety of life history patterns or age classes in a single spawning population. Lampreys spawn in low gradient stream sections and construct gravel nests at the tail-outs of pools or in riffles. Most authorities believe that all lampreys die after spawning. However, there have been several reported observations of robust lamprey kelts migrating downstream and an indication of repeat spawning in one Olympic Peninsula population (Kostow 2002).

Lamprey eggs hatch within 2-3 weeks, depending upon water temperature. The juveniles emerge from the spawning gravel at approximately 1 cm in length. The ammocoetes burrow into the soft substrate downstream from the nest and may spend up to six or seven years in the substrate. They are filter feeders that feed on algae and diatoms. The ammocoetes will move gradually downstream, often at night, seeking coarser sand/silt substrates and deeper water as they grow. They appear to concentrate in the lower parts of basins before undergoing their metamorphism, or body transformation. After completing their metamorphism from the juvenile to adult stage, they migrate to the ocean from

November through June (Kostow 2002). In the Umatilla River this out-migration was observed to occur in the winter to early spring (Kostow 2002).

Pacific lampreys enter saltwater and become parasitic. They feed on a wide variety of fishes and whales. They appear to move quickly offshore into waters up to 70 meters deep. Some individuals have been caught in high seas fisheries. The length of their ocean stay is unknown, but some have speculated that it could range from 6 to 40 months (Kostow 2002).

Genetic Integrity

Little is known about straying of lamprey in the Deschutes River subbasin, including the straying of lamprey from other subbasins into the Deschutes. Studies of sea lamprey (*Petromyzon marinus*) in the Great Lakes indicate that some lampreys have essentially no homing behavior. Instead, the adults may be attracted to streams with concentrations of ammocoetes, which were detected by some chemical stimuli (Kostow 2002). If these observations apply to Pacific lampreys, straying may be common if the chemical stimuli are an indiscriminate attractant for all lampreys.

Effects of hatchery releases: There have been no artificial lamprey production programs anywhere within the subbasin.

Effects of harvest: All lamprey harvest in the subbasin is associated with the Tribal salmonid subsistence fishery located at Sherars Falls. Tribal harvest of adult lampreys in recent years has been low, but there are no estimates of the numbers of lampreys harvested. The first sampling program designed to monitor tribal harvest of adult lamprey from the Deschutes River is scheduled to begin in 2003 at Sherars Falls (run 2003).

Relationship with Other Key and/or Sensitive Species

Lampreys are not parasitic while in fresh water. There is an overlap of fresh water habitat with other subbasin focal fish species, but since the lampreys are filter feeders there is little opportunity for competition. Juveniles are likely a food source for other fish.

Population Trends and Risk Assessment

Risks to lamprey populations include stream habitat degradation (including erratic or intermittent flow, decreased flows, increased water temperatures and poor riparian areas), predation in all life stages, artificial barriers and the lack of appropriate screening for lampreys. They are particularly vulnerable to pollution and erratic stream flows during their juvenile or ammocoete life stage because of the length of time they reside in the stream substrate. Migrating ammocoetes are especially vulnerable to predation during their in-river and ocean migration. While most movement appears to occur at night, their size (up to 10 cm) and the number of predators — especially in the Columbia River and impoundments — pose a serious risk.

3.2.5. Sockeye Salmon

This assessment considers both anadromous sockeye salmon, which were extirpated from the subbasin about 1940, and the landlocked sockeye or kokanee salmon, which is an important subbasin fish species today. Appendix I provides a more detailed discussion of the populations.

Importance

Sockeye were an indigenous, anadromous species found in the Deschutes Subbasin and were selected as a focal species because of their historic ecological value, tribal significance and potential for re-introduction if remedial fish passage issues at the Pelton Round Butte Project are successful (Table 3.5).

Table 3.5. Rationale for Selection of Sockeye as a Focal Species.

Species Designation	Species Recognition	Special Ecological Importance	Tribal recognition
Sockeye/kokanee salmon within the Mid-Columbia ESU are not listed on the state or federal sensitive species lists.	Since sockeye salmon were indigenous to Suttle Lake and Link Creek, it is reasonable to believe a residual sockeye (kokanee) population existed as well. The 1940 lake survey of Suttle Lake (Newcomb 1941) reported that land-locked Blueback salmon were abundant. It is unknown if the indigenous form of kokanee are still present in Suttle Lake (Fies et al. 1996).	Sockeye salmon were once an important anadromous species in the subbasin, with habitat in the Deschutes River and the Metolius River and tributaries. Sockeye die shortly after spawning. Their carcasses were utilized by various scavenger species and contributed rich nutrients throughout their freshwater and associated riparian habitat. Large spawning populations of kokanee salmon are now making similar contributions to the ecosystems in the upper portion of the subbasin.	Sockeye are highly regarded by members of the Confederated Tribes of the Warm Springs Reservation. The adult sockeye salmon were a high quality fish that was an important Tribal food source. They were captured as adults on the Deschutes River at Sherars Falls and in the Metolius River system on their spawning grounds.

Population Abundance

Sockeye salmon in Suttle Lake were an indigenous species (Fies and Robart 1988; Fulton 1970; NOAA No. 618) that used Link Creek for spawning and Suttle Lake for rearing. The historic sockeye run was suppressed by the 1930's and apparently extirpated by 1940, due to passage problems on Lake Creek near the outlet of Suttle Lake (Fies et al. 1996). Recent estimates of spawning adult kokanee in the Metolius River basin range from 83,471 adults in 1996 to 569,201 adults in 2000 (Thiede et al. 2002). Modeling of potential sockeye production was completed by Oosterhout (1999) using the Passage Risk Assessment Simulation (PasRAS) for Lake Billy Chinook and tributaries based on downstream passage efficiencies and incorporates simulated life-cycle survival. Oosterhout notes that the PasRAS model is primarily intended for assessing passage options. Oosterhout (1999) ran four scenarios using collection efficiencies between 60% and 100%. Predicted spawner populations ranged from 17,472 spawners with a starting population of 1-3,000 adults and supplementation to 209,476 spawners with collection efficiencies of 100% and full seeding with supplementation.

Kokanee, the resident form of the species, provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex. The composite subbasin kokanee carrying capacity has not been estimated.

Key Life History Strategies

Sockeye salmon populations often exhibit a number of different life history patterns from each brood year's production. Most sockeye juveniles smolt and migrate to the ocean after 12 to 15 months rearing in a freshwater lake environment. A small percentage smolt and migrate after two years of lake rearing. Adult sockeye return to spawn after 1 to 3 years of ocean life (Wydoski and Whitney 1979).

Kokanee generally reach sexual maturity at age-3, and then die in the fall after spawning (Fies et al. 1998). Kokanee migrate from Lake Billy Chinook each fall to spawn in the Deschutes River above Lake Billy Chinook and in the first two miles of Squaw Creek (Fies et al. 1998). Kokanee from Lake Billy Chinook also spawn in the Metolius River and tributaries. A similar migration of Wickiup Reservoir Kokanee occurs annually in the short segment of the Deschutes River below Crane Prairie Dam.

Genetic Integrity

Out-of-basin sockeye stray into the Deschutes River and are captured in the Pelton Fish Trap each year. These fish have reached a dead-end and have no biological impact on the subbasin since the native sockeye salmon population was extirpated. There is no evidence that the small numbers of kokanee out-migrants leaving the subbasin are straying into other subbasins.

Effects of hatchery releases: Hatchery-reared kokanee salmon are released annually within the subbasin in several lakes and reservoirs, including East and Paulina lakes and Crane Prairie Reservoir. Other kokanee populations associated with subbasin lakes and reservoirs are self-sustaining. Hatchery releases of kokanee into subbasin waters have originated from a number of in-subbasin and out-of-subbasin sources. Current kokanee released into East and Paulina lakes are reared at the Wizard Falls Fish Hatchery from eggs collected annually at the outlet of Paulina Lake (Fies et al. 1998).

Effects of harvest: The only sockeye salmon harvest occurring within the basin is minor incidental harvest of a few individuals annually in the subsistence tribal fishery at Sherars Falls. Kokanee provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex.

Relationship with Other Key and/or Sensitive Species

Historically sockeye spawning and juvenile rearing occurred in the same habitat utilized by bull trout. Juvenile sockeye or kokanee could provide an important food source for sub-adult and adult bull trout. Sockeye likely interact with other species during downstream migration in the mainstem Deschutes.

Population Trends and Risk Assessment

The indigenous Deschutes River subbasin sockeye salmon population was extirpated by 1940. Currently, the only adult sockeye salmon found in the subbasin are the few fish observed at the Pelton Reregulating Dam fish trap each year. These fish are assumed to be out-of-basin strays or adults returning from kokanee that successfully migrated downstream through the Pelton Round Butte Project.

3.3. Terrestrial Focal Species

Focal species were selected by considering listed species, and by considering species of concern by local biologists. Wildlife recognized by local biologists as rare or significant to local areas in the subbasin are shown on Table 3.6. Other considerations during the focal species selection process are identified below.

Table 3.6. Wildlife Species Recognized as Rare or Significant to a Local Area.

Wildlife Species Recognized as Rare or Significant		
Species	**Significance**	**Assessment Unit(s) Locations of Local Areas**
Mule deer (white-tailed deer and black-tailed deer are also present in the subbasin)	Ungulate winter range degradation (George, p.c.)	Lower Deschutes, Metolius/Squaw Creek.
Bighorn sheep (reintroduced population)	Ungulate winter range degradation (Kunkel, p.c.)	Lower Deschutes, Eastside.
Mountain goat (former population)	ungulate winter range degradation (ODFW 2003b)	White River, Lower Deschutes, Metolius/Squaw Cr
Sharp-tailed grouse (former population) habitat	Habitat loss, grasslands (Kunkel p.c.)	East Side, Upper Crooked, Lower Crooked
Greater sage grouse	Habitat degradation, shrub-steppe (Hanf, p.c.)	Lower Crooked River, Upper Crooked River
Golden eagle habitat	Threat of habitat degradation, rimrock and cliff nesting sites (Gilbert p.c.)	All except Cascade Highlands

Managed Wildlife Species. Currently, 68 wildlife species are harvested during hunting seasons in the subbasin (Appendix III).

HEP Wildlife Species. Species used in loss assessments for hydrosystem development. Twenty-four wildlife species used in the HEP process occur in the subbasin (Appendix III).

Partners in Flight. High priority bird species used for monitoring. A total of 111 species occurring in the subbasin were listed by the Partners in Flight organization (Appendix III).

Critical Functionally Linked Species. A list of critical functionally linked species thought to occur historically in the subbasin (Appendix III).

Species of Special Cultural Significance. Members of the Confederated Tribes of the Warm Springs Indian Reservation consider all forms of wildlife to be culturally important. While some species are important primarily for one purpose, such as food, often a single species is important for several reasons. For example, mule deer are important as food, but non-food parts of each animal could be valuable for clothing, regalia, medicine, and other uses. The presence of frogs in a small spring might indicate that the water is safe to drink. The complex relationship between tribal members and wildlife of all species in the subbasin is a fundamental part of tribal culture (Calvin 2004).

Based on these considerations, seven terrestrial focal species were selected (Table 3.7). These focal species were chosen to represent a “guild” of species whenever possible, for example, the sharp-tailed grouse could represent grassland species, and the sage grouse could represent shrub-steppe species.

Table 3.7. Wildlife Focal Species in the Deschutes Subbasin.

Wildlife focal species selected and rationale for selection, and associated habitats.

Focal Species	Rationale for Selection*	Associated Habitats
American beaver	Riparian habitat species, modifies habitat. On list 5.	Riparian, herbaceous wetlands.
Columbia spotted frog	Riparian habitat and herbaceous wetlands habitat species. List 1.	Riparian, herbaceous wetlands
White-headed woodpecker	Large ponderosa pine tree habitat species. List1.	Ponderosa pine forest and woodlands.
Mule deer	Ungulate winter range habitat species. Lists 2 and, 4.	Ungulate winter range.
Greater sage grouse	Shrub-steppe habitat species. Lists: 1,2,3,4,5.	Shrub-steppe.
Columbian sharp-tailed grouse	Grassland species. List 3.	Eastside interior grasslands.
Golden eagle	Cliff and rimrock habitat, grassland, shrub-steppe habitat species. List 2.	Cliff and rimrock habitats, grassland, shrub-steppe.

* 1=threatened, endangered, and state sensitive species, 2=species recognized as rare or significant to a local area, 3=Partners in Flight species, 4=HEP species, 5=game species, 6=critically functionally-linked species.

Species accounts for each terrestrial focal species are presented in Appendix III. These accounts present biological, populations and trends data if available. A summary of status for each focal wildlife species in the subbasin is presented in Table 3.8. Of the focal species selected, only the sharp-tailed grouse has been extirpated from the subbasin (Csuti et.al 2001). Local biologists believe the American beaver has been extirpated from many former habitat areas in the subbasin, as are Columbia spotted frogs. No introduced species were chosen as focal species.

Current and Historical Habitat types are shown on Maps 9-12 for the Deschutes Subbasin and larger Columbia Plateau Province.

Table 3.8. Terrestrial Focal Species Distribution, Populations and Trends.

Species	Terrestrial Focal Species Distribution in Assessment Units	Population and trends
American beaver	All	Historically depleted, but now recovered. Currently harvested during hunting and trapping season, population tracked by ODFW
Columbia spotted frog	Upper Crooked River	Remnant population. Declining.
White-headed woodpecker	All	Status unknown.
Mule deer	All	Game animal. Population tracked by ODFW. Declining in some areas due to development on winter ranges.
Greater sage grouse	Upper Crooked River, Lower Crooked River.	Game bird. Population tracked by ODFW. Declining.
Columbian sharp-tailed grouse	Extirpated.	Extirpated.
Golden eagle	All.	57 active nest territories counted in 2000 (Clowers 2004.) Population trend unknown in Oregon (Ibid, Marshall 2003.) Some indications of decline in the general region of northern Great Basin (Marshall 2003 p. 162.)

3.3.1. American Beaver

Importance

The American beaver was chosen as a focal species because of its unique habitat-altering role in riparian habitats. This unique species alters the riparian habitat by constructing dams across streams to form still-water ponds, building stick lodges in the ponds, felling large trees into the water, and transporting smaller woody material into the aquatic environment.

Population Abundance and Distribution

The beaver occurs throughout most of the U.S. and Canada and into northern Mexico, except for the Arctic northern fringe, southern Florida and California, and the southern half of Nevada (Burt 1976). The beaver occurs throughout the State of Oregon. The subspecies *Castor Canadensis leucodontus*, a large chestnut-brown colored variation, occurs in the northern two-thirds of Oregon east of the Cascade Range, including the Deschutes Subbasin (Ibid).

No estimates of beaver populations are available for Oregon and, in the absence of systematic population estimates, harvest and damage complaint levels are considered indicative of the population levels in local areas and statewide (Ibid). From 1981 to 1991, over 5,000 complaints of beaver damage were received by the Oregon

Department of Fish and Wildlife (Ibid). During the 1930s, many beaver were transplanted in Oregon from areas of damage to areas of suitable habitat with no beaver (Ibid). The range of reported annual beaver harvests for the counties within the Deschutes Subbasin for the years 1990-95 are shown in Table 3.9. Clatsop County's harvest range is shown for comparison. Special beaver harvest regulations were in place within the subbasin for July 1, 2002 through June 30, 2004 (ODFW 2002).

Table 3.9. Range of Annual Beaver Harvest for the Years 1990-95 for counties in the Deschutes Subbasin. Clatsop County harvest range is shown for comparison.

County	Range of Numbers of Beaver Harvested Annually, 1990-95.
Clatsop	212-821
Deschutes	31-63
Crook	13-50
Hood River	18-40
Jefferson	4-31
Sherman	No numbers shown (previous 5 years: 0-8)
Wasco	24-86

All wetland cover types (e.g., herbaceous wetland and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation in order to provide suitable beaver habitat (Slough and Sadleir 1977). Water provides cover for the feeding and reproductive activities of the beaver. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge (e.g., high spring runoff) or a stream channel gradient of 15 percent or more, will have little year-round value as beaver habitat.

Beavers can usually control water depth and stability on small streams, ponds, and lakes; however, larger rivers and lakes where water depth and/or fluctuation cannot be controlled are often partially or wholly unsuitable for the species (Murray 1961; Slough and Sadleir 1977). Rivers or streams that are dry during some parts of the year are also assumed unsuitable beaver habitat (Ashley and Stovall 2004). In riverine habitats, stream gradient is the major determinant of stream morphology and the most significant factor in determining the suitability of habitat for beavers (Slough and Sadleir 1977). Stream channel gradients of 6 percent or less have optimum value as beaver habitat (Ashley and Stovall 2004).

An adequate and accessible supply of food must be present for the establishment of a beaver colony. The actual biomass of herbaceous vegetation will probably not limit the potential of an area to support a beaver colony (Boyce 1981). However, total biomass of winter food cache plants (woody plants) may be limiting. Low marshy areas and streams flowing in and out of lakes allow the channelization and damming of water, allowing access to, and transportation of, food materials (Ashley and Stovall 2004).

Key Life History Strategies

The basic composition of a beaver colony is the extended family, comprised of a monogamous pair of adults, subadults (young of the previous year), and young of the year (Svendsen 1980). Female beavers are sexually mature at 2.5 years old. Females normally produce litters of three to four young with most kits being born during May and

June. Gestation is approximately 107 days (Linzey 1998). Kits are born with all of their fur, their eyes open, and their incisor teeth erupted (Ashley and Stovall 2004).

Subadults disperse during the late winter or early spring of their second year, with increased runoff from snowmelt or spring rains. Subadult beavers have been reported to disperse as far as 236 stream km (147 mi) (Hibbard 1958), although average emigration distances range from 8 to 16 stream km (5 to 10 mi) (Hodgdon and Hunt 1953; Townsend 1953; Hibbard 1958; Leege 1968). The daily movement patterns of the beaver centers around the lodge or burrow and pond (Rutherford 1964; Ashley and Stovall 2004).

3.3.2. Columbia Spotted Frog

Importance

The Columbia spotted frog was chosen as a focal species since it represents species that require a permanent-water habitat. The species occupies habitats in the Crooked River drainage. The Oregon spotted frog, while not a focal species, shares many of the same habitat requirements. Important habitat for this spotted frog lies in the upper Deschutes subbasin. Immediate opportunities exist for spotted frog habitat restoration.

Population Abundance and Distribution

The adult Columbia spotted frog (*Rana luteiventris*) is about 4 inches long, not including the legs. The adult frogs are green to greenish-brown, with large black spots on the back. Eggs are deposited in a soft, orange-sized egg masses, sometimes several egg masses on top of one another, and the egg masses may separate and float on the top of the water in a frothy mass before hatching. Tadpoles are small, from 0.25 in. to 1.5 in. long.

This frog occurs from British Columbia south into Eastern Oregon and Northern Nevada and Utah in small isolated populations (Csuti et al. 2001). In the Deschutes Subbasin, it occupies small areas in the upper and lower Crooked River drainage (Carey 2004).

The Columbia spotted frog is relatively aquatic and is rarely found far from water. It occupies a variety of still water habitats, and can be found in streams and creeks (Hallock and McAllister 2002). They are closely associated with clear, slow-moving or ponded surface waters, with little shade (Reaser 1997). The Columbia spotted frog occupies aquatic sites with a variety of vegetation types, from grasslands to forests (Csuti 1997). A deep silt or muck substrate may be required for hibernation and torpor. In colder portions of their range, they use areas where water does not freeze, such as springheads and undercut streambanks with overhanging vegetation (IDFG et al. 1995). They may disperse into forest, grassland, and brushland during wet weather, and will use streamside small mammal burrows as shelter. Adults are opportunistic feeders and feed primarily on invertebrates. Larval frogs feed on aquatic algae and vascular plants, and scavenged plant and animal materials (Morris and Tanner 1969).

Key Life History Strategies

Columbia spotted frog populations reproduce in habitats characterized by springs, floating vegetation, and larger bodies of pooled water (e.g., oxbows, lakes, stock ponds, beaver-created ponds, seeps in wet meadows, backwaters) (IDFG et al. 1995; Reaser 1997). Breeding habitat is the temporarily flooded margins of wetlands, ponds, and lakes (Hallock and McAllister 2002). Breeding habitats include a variety of relatively exposed, shallow-water (<60 cm), emergent wetlands such as sedge fens, riverine over-bank pools, beaver ponds, and the wetland fringes of ponds and small lakes. Vegetation in the breeding pools generally is dominated by herbaceous species such as grasses, sedges and rushes.

Though movements exceeding 1 km (0.62 mi) and up 5 km (3.11 mi) have been recorded, these frogs generally stay in wetlands and along streams within 0.6 km (0.37 mi) of their breeding pond (Bull and Hayes 2001). Frogs in isolated ponds may not leave those sites.

3.3.3. White-headed Woodpecker

Importance

The white-headed woodpecker was chosen as a focal species due to the unique large ponderosa pine tree habitat required by this species, which was of some special concern in the subbasin, and its role as a primary excavator of tree cavities that are used by other species.

Population Abundance and Distribution

The white-headed woodpecker (*Picoides albolarvatus*) is a robin-sized black woodpecker with white wing patches which are visible in flight, and is the only woodpecker in Oregon with a white head, although the acorn woodpecker is somewhat similar with some white on the head (Robbins 1966).

This woodpecker is found from interior British Columbia south to Nevada and southern California. In Oregon, it is found in the Ochoco, Blue, and Wallowa mountains in Eastern Oregon, and also in some areas in the Siskiyou Mountains and on the “north part of the east slope of the Cascades” (Marshall et al. 2003). Marshall et al. (2003) states that this bird occurs in “…open ponderosa pine or mixed-conifer forest dominated by ponderosa pine.” It may occur in areas dominated by large-diameter ponderosa pine even if the stand has undergone silvicultural treatments such as thinning (Ibid.). The range in Oregon appears not to have changed from 1940, but “…seems to have become more patchy because of habitat deterioration (Ibid.). White-headed woodpecker density found in 1997 on five study areas in the Deschutes National Forest were calculated to be 0.03-1.54 birds per 100 acres. Still, the population may be declining on the forest, despite the fact that the Deschutes and Winema National Forests may provide some of the best remaining white-headed woodpecker habitat in Oregon (ibid.).

Key Life History Strategies

White-headed woodpeckers excavate nests in large-diameter snags, stumps, leaning logs, and dead tops of live trees. Mean dbh of nest trees in the Deschutes National Forest was found to be 25.6 in. or 65 cm for 43 nests observed (Ibid). Nesting activities occur in May and June, and young birds fledge in June and July.

This woodpecker is non-migratory. Some seasonal wandering outside the nesting territory occurs.

3.3.4. Mule Deer

The Rocky Mountain Mule Deer (*Odocoileus hemionus hemionus*) is a native species to Oregon, and occurs generally east of the crest of the Cascade Mountains, including the entire Deschutes Subbasin (ODFW 2003). It was chosen as a focal species because it serves as an example of species that use aspen groves, oak groves, and ungulate winter ranges.

Population Abundance and Distribution

Mule deer occupy all terrestrial habitats in the subbasin (IBIS 2004). Oregon Department of Fish and Wildlife biologists survey mule deer in Oregon each year to estimate the populations in each of the wildlife management units that make up the Eastern Oregon mule deer range. The population objective for the nine wildlife management units that exist in the Deschutes Subbasin is total of 71,500 deer (Table 3.10). This total could be considered an estimate of the current deer population in the Deschutes Subbasin.

Table 3.10. Population management objectives for mule deer for 9 wildlife management units that approximately make up the Deschutes Subbasin, Oregon; mule deer population estimate for Warm Springs Reservation; and hunting tags issued, hunter-days expended, and deer harvest estimates for 1996 for the 9 wildlife management units and the Warm Springs Reservation (ODFW 2003).

Wildlife management unit	1996 Hunting Tags	1996 Hunter-days used	1996 Hunting Harvest	Population management objective (1990)
Ochoco	6324	34,959	1199	20,500
Grizzly	2843	15,823	810	8,500
Maury	1035	4,804	273	5,200
Maupin	355	1,167	198	3,000
White River	2920	12,977	826	9,000
Hood	641	2,923	118	400
Metolius	2307	11,420	581	6,200
Paulina	3425	20,088	705	16,500
Upper Deschutes	4425	26,971	679	2,200
Warm Springs Reservation	1300	--	455	7,100*
Total	25,575	131,132	5844	71,500

*Population estimate calculated by biologists in spring 1998 (CTWSRO 1999).

Key Life History Strategies

Mule deer generally summer at higher elevations, then move to lower elevations for the winter. These lower elevation areas are referred to as winter ranges (Map 13).

Mule deer are adapted to the cycle of food availability during the year, so that they are able to maintain functions during cold winters when food is scarce, and then are able to take advantage of food abundance in the summer for reproduction and for storing fat reserves for winter. During winter, mule deer utilize snow as a source of water, but require free water during other times of the year, especially nursing females and fawns.

Supplemental winter feeding may or may not be effective in saving deer that are starving, depending on when the feeding is started and what feed is provided to the deer.

Mule deer feed on a wide variety of grasses, small weedy plants, and leaves and twigs in a selective manner, choosing the best pieces of forage based on smell, taste, appearance, and touch, and the physical form of their long nose and teeth are well suited to this selective feeding (Wallmo 1981). During critical winter months, new growth on the ends of twigs on shrubs and trees serve as food for mule deer. Sagebrush, bitterbrush, rabbitbrush, juniper and mountain mahogany are also eaten during winter. Deer also eat acorns, legume seeds, and fleshy fruits, and mushrooms and other fungi, all of which are highly digestible for the deer digestive system (Wallmo 1981).

Breeding occurs in the fall and winter from October through early January, and one to three fawns are born by each doe the following May through July. A buck deer will seek out and mate with many females, and there is no pair fidelity. The female cares for the fawn.

3.3.5. Greater Sage Grouse

Importance

Greater sage grouse was chosen as a focal species due to the unique aspects of habitat requirements of the bird within the steppe habitats, and special concerns for components of the areas the bird inhabits. The sage grouse requires a very specific plant species, big sage, within the shrub steppe habitat, and the concern for steppe habitat management involving fire and plant succession and plant species composition changes is an issue in the subbasin as well as throughout the West.

Population Abundance and Distribution

The greater sage grouse is a pheasant-sized bird. The male has black markings on the belly and throat and neck, while the female appears uniformly gray (Robbins et al. 1966). Of the three subspecies of sage grouse, the subspecies occupying areas in the Deschutes Subbasin is *Centrocercus urophasianus urophasianus* (Marshall et al. 2003).

Once found across most of the Western U.S. and into Canada, the sage grouse "…now has a local reduced population in the central part of western North America." "…from Eastern Washington to North Dakota." (Csuti et al, 2001). Marshall (2003) states that sage grouse had contracted in range in Oregon by 50 percent from previous population levels by the 1940's, and that populations were lost in the Blue Mountains and Columbia Plateau ecoregions of Oregon by that time. In the Deschutes Subbasin, sage grouse are currently found in eastern Crook and Deschutes counties (Ibid,) within the Upper Crooked and Lower Crooked assessment units.

Key Life History Strategies

No regular migration occurs, but sage grouse may move several miles between feeding and brooding areas to find suitable forage, and will move several miles to areas where sage is not covered by snow to obtain forage in the winter (Marshall et al. 2003). Sage grouse primarily eat the leaves of sagebrush throughout the year, but small weedy plants and insects are important during the nesting and brood seasons. They do not eat grasses.

Male sage grouse gather on display areas, or leks, in late February, and strut early in the mornings, beginning before dawn, to attract females. Females are attracted from surrounding habitat by the males displaying, and may choose a single male in a certain area of the lek as the primary breeding male. Leks are usually areas of sparse vegetation within sagebrush habitat. New leks have been established on recently burned sites. Nests are established as shallow depressions lined with grass, usually under sagebrush, and usually in taller sagebrush habitat. Eggs are laid in May, and hatch in late May to mid-June. Nest success from an area near Prineville was 31 percent, with most unsuccessful nests the victims of predators. Hens may return to the lek and then renest after losing the first nest. Nest success in Oregon is lower than that reported from other areas states (Marshall et al. 2003).

3.3.6. Columbian Sharp-Tailed Grouse

Importance

The Columbia sharp-tailed grouse was chosen as a focal species due to the unique aspects of its habitat requirements. The sharp-tailed grouse requires a mix of riparian and grassland habitat types within the steppe habitat, and riparian habitat issues have been identified as the first priority in the subbasin.

Population Abundance and Distribution

Sharp-tailed grouse were called prairie chickens by early Oregon residents, and these birds were abundant in grasslands and foothills in Eastern Oregon “prior to the late 1800s” (Marshall et al. 2003). Although sharp-tailed grouse have not been found in Eastern Oregon or the Deschutes Subbasin since the 1970s, it is thought by local biologists to be a good candidate for future re-introduction in the subbasin. An unsuccessful re-introduction of the plains sharp-tailed grouse subspecies *Tympanuchus phasianellus jamesi* was conducted in Jefferson and Wasco counties in 1963 (Marshall et al. 2003). Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus* are being re-introduced in an ongoing effort near Enterprise in Wallowa County, Oregon that was started in 1991, and some success seems to have occurred. The Oregon Department of Fish and Wildlife was reported to be considering areas for restoration of sharp-tailed grouse populations west of the Blue Mountains prior to 2003.

The sharp-tailed grouse is a pheasant-sized bird with an overall light gray-brown coloration. Sexes are similar in appearance. When in flight, the narrow pointed tail is edged in white, distinguishing the sharp-tail from pheasants (Robbins et al. 1966). Of six subspecies, only the Columbian sharp-tailed grouse was found in Oregon (Marshall et al. 2003).

Key Life History Strategies

Sharp-tailed grouse inhabit grasslands or grass-shrublands and utilize deciduous shrubs and trees for wintering (Marshall et al. 2003). Adult birds feed extensively on small weedy plants, and chicks require insects for feed. In the winter when snow covers ground plants, birds feed on the buds of quaking aspen, chokecherry, black hawthorn, and willow. In Wallowa County, Oregon where Columbian sharp-tailed grouse are being released to establish new populations, birds can be seen in the winter perched in shrubs and small trees, presumably feeding on buds. Marshall (2003) reports that birds moved as far as four miles to deciduous shrub patches after a heavy snowfall. In Wallowa County, Oregon released birds used Conservation Reserve Program agricultural fields that were planted to perennial grasses and small weedy plants for lek sites and for late summer and fall feeding.

Male birds display on special openings in the grasslands or grass-shrubland called leks from early March through early June, attracting females for breeding. Nesting occurs in May and June. Two nests found near the mouth of the Deschutes in 1935 consisted of slight hollows in the ground of an agricultural grainfield lined with grasses, grains, stems, and feathers (Gabrielson and Jewett 1970).

Columbian sharp-tailed grouse are non-migratory, but may move several miles away from the lek during the year (Csuti et al. 2001). The grouse form flocks during the winter.

3.3.7. Golden Eagle

Importance

Golden eagles are a native species to the subbasin and are protected by the Bald Eagle Protection Act. It is unlawful to possess any part of any eagle except by federal permit. Four counties in the Deschutes subbasin have adopted ordinances designed to protect golden eagle nest sites by regulating development within a 0.25-mile zone around the nest: Deschutes, Jefferson, Crook, and Wasco counties (Marshall et al. 2003). The golden eagle serves as an example of species that require cliffs and rimrocks for habitat.

Population Abundance and Distribution

The golden eagle (*Aquila Chrysaetos*) is one of two eagles occurring in Oregon, the other being the bald eagle. The golden and bald eagle are the largest raptors currently occurring in Oregon, formerly being exceeded in size only by the condor. Adult golden eagles are colored a rich brown with lighter golden nape feathers, and the sexes are similarly colored. Adult and juvenile golden eagles are easily confused with immature bald eagles, all three birds being generally dark colored at a distance (Robbins 1966).

The golden eagle occurs worldwide. In North America, it occurs in Alaska and Canada, and in western North American south to Mexico (Csuti et al. 2001). Golden eagles occur most commonly east of the Cascades in Oregon, and have been noted from all Eastern Oregon counties, including all counties in the Deschutes Subbasin (Marshall et al. 2003).

Numbers of golden eagles in Oregon were estimated to number 1,000-1,500 in 1982 (Marshall et al 2003). Numbers of golden eagles observed during mid-winter bald eagle surveys in Oregon during 1992-2001 have averaged 97 (Ibid). Fifty-seven active golden eagle nesting territories were identified in the Deschutes Subbasin in 2000 (Clowers 2004). Taking into account areas not inventoried by past surveys, biologists estimate that about 60 nesting territories currently exist in the subbasin (Carey 2004). The population trend of golden eagles in Oregon, or the Deschutes subbasin is unknown (Marshall et al. 2003; Clowers 2004).

Key Life History Strategies

Generally, golden eagles in Oregon are considered resident birds, but out-of-state migrant golden eagles from northern regions have been recorded passing through the State (Marshall et al 2003).

Unlike the bald eagle, golden eagles are aggressive hunters. The black-tailed jackrabbit was historically a basic food item for golden eagles, but other animals such as marmots, ground squirrels, birds such as sage grouse and sharp-tailed grouse, and other species are taken. Golden eagles kill deer and pronghorn fawns, wild and domestic lambs, and will eat fresh carrion and steal prey from other raptors.

Nests are established most frequently in cliffs (65 percent of 506 occupied nests in Oregon in 1982), but nests are also built in large trees greater than 30 inches dbh, and occasionally on electric towers. Egg-laying occurs from late February to mid-April and young are fledged between Late June and early August. Breeding territories range in size between 10-40 sq. mi., and may include several habitat types. Alternate nest sites, consisting of partially built or complete nests, within the same nesting territory may be maintained. Tolerance to human disturbance at nest sites varies widely among individual nesting pairs; some are very tolerant, others will abandon the nest if disturbed.

Environmental Conditions — Section 4

The unique geology, hydrology and climates of the Deschutes River Subbasin create a diverse mix of habitat conditions for fish and wildlife. These populations are linked to the ecosystems in which they live and their health, individual characteristics and abundance reflect the diversity — and quality — of their environments.

This section describes the often diverse environmental conditions that define the Deschutes River watershed. It builds on the more general review provided in the Overview by discussing conditions within the eight assessment units (Map 14):

- **Lower Westside Deschutes Assessment Unit:** Lower Deschutes River from RM 0 to RM 100, the Warm Springs River and Shitike Creek, and all small tributaries entering the lower Deschutes River.
- **White River Assessment Unit:** White River watershed above White River Falls (RM 2).
- **Lower Eastside Deschutes Assessment Unit:** Major Deschutes River tributaries draining the lower eastern portion of the Deschutes Subbasin, including Buck Hollow, Bakeoven, Trout and Willow creeks.
- **Lower Crooked River Assessment Unit:** Lower Crooked River drainage below Bowman and Ochoco dams, including lower Ochoco Creek and McKay Creek.
- **Upper Crooked River Assessment Unit:** Upper Crooked River drainage above Bowman and Ochoco dams, including upper Ochoco Creek, north and south forks of the Crooked River and Beaver Creek.
- **Middle Deschutes Assessment Unit:** The 32-mile reach of the Deschutes River from the Pelton Round Butte Complex (RM 100) to Big Falls (RM 132) and its two major tributaries, Metolius River and Squaw Creek.
- **Upper Deschutes Assessment Unit:** The upper Deschutes River drainage from Big Falls to Wickiup Dam (RM 222), including Tumalo Creek, Spring River, the Little Deschutes River and Fall River.
- **Cascade Highlands Assessment Unit:** The Deschutes River drainages above Wickiup Dam, including the Cascade Lakes.

The section looks briefly at historical conditions within each assessment unit — those conditions believed to exist at the time of European settlement in the early and mid 1800s. It summarizes unique environmental conditions in each assessment unit that exist today. In addition, it identifies desired future conditions for the assessment units, and examines what future conditions might exist with no additional actions. Appendix II provides more detailed information on environmental conditions in the Deschutes Subbasin.

4.1. Lower Westside Deschutes Assessment Unit

The lower 100 miles of the Deschutes River flow through a low gradient channel with scattered rapids set in a deep, narrow, arid valley. Stream width of the lower river averages 236 feet and varies from 30 to 560 feet, excluding islands. The reach provides important spawning and rearing habitat for fall chinook, summer steelhead and redband trout, and rearing habitat for spring chinook and bull trout. Salmonids also use the reach as they move to and from tributary spawning and rearing grounds.

Principal westside tributaries of the lower Deschutes River are the Warm Springs River and Shitike Creek. Both watersheds lie within the Warm Springs Reservation. The Warm Springs watershed covers 526 square miles, reaching from 3,775 feet in elevation in the Cascade Mountains to 1,230 feet at its confluence with the Deschutes River (RM 84). The river flows 53 miles and provides 41 miles of anadromous fish habitat. Two major tributaries, Mill Creek and Beaver Creek, also support anadromous fish. Shitike Creek drains 76 square miles, with elevations ranging from 5,280 to 1,476 feet. It extends 30 miles, providing 25.7 miles of anadromous fish habitat, and joins the Deschutes River at RM 97. Minor westside tributaries include Fall, Ferry Canyon, Oak Brook, Wapinitia, Nena, Eagle and Skookum creeks. Minor eastside tributaries include Macks Canyon, Jones Canyon and Stag Canyon creeks. These are generally short, steep streams with small watersheds. The assessment unit also includes the lower two miles of White River below White River Falls, which provides spawning and rearing habitat for resident redband trout and summer steelhead.

Cliffs and rimrocks are present along many of the stream and river canyons, and are valuable habitat for species such as the golden eagle. Ungulate winter ranges are present on many low elevation hillsides and valleys.

4.1.1. Historical Conditions

Before 1855, lower Deschutes River channel characteristics and configurations resembled those seen today. The river flowed within a constrained channel flanked by deep canyon walls with few side channels. Streamflow was quite uniform throughout the year, due to a high contribution of spring fed waters from upstream springs. Periodic high flow events and associated bedload redistribution occurred, but were infrequent (Hosman et al. 2003). Flows from runoff-dominated tributaries were moderated by well vegetated floodplains, which stored and released water throughout the drier summer months. This stable flow pattern supported healthy riparian communities. Alder, willow, birch and some cottonwood trees dominated riparian vegetation with shrubs, grasses, sedges, rushes, and other forbs skirting the water’s edge. Water temperatures in the mainstem and many tributaries were also more stable year-round, due to the moderating effect of upstream springs.

The Warm Springs River and Shitike Creek displayed complex and very favorable riparian and instream channel conditions for salmonid production (CTWS 1999a). Variable habitat characteristics within constrained and unconstrained stream reaches provided single and multiple channel areas. Beaver created off-channel habitat and wet meadows along unconstrained reaches. Riparian corridors were well developed with deciduous and coniferous trees, shrubs and grasses. Groundwater recharge from wet meadows and beaver complexes stabilized summer flows and moderated water temperatures. Summer water temperatures were optimal for salmonid growth and survival, while cold winter flows were moderated by springs and groundwater discharge from well developed riparian areas. Abundant supplies of large woody debris and logjams provided high quality fish hiding and rearing habitat, and sorted and collected gravel suitable for fish spawning. Stable watershed conditions produced smaller fine sediment loads in the Warm Springs River and Shitike Creek (CTWS 1999a).

Eagle, Nena, Wapinitia, Oak Brook, Jones Canyon, Macks Canyon, Stag Canyon and Ferry Canyon creeks drained smaller watersheds, but frequently contained good spawning gravel for summer steelhead and redband trout. Diverse riparian corridors with functional floodplains provided good instream habitat complexity. Some juvenile salmonids left these streams to rear in the Deschutes as flows receded in late spring.

Historic habitat maps indicate that nearly 100,000 acres of wild grassland habitat were once present in the assessment unit (IBIS 2003). The grasslands mostly covered three large areas in the center and north end of the assessment unit. Shrub-steppe habitat and ponderosa pine forests dominated remaining areas at mid- and lower elevations, with mixed conifer forests in the higher elevations in the Cascades.

4.1.2. Current Conditions

Uplands

The lower Deschutes subbasin displays steppe, shrub-steppe and juniper savanna habitats in the canyon and plateau areas, and coniferous forests in the Cascade mountains. The Warm Springs River and Shitike Creek begin in mountain forests and drop into semi-arid environments. Lands are in public, Tribal and private ownership and generally managed for agriculture, range, timber harvest and recreational uses. Comparison of historic and current habitat maps indicates that 37 percent of historic ponderosa pine forest shave been replaced by mixed conifer forests (IBIS 2003).

Degradation of many upland areas has occurred through livestock use, forest and agricultural practices, and invasion by western juniper and noxious exotic vegetation. Native grasslands in the assessment unit have been completely replaced by agricultural crops, shrub-steppe and juniper woodlands. Many oak groves once present on benches above the streams and rivers are also now gone. The loss of grasslands, oak and cottonwood groves, and conversion of habitat to other uses has degraded ungulate winter ranges. In some areas, development for homesites and other uses have reduced use of cliff and rimrock habitat that supports many wildlife species, including golden eagle and bighorn sheep.

Many upland areas show reduced ability to capture and slowly release precipitation. Still, watershed stability in the Warm Springs River and Shitike Creek drainages is usually good to very good, with higher stability in upper watersheds. Several drainages, including Warm Springs tributaries Quartz and Coyote creeks, have highly erosive soils and watershed stability is poor to fair (CTWS 1999b). Uplands in the smaller Deschutes River tributaries are often more prone to erosion, primarily due to conversion of native grasslands to grazed range and tilled fields.

Riparian Areas

The lower mainstem is confined in a deep, narrow valley with interspersed basalt canyon walls and shows many aspects of a spring-controlled system. Many reaches are lined with a narrow fringe of trees and other riparian vegetation. The channel is remarkably stable and has not shifted more than 200 feet in the last 90 years, despite two exceptionally large floods (O'Connor et al. 2003, Curran and O'Connor 2003). In some areas, land use activities have degraded vegetation and reduced habitat complexity along stream margins of the lower Deschutes. However, camping and vehicle use restrictions, and grazing management have initiated riparian recovery in some reaches. Riparian condition along some reaches of the lower Deschutes has improved dramatically over the last 20 years because of restoration efforts.

The Warm Springs and Shitike Creek drainages show a slight to moderate loss of riparian vegetation or vegetative species diversity and of proper floodplain function. Many stream reaches remain in good to excellent condition, with overall conditions improving as land management practices improve. Complex riparian vegetative corridors with good species diversity armor these stream reaches. One of the largest remaining stands of old growth cottonwood in the area frames the lower six miles of Shitike Creek. The greatest losses of habitat quality have occurred along lower stream reaches, although timber harvest and livestock grazing have degraded localized areas in the upper watershed. In the Warm Springs system, stream channels have been incised along the Warm Springs River (Ka-Nee-Ta Resort area), Beaver Creek (below Quartz Creek) and in the Quartz and Coyote Creek systems. Channel alterations and stream bank armoring along the lower Warm Springs River in the Ka-Nee-Ta Resort area degrade two to three miles of riparian and floodplain lands. Parts of lower Shitike Creek below RM 4 are also degraded. Smaller Deschutes River tributaries have lost riparian vegetative species diversity due to land use practices. The three smaller eastside stream drainages have been ravaged by wild fires in the last ten years.

Instream Habitat

A complex aquatic habitat — including large boulders, bedrock irregularities, rooted aquatic macrophytes, overhanging vegetation, and varying water turbulence and depth — provides diverse cover for focal species in the lower 50 miles of the Deschutes River. The stream and island margins provide important rearing habitat and escape cover for 0-age fish. In 1995, about 68 percent of all steelhead spawning from the Reregulating Dam to the mouth of Trout Creek occurred in side channels between islands and channel margins, despite the fact that such side channels comprise less than 10 percent of the channel length within the reach (Zimmerman and Ratliff 2003; Zimmerman 2000). Large boulders and cobble also provide good instream structure. Wood from riparian areas, mainly dead white alders, accumulates between high flows and enhances instream habitat.

Some reaches are deficient in instream structural habitat diversity. The substrate of the lower 46.5 miles of the Deschutes River contains high levels of glacial sand and silt that originate from White River. The lower river also receives heavy silt loads from other tributaries during high intensity storms. As a result, lower mainstem spawning areas often contain high amounts of glacial sand and silt and are frequently embedded (Huntington 1995). Fine sediments also impact larger gravels used by fall Chinook salmon, though these larger fish move and clean the substrate during spawning (Huntington 1995).

Warm Springs River and Shitike Creek channels have boulder/cobble substrate floors that create good spawning and rearing habitat. Spawning gravel abundance, however, has likely declined below historic levels because of a drop in large wood supply due to land use practices (Weldon 2004). Fine sediment content in spawning gravels is also a concern. Instream channel structure, cover and complexity has been lost due to flashier flow regimes, channel simplification, and land use practices, particularly along lower reaches of the Warm Springs River and Shitike Creek.

Flashy flow regimes have accelerated floodplain scouring and loss of instream habitat structure in the small westside Deschutes River tributaries. The few remaining pools, which contain little or no cover or cool spring water inflow, provide limited salmonid habitat. Many small eastside tributary reaches also lack instream habitat complexity. Lack of instream cover makes fish more susceptible to harassment and predation. Fish passage obstacles at road crossings of Jones Canyon and Stag Canyon creeks hinder upstream movement.

Flows

The lower river experiences only small seasonal variations in discharge because of the large groundwater contributions from the upper Deschutes River, Metolius River and lower Crooked River (Gannett et al. 2003). Groundwater contributions boost flow further in this stretch of the Deschutes, as the river gains 400 cfs from groundwater inflow between Round Butte Dam and Dry Creek at RM 91.8 (Gannett et al. 2001). The river level is also controlled by long-term weather patterns and by Pelton Round Butte Complex operations. Mean annual flow near the confluence with the Columbia River (Moody gage) averages 5,739 cfs and ranges from 4,290 to 7,380 cfs. Maximum flows occur from January through March and minimum flows from July to October. Water withdrawals from the lower reach for irrigation or other uses are minimal. Flows from lower westside tributaries contribute significantly to peak flows in the mainstem Deschutes. More than 70 percent of the peak discharges of both the December 1964 and February 1996 flood flows in the lower Deschutes entered the river below the Pelton Round Butte Complex (O'Connor et al. 2003).

Snowmelt dominates runoff in the Warm Springs River and Shitike Creek, causing flows to peak in spring, taper off throughout summer, and drop to base flows in August or September. The Warm Springs River maintains a mean annual flow of 425 cfs and recorded flows range from 149 to 24,800 cfs. Shitike Creek contributes a mean annual flow of 93.3 cfs to the Deschutes River and recorded flows range from 17 to 4,500 cfs. Flows in smaller westside Deschutes tributaries are also dominated by snowmelt and peak in the spring. High flows in these drainages taper off through summer and drop to base flow or, in some cases, dry channels. Occasionally, warm winter storms cause rain-on-snow events with extremely high flows in the affected drainages. Small eastside Deschutes River tributaries have extended reaches with intermittent flow or dry channel during the summer and fall months.

Water Quality

The lower Deschutes River and several westside tributary reaches are included on the 2002 ODEQ 303(d) list of water quality limited streams (Appendix II, Table x). The lower Deschutes exceeded temperature criteria for spawning below White River, and for bull trout (50°F) and salmonid rearing (55°F) from White River to the Reregulating Dam. The reach above White River also exceeded the dissolve oxygen criteria for salmonid spawning from September 1 to June 30. In addition, the lower Deschutes exceeded the State's pH standard 23 percent of the time at the river mouth and 11 percent of the time at RM 96 (ODEQ 2002). White River flushes large amounts of glacial sand and silt into the lower Deschutes River that occasionally cause significant turbidity (ODFW 1997).

Water temperatures in lower reaches of the Warm Springs River and Shitike Creek can exceed 70 °F from mid to late summer. Excessive sediment loads also occur occasionally in the Warm Spring River, primarily due to runoff from lower tributaries, including Coyote and Quartz creeks in the Beaver Creek drainage. Turbidity from intermittent tributaries also reduces water quality in Shitike Creek during high intensity storms. Municipal waste spill/discharge can degrade water quality in Shitike Creek.

4.2. White River Assessment Unit

White River begins on the White River Glacier on Mount Hood and flows southeast to join the Deschutes River just upstream of Sherar's Falls at RM 47.5. The watershed covers 419 square miles, with elevations ranging from 11,291 feet on Mount Hood to 789 feet at the river mouth. Major tributaries to White River include Clear, Boulder, Threemile and Tygh creeks.

This assessment unit includes the drainage above White River Falls, a series of three drops totaling 180 feet, which lies two miles above the river's mouth and prevents anadromous fish access to the rest of the watershed. The falls also isolates populations of redband trout and other resident fish above the falls from those downstream. Redband trout in the upper White River system above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin of south-central Oregon, both genetically and morphologically, than they are to lower Deschutes redband trout (Currens et al. 1990).

4.2.1. Historic Environment

White River and tributaries were generally shaped by a confined narrow, V-shaped canyon in some areas and by unconfined broad, flat-bottomed U-shaped valleys in other areas. The river transported large volumes of fine glacial sand and silt from its source on Mount Hood. This made the mainstem channel unstable, with high glacial sediment and sand loading. Tributary channels not affected by glacial activity were more stable.

Historic habitat maps show that uplands were predominately covered with ponderosa pine forests, with mosaics of oak groves interspersed at mid-elevations in the Cascades. Higher elevations in the Cascades were characterized by mixed conifer forests. Lower elevations, such as Tygh Valley, were characterized by shrub-steppe habitat (IBIS 2003).

Flows in the White River system, which are influenced primarily by surface runoff, showed normal season variation, with late spring high flows and fall low flows. Conditions supported development of complex riparian vegetation along stream margins, with good species diversity. Functional floodplains and frequent beaver activity along tributaries added to habitat diversity and complexity. Water temperature variations were slight to moderate because of prolonged snow and/or glacial melt. Other water quality variables, such as dissolved oxygen and pH, were also good, except for turbidity caused by glacial runoff.

4.2.2. Current Environment

Uplands

The watershed is heavily forested in the upper drainage, but becomes more arid at lower elevations. It supports timber, grazing and farm uses. Forest lands cover 188,000 acres in the watershed and rangelands 90,000 acres. Agricultural lands cover 47,500 acres, with 38,500 acres non-irrigated as the watershed receives less than 20 inches of precipitation annually (Lamson and Clark 2003). Approximately 4,490 acres are included in the Conservation Reserve Program or have been converted to pasture grasses (Clark 2004). The watershed contains one of only two Oregon White Oak plant communities east of the Cascades.

Many ponderosa pine forest areas and interspersed oak groves and shrub steppe areas have been replaced by encroachment by mixed conifer forest, agricultural uses, by development for homesites, and other uses. Comparisons of historic and current wildlife habitat maps indicate that ponderosa pine forests and interspersed white oak groves have been reduced by 57 percent from historic levels. Shrub-steppe habitat has been reduced by 36 percent from historic levels (IBIS 2003).

Riparian Areas

Overall riparian condition in the upper White River watershed is good with diverse vegetation, though some areas have been degraded through land use practices. Some reaches have wide floodplains and others support wetlands and meadow. Riparian vegetative condition declines in the middle watershed, primarily because of past forest fire and, in some cases forest and agricultural practices and overgrazing. Loss of riparian vegetation has reduced beaver numbers and distribution. Riparian conditions in the Tygh and Threemile systems generally show degradation from agricultural, range and forest practices. Riparian conditions in the lower watershed remain good, except in isolated canyon areas where steep walls and flashy flows limit vegetative growth. A band of mature cottonwood borders the river above White River Falls.

Instream Habitat

White River carries considerable glacial silts and sands. The river cuts through old mudflows and glacial deposits and is often unstable, particularly in the upper reaches. More than 20 miles of braided channel flow out of the White River Glacier (Lamson and Clark 2003). The fine sand and sediments from the glacier are deposited in slack water areas and affect spawning gravels down to the river mouth. Lack of habitat complexity and large wood limit instream habitat condition in some areas. The subbasin also contains many barriers to fish movement including natural waterfalls, road culverts, dewatered stream reaches, diversion structures, and impassable dams at large storage impoundments. Most water diversions in the system are unscreened.

Flows

Flows in White River are heavily influenced by snowmelt and glacial runoff. They peak during periods of runoff in winter and spring, and diminish as the summer progresses.

The mean low and mean high river discharge into the Deschutes River are approximately 100 cfs and 1,500 cfs, respectively (Heller et al. 1983). Naturally low flows in the system are further reduced by spring-fall irrigation diversions and winter-spring reservoir storage. The lowest flow recorded at White River Falls was 66 cfs in January 1979, followed by 68 cfs in September 1977 (Lamson and Clark 2003).

Water Quality

Water temperatures in lower White River and several tributaries often exceed the 64.4°F standard for salmonid rearing during summer months. Stream reaches on the 2002 ODEQ 303(d) list for exceeding water quality criteria for stream temperature included Clear Creek (mouth to RM 15.1), Gate Creek (mouth to RM 14.3), Rock Creek (mouth to RM 8.1 and RM 8.8 to 14.1), Threemile Creek (mouth to RM 11.3) and White River (mouth to RM 12). Turbidity associated with glacial silt and rock flour also reduces water quality in the White River system. Stream reaches on the 2002 ODEQ 303(d) list for sediment concerns included Gate Creek (mouth to RM 14.3) and Rock Creek (mouth to RM 15.9).

4.3. Lower Eastside Deschutes Assessment Unit

Four stream systems are included in this assessment unit — Buck Hollow, Bakeoven, Trout and Willow creeks. Three of these systems —Buck Hollow, Bakeoven and Trout creeks — provide the primary spawning and rearing habitat for summer steelhead in the Deschutes Subbasin. The tributaries also support redband trout, though steelhead appear to use the tributaries more than resident trout (Zimmerman and Reeves 2002). Trout Creek may have also supported chinook salmon production at one time. Willow Creek currently supports a small redband trout population.

Streams in the assessment unit drain the lower eastside of the Deschutes watershed. Buck Hollow Creek drains 198 square miles, with elevations from 680 to 3,325 feet. It extends 36.3 miles from its confluence with tributary Thorn Hollow Creek to where it enters the Deschutes River just below Sherars Falls (RM 43). Bakeoven Creek drains 146 square miles, with elevations ranging from 3,487 feet at Bakeoven Summit to 870 feet where it meets the Deschutes River at Maupin (RM 51). Trout Creek drains 697 square miles, with elevations from 5,940 feet to 1,280 feet. It extends 51 miles in length from its headwaters in the Ochoco Mountains to its confluence with the lower Deschutes River at RM 87, six miles west of the community of Willowdale. The drainage includes 115.5 miles of perennial streams and 41.2 miles of intermittent streams, with 113 miles currently supporting summer steelhead production. Willow Creek drains 180 square miles and extends 34 miles from the Ochoco Mountains to Lake Simtustus, part of the Pelton Round Butte Complex (RM 105), where it joins the Deschutes River.

4.3.1. Historic Conditions

The lower eastside tributaries once displayed highly favorable conditions for redband trout and summer steelhead production (CTWS 1999a). Lush bunch grass plant communities covered much of the area and were interspersed with well-vegetated stream corridors. Variable habitat characteristics existed within constrained and unconstrained stream reaches, providing a mix of single channel and multiple channel areas. In lower gradient reaches, stream channels were sinuous and bordered by thick deciduous vegetation and grasses. Beaver complexes and off-channel habitat were common along the unconstrained reaches. Relatively good supplies of in-channel large wood and debris dams provided adult and juvenile cover and rearing habitat (CTWS 1999a).

Still, the lower eastside of the Deschutes Subbasin exhibit some of the highest average slope and drainage densities in the entire Deschutes subbasin (O'Connor et al. 2003), and these stream systems likely showed more response to climatic changes than other subbasin areas — although the magnitude of the climatic affects was moderated by healthy watersheds. As today, occasionally severe thunderstorms caused sudden and high flows, promoting more dynamic stream channel behavior and characteristics than typically found in other tributary streams within the Deschutes Subbasin. In streams where natural flows often dropped to low levels during summer months, late summer water temperatures became elevated, particularly during low precipitation years. Large floodplains with diverse vegetative communities helped stabilize flows and water temperatures. Beaver complexes and wet meadows also promoted sustained groundwater recharge (CTWS 1999a). Deep pools and recharge areas provided refuge for salmonids when flows were low and water temperatures high.

4.3.2. Current Conditions

Uplands

The lower eastside Deschutes watershed generally displays steppe, shrub-steppe and juniper savannas in the canyon and plateau areas, and mixed conifer forests in the headwaters of Trout Creek. Comparisons of historic and current wildlife habitat maps indicate that more than 370,000 acres of wild grassland habitat existing historically on upper bench lands in the eastern part of the assessment unit have been completely lost (IBIS 2003).

Private lands cover much of the area and are used as rangeland and cropland. The Bakeoven Creek drainage contains about 83 percent rangeland and 15 percent cropland, with 8,512 acres of cropland currently enrolled in the Conservation Reserve Program. (Wasco SWCD 1994; Clark 2004). The watershed is sharply dissected by deeply entrenched drainage systems and contains no urban areas. The Buck Hollow Creek drainage contains about 52 percent rangelands, with remaining lands used as cropland (19 percent), Conservation Reserve Program (26 percent), and roads and urban (3 percent) (CTWS 1999a). The Trout Creek drainage is about 86 percent rangeland, and most remaining lands are headwater forests (12 percent) in the Ochoco Mountain Range. Agricultural (1.5 percent) and residential/urban uses also cover small amounts of land in the Trout Creek drainage, with Antelope and Ashwood the main population centers. The Willow Creek drainage is about 75 percent rangeland and 25 percent cropland, with 70 percent of the cropland irrigated (MDLAC 2001). Willow Creek runs through the Crooked River National Grasslands and City of Madras.

Uplands in the assessment unit are generally degraded with reduced ability to collect and store runoff, and maintain soil stability. Soils in the assessment unit are often highly susceptible to erosion, and the loss of watershed retention capabilities due to human activities has reduced the watersheds' ability to buffer high runoff events. Consequently, the watersheds' respond quickly to snowmelt and precipitation, and are vulnerable to flash flooding. Upland conditions are improving in parts of these watersheds due to restoration efforts over the last 15 years.

Riparian Areas

Riparian areas in the Buck Hollow, Bakeoven, Trout and Willow creek watersheds have generally been degraded by overgrazing, periodic wild fires and catastrophic flooding over the last century. Today, Buck Hollow Creek is incised in the valley floor in some areas and has scoured laterally in other areas to form broad, shallow channels with little or no bank structure or stability and very little shade. Few riparian trees exist along the creek. Similar conditions exist in the Bakeoven drainage. Riparian habitat conditions are considered poor along 59 percent of Bakeoven Creek, 49.4 percent of Deep Creek, and 92.3 percent of Robin Creek (Wasco County SWCD 1994). Wide, shallow stream channels with sparse riparian cover in both the Buck Hollow and Bakeoven systems are prone to icing and corresponding fish loss during occasional periods of prolonged cold temperatures. Degraded riparian conditions also exist along middle and upper Willow Creek, though conditions improve below the City of Madras where the creek flows through a narrow basalt canyon with numerous springs before entering the Deschutes River.

Many streambanks and most riparian areas in the Trout Creek drainage are also in low ecological condition (MDLAC 2001). Currently, only 31 percent of the riparian areas are in satisfactory condition (Runyon et al. 2002). Increased runoff peaks have overloaded and exceeded the capacity of the natural floodplains in some places. Flood control berms, constructed after flooding in 1964, added to riparian and stream channel degradation by destroying natural channel meander, backwaters, and oxbow sloughs. Riparian vegetation, such as willow and alder, now occupy less than 25 percent of the stream margin along lower Trout Creek (Runyon et al. 2002). In other areas, riparian condition is constrained by livestock grazing, agricultural practices and other uses. The Mud Springs Creek drainage appears to have the lowest portion (10 percent) of riparian areas in satisfactory condition in the Trout Creek watershed (Runyon et al. 1998), while the upper Trout Creek watershed has the largest proportion of riparian stands in satisfactory condition.

Efforts continue to improve riparian condition in these watersheds through livestock management, berm removal and other restoration activities. Trout Creek, for instance, has been part of an intensive fish habitat restoration program for the last 15 years. Restoration strategies appear to be effective in enhancing riparian conditions along some stream reaches.

Instream Habitat

Loss of riparian vegetation, channel alterations and flood scouring have contributed to a general lack of instream habitat complexity and pool habitat in most stream reaches. Buck Hollow and Bakeoven creeks contain wide, shallow or braided reaches that move laterally across the valley during high flow events. They also lack instream cover and structure, including large woody debris, and have limited supplies of cobble and boulder. Fine sediment deposits are more of a problem in Bakeoven Creek than in Buck Hollow, which is a gravel-rich system. Intense runoff events in the Bakeoven system have scoured out long reaches of the creek, removing large woody debris, and causing erosion and siltation of pools (CTWS 1999a). The lack of pool habitat is a primary factor limiting salmonid production in the drainages. The streams contain only small numbers of scattered pools that provide limited holding and summer low flow rearing habitat. The remaining deep pools provide the best over summer habitat for adult and juvenile fish. Fish are often concentrated in these pools with little overhanging vegetation, or instream vegetation or woody structure for hiding, which exposes them to serious predation. Instream habitat complexity is also limited in much of the Willow Creek drainage, though it improves in the lower basalt canyon.

In the Trout Creek watershed, most high quality fish habitat lies in the upper drainage. Instream and overhead cover are lacking in most of the watershed, and infrequent shallow pools and woody cover provide much of the fish habitat. A lack of pools and cover leaves fish in many areas vulnerable to predation at low or intermittent flows. The stream substrate generally displays large gravel, cobble and boulders, with many spawning and incubating habitats degraded by elevated fine sediment inputs. Physical barriers, such as irrigation dams and road culverts also restrict fish from volitional movement and use of connective habitats during critical periods of their life history (CTWS 1999a).

The lack of channel continuity and complexity in Trout Creek increased following the large flood of 1964 with the diking of several central and lower stream reaches. Some channels were also straightened and/or isolated from their floodplains and side channels. This channel work altered velocities, sediment movement and deposition, and bed morphology. It generally reduced diversity of aquatic habitat in much of lower and central Trout Creek (WPN 2002a). Long reaches of several major tributaries — including Antelope, Mud Springs, and Hay creeks — have also been channelized, relocated or blocked and are no longer accessible to steelhead.

Flows

Watershed and stream corridor degradation have resulted in an altered flow regime with higher peak flows and lower or intermittent flows in many stream reaches. Flows peak in winter and early spring, and during severe summer thunderstorms. Streamflows drop to low levels during extended cold winter periods and from mid-summer to late fall. Fluctuations in flow are now larger in the assessment unit than they were historically. The Natural Resource Conservation Service, for example, estimates that current peak flows in some segments of the Trout Creek system are two to three times greater than under pre-settlement conditions (Jefferson County SWCD 1996). Loss of vegetative cover, decrease in number and size of beaver dams, channel down cutting and channelization, loss of wet meadows and other wetlands appear to be factors responsible for changes in flow patterns, and for moving some reaches of Trout Creek from a perennial to an intermittent flow condition (WPN 2002a).

In Buck Hollow Creek, average discharge ranges from 95 cfs in April to 2 cfs from July through October. Tributary flows are frequently intermittent during summer and fall months. One surface water right exists in the Buck Hollow Creek watershed, diverting up to 0.57 cfs for irrigation of 34 acres (LDLAC 2002).

In the Bakeoven Creek drainage, stream flow is generally perennial in Deep Creek and upper Bakeoven Creek and intermittent in lower Bakeoven Creek. Most tributaries are currently intermittent (Wasco County SWCD 1994). No active surface water irrigation withdrawals remove water from this stream system, though several large irrigation wells exist within the watershed. Flow in Willow Creek in and above the City of Madras is generally lacking or intermittent for much of the year (Ratliff 2004).

In the Trout Creek watershed, consumptive use of water for irrigation exceeds the estimated volume of natural stream flow during the summer months in all drainages (WPN 2002a). These withdrawals contribute to an inability to meet instream water rights in the areas where they have been established. Flows in Trout Creek below diversions in the Ashwood and Willowdale areas frequently become intermittent from mid-summer to late fall. Streamflows in Trout Creek below Amity Creek average less than 1 cfs during the hot months of August and September, and have also fallen below 1 cfs during dry years from May through December (WPN 2002a).

Water Quality

High water temperatures in the Buck Hollow, Bakeoven, Trout and Willow Creek systems limit fish production. Water temperatures in the systems typically exceed State water quality criteria for salmonid rearing during summer months. In Trout Creek, water temperatures usually surpass recommended levels by late May and can remain high through October. In Buck Hollow Creek, summer water temperatures often pass 75°F, except in areas of cool water refugia where seeps and springs enter the channel, or where widely scattered deep pools are recharged with cool subsurface flow. Summer temperatures in Willow Creek upstream from Lake Simtustus also range into the middle and upper 70’s. Bakeoven Creek experiences high water temperatures and other water quality problems, including turbidity, low dissolved oxygen, and nutrients. The entire length of Trout Creek and a number of tributaries (Auger, Big Log, Bull Cartwright, Dick, Dutchman and Potlid creeks) are listed as water quality limited because of temperature and sediment concerns (ODEQ 2002).

4.4. Lower Crooked River Assessment Unit

The assessment unit includes areas in the Crooked River watershed below two major impoundments: Bowman Dam on the Crooked River (completed in 1960) and Ochoco Dam on Ochoco Creek (completed in 1921). Dam operations alter flow patterns and restrict fish production in the lower 68.2 miles of Crooked River and lower 10 miles of Ochoco Creek. In addition, the dams lack fish passage facilities and isolate fish populations in lower stream reaches from spawning and rearing habitat in upper watershed areas. The Pelton Round Butte Complex blocks all anadromous fish access to the drainage.

Before construction of dams and water diversions, the Crooked River supported spring Chinook, summer steelhead, redband trout, bull trout, mountain whitefish, and non-game fish species. Today, watershed supports several resident indigenous fish populations, including redband trout. A major tributary McKay Creek joins the lower Crooked River at RM 45.2 and provides more than 50 miles of fish habitat.

4.4.1. Historical Conditions

Early explorers and military expeditions described the Crooked River drainage as rich in abundant riparian vegetation and adequate supplies of grass, water and firewood. Forested uplands in the lower drainage were described as open, park-like stands of ponderosa pine and western larch maintained by frequent ground fires. Lower and middle elevation lands were often covered by abundant bunch grasses. According to one early rancher, *"This was, certainly, as fine a country then as a stock man could wish to see. The hills were clothed with a mat of bunch grass that seemed inexhaustible. It appeared a veritable paradise for stock* (George Barnes, Prineville rancher, 1887)."

Riparian and floodplain areas in the watershed had significantly more woody vegetation than now (CRLAC 2003). Floodplains were dominated by bunchgrass and wild rye grass, with little invasion of juniper and sage communities. The Crooked River had a large floodplain that was described by early settlers as having waist high grasses. Willows were a primary component of riparian species (Ochoco means 'willow' in Paiute) but cottonwoods, aspen, alder, and shrub species such as chokecherry, hawthorn, or dogwood were also common. In some areas, the dense vegetation along the Crooked River had to be cut away to facilitate travel (Buckley 1992). Journals of early explorers comment on the abundant grasses and willows.

These healthy upland and riparian conditions modified streamflow fluctuations in the Crooked River drainage. Groundwater was regularly recharged during the wet season and streamflow was augmented during the dry part of the year. More springs and watercourses existed in the basin because of higher water tables. Beaver dams were plentiful and instrumental in maintaining a high water table under most stream valleys. As a result, many streams that are now intermittent were perennial (Whitman 2002). Seasonal flow fluctuations occurred, but were smaller than seen today where natural headwater water storage has been reduced. One expedition described Crooked River tributaries in late June, 1859 as, *"all the principal streams and their tributaries are pebbly bottomed and skirted with willows, some of them from four to six inches in diameter, affording good fuel, and the waters are generally sweet and icy cold"* (U.S. Congress 1860; Stuart et al. 2002).

4.4.2. Current Conditions

Uplands

Livestock production and livestock forage dominate land use in the lower Crooked River watershed. Forest lands, as in the upper McKay drainage, also support timber production. Irrigated agriculture occurs in the Prineville area and along narrow stream valleys.

Comparisons of historic and current habitat maps indicate that 34,000 acres of native grassland and 84,000 acres of lodgepole pine forests that existed historically in the assessment unit are now gone (IBIS 2003). Upland watershed health remains high where perennial grasses are present, but has been lost or diminished though most of the area (CRLAC 2003). As in most other lower eastside drainages, soils are generally finely textured and highly susceptible to precipitation-driven erosion (Whitman 2002). Degradation of uplands through land use practices, and invasion of western juniper and noxious exotic vegetation, has reduced their ability to collect and store runoff and maintain soil stability. Sections of the Crooked River and Ochoco Creek also run through the City of Prineville urban growth boundary and support residential, industrial and commercial uses.

Riparian Areas

Degraded riparian condition is a common problem in the lower Crooked River drainage. Stream channelization and over use has caused downcutting along many stream reaches, leaving streams disconnected from their floodplains (CRLAC 2003). On-going restoration efforts have improve riparian conditions along some stream reaches, but recovery of riparian communities is slow (Whitman 2002). Riparian areas along the Crooked River corridor between RM 57 and Highway 97, and along lower Ochoco Creek and McKay Creek (Walter 2000) are generally degraded. The Crooked River below Highway 97 displays the best riparian condition, with a relatively undisturbed character. Riparian conditions also remain fair to good along the Crooked River from Bowman Dam to RM 57.

Instream Habitat

Stream channel alteration has reduced instream habitat complexity in many parts of the assessment unit. Instream habitat complexity is limited in much of McKay and lower Ochoco creeks, with surveys in McKay Creek showing that pools average less than 10 percent of the channel (Walter 2000). The reach of the Crooked River from the City of Prineville to RM 34 also lacks instream habitat complexity and the substrate contains a high percentage of fine sediment. Lack of large wood also reduces instream condition. In addition, the lower drainage contains several artificial passage barriers that limit fish production and connectivity. Some irrigation diversions lack fish screens (Marx 2004).

Instream habitat condition generally remains good in the Crooked River from Bowman Dam to the city of Prineville, and from RM 34 to the mouth. Channel conditions below Bowman Dam are stable, though spawning habitat is limited. The coarse substrate in this reach provides instream habitat complexity as large wood is lacking. Instream conditions improve in the Crooked River from RM 57 to the City of Prineville, displaying good riffle/pool ratio and spawning gravel. The canyon reach from RM 34 to Highway 97 displays a mix of boulder-strewn riffles and long glides with a low gradient. The reach from Highway 97 to the mouth displays very good instream condition and complexity, and contains a mix of high gradient boulder reaches and long slow glides.

Flows

Flows below Bowman Dam are regulated by the Bureau of Reclamation and managed by the Ochoco Irrigation District. Flows below Bowman Dam typically range from 200-250 cfs during summer irrigation and 30-75 cfs during winter storage.

Summer flows in the Crooked River drop significantly at RM 57, where 160 to 180 cfs is diverted during the irrigation season. Several other diversions remove additional flow below RM 57. Together, these diversions remove most remaining flow and leave the Crooked River below Prineville with very low summer flow. River flows range from 10 cfs, the minimum flow required by the project, to 3,100 cfs, the legal maximum. Some irrigation return water from Ochoco and McKay creeks augments flow in the lower Crooked River, though additional irrigation diversions downstream continue to withdraw water. IFIM studies suggest that higher flows would be required to obtain optimal production of adult and spawning redband trout (ODFW 1996c). Natural spring releases augment flows in the Crooked River below Highway 97. The volume of spring flow increases as the river flows north, with Opal Springs discharging up to 240 cfs. The river averages over 1,550 cfs when it joins the Deschutes at Lake Billy Chinook.

Flows in lower Ochoco Creek also respond to water storage and releases. Ochoco Dam operations reverse the natural seasonal flow pattern in the lower stream reach. High flows occur during irrigation (April to mid-October) and low flows occur while water is stored for the next irrigation season.

Watershed and stream corridor degradation, and irrigation withdrawals in the McKay Creek system contribute to flashier flows and produce low or intermittent flows in many stream reaches. Flows in McKay Creek are frequently intermittent or dry from the Allen Creek confluence to the mouth during the irrigation season.

Water Quality

Cold-water reservoir releases strongly influence water temperatures in the Crooked River below Bowman Dam. Summer water temperatures average 47° F to 50° F, with a high of 54° F; and winter temperatures average 37° F to 40° F, with a low of 32° F. Water discharged from the reservoir rarely exceeds 54° F. Sediments suspended in the reservoir water, however, create turbid flow in the Crooked River from the dam to near Highway 97 where spring inflow contributes to good water clarity and cooler temperatures (ODFW 1996c). Variable discharges cause nitrogen super saturation when water is spilled over Bowman Dam or high volumes are released through the outlet structure (ODFW 1996c).

Summer water temperatures increase in the Crooked River as flow is diverted for irrigation, and water temperatures near Prineville can exceed 80° F. The reach from Prineville to Highway 97 also suffers from high pH (summer and winter), high bacteria (summer), high BOD, and low dissolved oxygen. Water quality improves below Highway 97 with additional flow from natural springs. The Crooked River below Baldwin Dam (RM 0-51) exceeds State water quality criteria for summer temperatures and bacteria, and pH (ODEQ 2002).

Water quality in McKay, Marks, Mill and Ochoco creeks also surpasses State water temperature criteria for salmonid spawning and rearing (ODEQ 2002). Summer water temperatures typically reach 75° F in Little McKay Creek, and reach 80° F in lower McKay and Allen creeks.

4.5. Upper Crooked River Assessment Unit

The upper Crooked River drainage above Bowman and Ochoco dams includes the upper mainstem Crooked River, the North Fork Crooked River drainage, Camp Creek, the South Fork Crooked River drainage, Beaver Creek, and the upper Ochoco Creek drainage. Redband trout are the only native game fish left in the upper basin and reside primarily in the headwaters of smaller tributaries located on USFS lands. Spring chinook and summer steelhead runs returned to the area historically.

4.5.1. Historical Conditions

Diverse and abundant vegetation in the upper drainage historically created good fish and wildlife habitat and provided for general watershed health. Large trees were primarily fire resistant ponderosa pine at lower elevations, Douglas fir and western larch at middle elevations and true firs at higher elevations (Whitman 2002). Frequent fires maintained an open park-like structure at lower elevations, but were less frequent on cooler and higher elevations. When fires did occur at higher elevations, they burned a high percentage of trees (Whitman 2002). Historic maps indicate that much of assessment unit was covered with juniper woodland and over one million acres of shrub-steppe habitat (IBIS 2003). An estimated 61,000 acres of natural grasslands covered the middle drainage (IBIS 2003), protecting the area's highly erodible soils during periods of runoff. Well developed floodplains and riparian areas also reduced erosion. Still, periodic natural events caused areas with fine-grained soils to erode. A study of Camp Creek in the upper Crooked River basin, for example, identified several periods of prehistoric incision followed by aggradation that may have corresponded to subtle climatic shifts (O'Connor et al. 2003).

Typical of drainages in the semiarid climate, stream flows rose following winter storms and dropped during dry summer months. There were also more springs and watercourses in the basin. Beaver dams were plentiful and instrumental in maintaining a high water table under most stream valleys. Ogden's' journals of his expeditions up the Crooked River in 1826 described the excellent quality of beaver habitat and noted specifically that all of the tributaries and the mainstem he observed were lined with willows and aspen, and grass as tall as 7 feet (Ogden 1950). Ogden also noted the presence of an Indian fish weir below the junctions of the North and South forks that was apparently used for capturing anadromous fish (ODFW 1996c). Other journals mention good trout and salmon populations in Ochoco and Beaver creek watersheds.

4.5.2. Current Conditions

Uplands

Generally, lands in the assessment unit are split equally into federal and private ownership. Public forest lands cover much of the headwaters and contain wet meadows and forested areas. Uplands in the middle and lower drainage generally support sagebrush and juniper communities, with irrigated meadows and hay fields along the stream bottoms. The South Fork Crooked River drains a high desert and plateau landscape, and more than a third of this drainage does not contribute runoff in most years. Camp Creek and several small tributaries drain the arid Maury Mountains.

Comparisons of historic and current habitat maps indicate that 93 percent of the native grasslands, 38 percent of the shrub-steppe, and 35 percent of the ponderosa pine forests in the assessment unit have been lost (IBIS 2003). The former shrub-steppe and ponderosa pine areas have been taken over by juniper woodland and mixed conifer forests, respectively, which have increased by over 200 percent and over 600 percent. Approximately 39,000 acres have also been replaced by agricultural uses (IBIS 2003).

Soils in much of the drainage are vulnerable to erosion due to steep slopes, high clay content and poor vegetative cover. Loss of forest structure and native grasslands, and expansion of western juniper and noxious weeds, has affected watershed hydrology and increased erosion and soil disturbance (Whitman 2002).

Riparian Areas

Most riparian corridors in the upper Crooked River drainage are degraded with open canopies that provide little to no shade (ODFW 1996c). Habitat surveys conducted by

USFS (1998) in the Bear, Camp, and Deep creek drainages and in the North Fork and middle Crooked rivers found that the loss of riparian tree and shrub species had reduced vertical habitat complexity and reduced water storage capacity of riparian areas. Surveyors noted density of riparian vegetation had improved since the1960s with land management changes, but the low gradient stream systems had not returned to historic condition (Whitman 2002). Surveys by ODFW have also found poor riparian conditions in the Beaver Creek and South Fork drainages (ODFW 1996c). Riparian condition along Camp Creek remains below historic level, though riparian density has improved significantly in some reaches due to restoration activities.

Riparian assessments conducted in 2000 in the Mill, Marks and Ochoco creek drainages using OWEB methodology showed that riparian recruitment was generally inadequate along Mill Creek, West Fork Mill Creek, Marks Creek and Ochoco Creek (Whitman 2002). USFS and ODFW surveys for the upper Ochoco Creek drainage in 1979, and for Marks and Mill creeks in 1977, showed that stream reaches with the best riparian conditions were upper reaches of Canyon and Ochoco creeks (ODFW 1996c). Some riparian areas along upper Mill Creek are still recovering from the Hash Rock forest fire.

Instream Habitat

The upper mainstem Crooked River and many of its tributaries, including Beaver Creek and the South Fork Crooked River, display low gradients with high pool:riffle ratios characterized by long slow moving shallow pools and long glides. Substrates often contain high levels of fine sediments in pools and glides, with occasional riffles of cobbles and boulders. Spawning gravel is limited. Many reaches of the upper mainstem Crooked River have been disconnected from adjacent floodplains and/or channelized. Many reaches of Camp, Bear and Sanford creeks have incised into the fine valley soils, with a corresponding drop of former floodplain water table. Streams generally lack large woody debris, instream habitat complexity, or perennial stream flow.

In the upper Ochoco Creek drainage, recent assessments indicate that channel sensitivity to erosion is high for 84 percent of the Ochoco Creek, and that riparian recruitment is inadequate for roughly two-thirds of stream reaches. Channel sensitivity for Marks and Mill creeks was rated as high for the entire channels (Walters 2000). Lack of instream habitat complexity and large wood contribute to reduced fish production in many reaches. Fish populations have also been fragmented by dams built for irrigation diversion and by the creation of small impoundments built without passage facilities or protection screens (Marx 2004).

Flows

Low summer flows, primarily created as a result of irrigation water withdrawals, reduce flows needed for aquatic production in much of the upper Crooked River drainage. Surface water rights are over-allocated for the entire Crooked River watershed. Summer flows in the upper Crooked River reach 1 to 7 cfs with temporary irrigation dams diverting much of the flow throughout private lands. In the North Fork Crooked River drainage, streams commonly carry late summer flows of less than 2 cfs, although Deep Creek, a major tributary below Big Summit Prairie, and the North Fork Crooked River below the confluence of Deep Creek, generally have flows of 5 to 10 cfs. Summer flows typically range from 2 to 9 cfs in the South Fork and from 0 to 5 cfs in the Beaver Creek drainage. Low summer flows are also a problem in Camp Creek and other Maury Mountain drainages. Most flow in Ochoco, Marks and Mill creeks below the Ochoco

National Forest is also diverted for irrigation, and Ochoco and Mill creeks are frequently dry above the reservoir in July, August and September.

Further, flood intensity, such as during the 1964 flood, has increased in much of the upper drainage because of the loss of natural water storage. The Post/Paulina area is particularly threatened by floods due to landscape condition. Rapid snowmelt, or a rain on snow event, sends water rushing from degraded headwater tributary streams to lower Beaver Creek and the upper Crooked River where the faster runoff can cause flooding (Whitman 2002).

Water Quality

High summer water temperatures, particularly as a result of low instream flow, affect fish production and restrict fish movement in much of the upper Crooked River drainage. The Upper Crooked River, North Fork, South Fork, Beaver Creek, Bear Creek, and many tributaries are included on the 2002 ODEQ 303(d) list for exceeding summer rearing temperatures. Summer water temperatures commonly reach the mid-70s and, in some areas, the mid-80s. Sedimentation also causes water quality problems in the drainage. Erosion from the mainstem Crooked River and tributaries, including Camp, Eagle, Lost and Conant creeks, contributes to turbidity and sediment loads in Prineville Reservoir. In addition, inactive mercury (cinnabar) mines located at the headwaters of Johnson Creek in the North Fork drainage may adversely impact water quality.

4.6. Middle Deschutes River Assessment Unit

This assessment unit includes the 32-mile reach of the Deschutes River from the lower end of the Pelton Round Butte Complex (RM 100) to Big Falls (RM 132). The reach historically supported anadromous fish production, with Big Falls blocking anadromous fish passage to upriver areas (Nehlsen 1995). Today, anadromous fish passage is blocked at the lower end of the Pelton Round Butte Complex.

Two tributaries to this reach of the Deschutes, the Metolius River and Squaw Creek, fall within the assessment unit. The Metolius River drainage covers 315 square miles and contains 110 miles of perennial streams, 324 miles of intermittent streams, 42 lakes and 121 ponds. The river flows 29 miles and joins the Deschutes at Lake Billy Chinook. The Squaw Creek drainage covers 230 square miles. The creek flows 35 miles to enter the Deschutes River at RM 123.1, a few miles above Lake Billy Chinook. These two major tributaries once provided important salmonid spawning and rearing habitat, and continue to provide important habitats for bull trout and redband trout populations. The drainages will provide important habitat for reintroduced salmon and steelhead when fish passage is restored at the Pelton Round Butte Complex.

4.6.1 Historical Conditions

The tightly confined canyon of the Deschutes River between Big Falls and Lake Billy Chinook exhibited many conditions seen today. Deciduous vegetation consisting of alders and willows dominated riparian areas along benches and islands. Juniper, scattered pine and various grasses and forb species armored the stable riverbanks created by a uniform flow regime. Large springs in the lower reaches maintained relatively cool and stable year-round temperatures that provided ideal conditions for salmonid growth and survival.

Upland areas in the assessment unit displayed a wide diversity in vegetation. Historic maps show that ponderosa pine forests were the predominant forest type, at an estimated 300,000 acres. Smaller acreages of shrub-steppe, juniper woodland, and mixed conifers forests were also present. Relatively small areas of wild grassland (15,000 acres) covered what is now called Plainview between Squaw Creek and the Deschutes River. Cottonwood and aspen groves were once abundant in the Squaw Creek and Metolius watersheds (IBIS 2003).

Tall stands of ponderosa pine armored streams in the spring-fed Metolius watershed, along with a well-developed growth of deciduous vegetation. The stream channel was very stable and constrained over most of its length, except a few locations where braiding occurred. Water quality was excellent, with low contributions of fine sediment and cool summer streamflows (CTWS 1999a). There was also more large wood in the streams, which slowly developed into floating island habitat.

Higher quality habitat conditions also existed in Squaw Creek before the late 1800s when flow allocations for irrigation began. High quality spawning gravel was well distributed throughout the system. Higher natural flows created an abundance of off-channel habitats in Squaw Creek and Indian Ford Creek, and more frequent use of side channels and floodplains. The higher summer flows also provided deeper pools for fish use during summer months. Diverse riparian vegetation grew along the streambanks and provided shade for off-channel and pool habitat. Pools formed by large wood may have been more frequent in lower Squaw Creek. Water temperatures were probably more suitable for salmonid spawning and rearing. Houslet (1998) found that if average summer flows were not diverted, the average maximum water temperature for August would be near 66.5°F above Alder Springs (RM 2).

4.6.2. Current Conditions

Uplands

The Deschutes River from Big Falls to Lake Billy Chinook flows within a narrow deep canyon surrounded by a desert landscape. Major land uses include livestock grazing, agriculture and recreation. Vegetative communities are dominated by juniper and sparse ponderosa pine communities.

The Metolius River and Squaw Creek drain the forested eastern slopes of the Cascade Range, and drop into sagebrush steppe and farm and ranch lands in the lower watersheds before reaching the Deschutes River. Public forestland managed by the Deschutes National Forest cover 60 percent of the Metolius River drainage and remaining lands are in private or Tribal ownership. Primarily land uses in this drainage include recreation, timber, farming and residential. The middle and lower Squaw Creek watershed contains farming and range lands, with more than half of the land along Squaw Creek is in private management (UDLAC 2002). The creek also runs through the City of Sisters.

All wild grasslands in the assessment unit are now gone, converted to other uses or encroached by juniper woodland and shrub-steppe vegetation. Comparisons of historic and current habitat maps indicate that ponderosa pine forests and western juniper woodlands have declined 47 percent and 80 percent, respectively, to be replaced by mixed conifer forests (IBIS 2003). Aspen and cottonwood groves are reduced or have been eliminated in much of their former areas.

Riparian Areas

From Big Falls to Lake Billy Chinook, the Deschutes River canyon gradually deepens to 700 feet and becomes narrower. The narrow riparian area is dominated by woody species, such as alder, red-osier dogwood, willow, chokecherry, rose and as well as sedge, rush and various grasses. Riparian vegetation is thicker in areas where springs emerge from the canyon walls, and along river benches and islands.

Stable flows within the Metolius River promote a healthy riparian corridor along the stream and undercut banks. Good riparian growth also exists along most of the river's tributaries. Riparian conditions along several reaches, however, have been damaged by dispersed recreational use, timber harvest, grazing, and recent wild fires.

Riparian condition along upper Squaw Creek is generally good, though some areas show damage from timber harvest and recreation use. The most severe riparian condition extends from just above the City of Sisters downstream 11 miles. This reach has been damaged by past grazing, channel alterations, and development. Many sections of lower Squaw Creek have a broad riparian area comprised of floodplains, willow stands, and cottonwood bottom lands. Riparian vegetation along Indian Ford Creek has also been degraded by past grazing.

Instream Habitat

Instream habitat remains in good conditions in the Deschutes River from Big Falls to Lake Billy Chinook. Spawning gravel recruitment is naturally limited and is lacking below Steelhead Falls, but good gravel exists in the Foley waters area above Steelhead Falls. Large boulders provide most structural diversity in this reach of the Deschutes as large wood is lacking.

Stream channels in the Metolius drainage are generally stable with functional floodplains and habitats created by beaver activity, including ponds and wetlands. The river also contains high quality spawning gravel suitable for redband trout, particularly in the reach above Gorge Campground. Instream habitat complexity in the Metolius River and some tributaries, however, is limited by the lack of large woody debris. Several cool, spring-fed tributaries to the lower Metolius River contain abundant spawning gravel, undercut banks, side channels and wood that form high quality bull trout rearing habitat (Ratliff et al. 1996).

In the Squaw Creek drainage, channel alterations and streambank erosion have reduced habitat quality for the native redband and bull trout populations. In particular, channel simplification has reduced channel complexity and stability from RM 24.7 to the National Grassland Boundary (RM 5), resulting in a loss of sinuosity and stream length. Lower Squaw Creek also displays a high percentage of fine sediment associated with unstable streambanks and livestock grazing. Large wood volume is low or absent from the channel below RM 25. Most irrigation diversions from Squaw Creek lack fish passage and protection facilities.

Flows

The Deschutes River gains a substantial amount of flow from groundwater releases in this reach. However, flows from upstream are substantially reduced during the irrigation season and flows remain low in parts of this reach. Summer flows in the Deschutes River near Lower Bridge (RM 134) drop to as low as 30 cfs in hot summer months (although flows to 1 cfs have been recorded). Approximately 400 cfs from groundwater flow is discharged into the river before it enters Lake Billy Chinook (Gannett et al. 2001). The 20-mile reach of the Deschutes from the top of Lake Billy Chinook to the Reregulating Dam is constrained by a series of reservoirs and dams that are managed by Portland General Electric and the Warm Springs Tribes for hydroelectric production.

Flow regimes in the Metolius River and Squaw Creek differ significantly. Constant flow from spring releases keeps the Metolius running bankfull at all times. Average flows at the river's mouth range from 1,653 cfs in June to 1,360 cfs in October. The river is swift flowing with a relatively uniform gradient. In comparison, streamflow in Squaw Creek is notoriously "flashy", fluctuating from extremely high flow to low flows that at times go subsurface. The creek is also heavily used for irrigation and stream flows are over allocated. The natural flow pattern in Squaw Creek remains generally undisturbed from the headwaters to RM 23.5, where a series of diversions remove most of the water for irrigation during summer months. Flows gradually improve between the City of Sisters and Camp Polk Road RM 17 with the discharge from a series of springs and irrigation return flow. Springs near Camp Polk Road contribute 7 cfs to flows in Squaw Creek. Indian Ford Creek, which joins Squaw Creek at RM 20, becomes dry due to irrigation diversions, though water lost in this tributary may later resurface as springs. Alder Springs (RM 2) contributes 74.5 cfs to the stream. A minimum of nearly 100 cfs discharges to the Deschutes River because of groundwater springs (UDLAC 2003).

Water Quality

The Deschutes River from Steelhead Falls to Big Falls was included on the 2002 ODEQ 303(d) list for exceeding temperature criteria for salmonid fish spawning between September 1 and June 30. Part of this reach, from Steelhead Falls to Bend, was also listed in 2002 for exceeding ODEQ criteria for pH and for salmonid rearing temperatures (Yake 2003).

Water quality is generally excellent in the Metolius system due to spring sources in the tributaries and the mainstem. Water testing has shown low dissolved solids, low alkalinity, and low conductivity. Phosphorus levels have measured higher than the recommended DEQ maximum. Water temperatures in the Metolius are generally cold because of cold water springs, and usually do not exceed 50°F (measured at Bridge 99) during the summer. The cool flows are preferred by bull trout, but limit growth of redband trout, which prefer temperatures of 55-65°F. Water temperatures in the lower Metolius can exceed the temperature criteria for bull trout (50°F) during certain seasons of the year, making those stream reaches candidates for inclusion on the ODEQ 303d list. In addition, water temperatures in one Metolius River tributary, Lake Creek, exceed State water temperature criteria for salmonid spawning and rearing (ODEQ 2002).

Squaw Creek is included on the 2002 ODEQ 303(d) list for exceeding water temperature criterion for salmonid spawning during summer months. High water temperatures particularly limit fish production in the diversion-impacted reach (RM 2 to 25). Below water diversions near the City of Sisters, water temperatures in Squaw Creek can rise to over 70°F. The warmer water temperatures result in lower dissolved oxygen as the stream flows through the dry canyon section (ODFW 1996a). Water quality in Squaw Creek is also reduced by turbidity, nutrients, streambank erosion, decreased stream flow, and insufficient stream structure.

4.7. Upper Deschutes River Assessment Unit

The largest of the assessment units, this drainage includes the reach of the Deschutes River that is primarily influenced by flow storage, releases and withdrawals. It also includes the upper watershed tributaries Tumalo Creek and Fall, Spring and the Little Deschutes Rivers.

Tumalo Creek extend about 20 miles fromits headwaters in the Cascade Range to where it enters the Deschutes River below Bend at RM 160.4. Several tributaries contribute an additional 20 stream miles to the system. Spring River originates from a spring source and is approximately one mile long, joining the Deschutes River at RM 191. The Little Deschutes River begins near Mule Peak in Klamath County and drains approximately 1,020 square miles, flowing 97 miles to its confluence with the Deschutes River at RM 192.5. Fall River originates from a spring and flows 8.15 miles to meet the Deschutes River at RM 204.5.

4.7.1. Historic Conditions

The upper Deschutes watershed displayed a diverse landscape extending from conifer forests, to extensive lodgepole pine forests and pumice plains, to grasslands of the arid high desert. Historic habitat maps show large areas of both ponderosa pine and lodgepole pine forests across the southern two-thirds of the assessment unit. Map analysis suggests that 479,000 acres of ponderosa pine forest and 359,000 acres of lodgepole pine forest existed historically (IBIS 2003). Historic forest conditions, shaped by frequent fire activity, were generally open in appearance. Journal notes by the Williamson—Abbott railroad survey crew in 1853 state *"We found yellow pine still abundant, forming by far the most constant feature in the vegetation of our route from Pit River to the Columbia. ….The volcanic soil, as light and dry as ashes, into which the feet of our horses sank to the fetlock, produces almost nothing but an apparent unending succession of large trees of P. Ponderosa* (Yake 2003; USFS 1998d*)."*

Below Bend, the river corridor transitioned from forest to desert canyon reflecting a more arid, high desert. Vegetative communities in the desert landscape were dominated by native grasses and widely scattered juniper trees. Historic habitat maps show 100,000 acres of juniper woodland in the area between what is now Bend and Redmond, as well as 37,000 acres of wild grassland in the Tumalo area (IBIS 2003).

The river's stable flows supported lush riparian zones. Springs and seeps frequently occurred along the stream banks between the present sites of Wickiup Dam and the city of Bend. Wet meadows and forested wetlands were associated with the high groundwater table and low stream gradient upstream from Benham Falls. Below Bend, the narrow basalt canyon exhibited many conditions seen today. Deciduous vegetation consisting of alders and willows dominated riparian areas along benches and islands.

4.7.2. Current Conditions

Uplands

Public forest lands cover much of the upper Deschutes River drainage above Bend and are managed by the U.S. Forest Service for recreation and timber harvest. Private lands are also scattered throughout the upper watershed above Bend and include lands around the La Pine area that are used as grazed timberland and for subirrigated agriculture. Many private lands in the Sunriver-La Pine area support rural or recreational home sites, including most of the land adjacent to the Deschutes and Little Deschutes rivers. Lands in the drainage below Bend are 61 percent private, 34 percent federal, 3 percent state and 2 percent county and support farming, ranching, rural residential development, municipal and recreational uses. The area also includes the communities of Bend, Redmond, LaPIne and Gilchrist.

All native grasslands in the Tumalo area have been replaced by other uses or vegetation types (Hostick 2004). Comparisons of historic and current habitat maps show that ponderosa pine and lodgepole pine forests have been fragmented, and 50 percent of the lodgepole pine forests have been lost to other uses or different vegetation types, including mixed conifer forest, which has increased over 110 percent (IBIS 2003).

Riparian Areas

Riparian areas below Wickiup Dam, especially in the reach above Benham Falls, show the signs of an altered flow regime. A 1978 streambank erosion survey estimated that bank erosion in the reach generally ranged from zero to two inches per year, but jumped to eight inches per year at many locations (Yake 2003). This erosion appears to have started after development of Wickiup Dam and subsequent changes in the timing of high and low river stages. Riparian vegetation degradation has been accelerated by freezing and thawing of exposed river bed and banks, followed by up to a 700 percent spring flow increase to supply irrigation water downstream. A comparison of 1943 and 1991 photographs reveals that the Deschutes River between Wickiup Dam and Benham Falls widened an average of 20 percent in the 48-year period (ODFW 1996a; USFS 1994).

Riparian condition improves below Benham Falls. From Benham Falls to Bend, lava flows, boulders, and rubble armor much of the streambed and banks from the erosive action of high irrigation flows. Vegetation stretching along the west side of the Deschutes shows signs of disturbance from recreational use, especially from Benham Falls to Lava Island Falls (Yake 2003). The Deschutes River canyon below Bend supports a narrow riparian area dominated by woody species, such as alder, dogwood, willow, chokecherry and rose, as well as sedge, rush and various grasses.

Tributaries to this reach of the Deschutes River drain mountain forests and are often in good condition, including Fall River, the upper Little Deschutes River, and much of Tumalo Creek. Some areas along Tumalo Creek show damage from past forest fires and salvage operations. Degraded riparian areas are common along the first 38 miles of the Little Deschutes and in many areas between RM 44.6 to RM 63 (ODFW 1995).

Instream Habitat

The Deschutes River displays a low gradient, averaging less than 1 percent, between Wickiup Dam and Benham Falls, except for Pringle Falls at RM 217. Sloughs and oxbows are found throughout the reach; and the river substrate is generally silt, sand, and pumice with an underlayer of clay and siltstone. Alluvial gravel is found mixed with these substrates. There is little instream habitat complexity, and large wood and boulders are scarce or lacking. ODFW, USFS and volunteers have conducted a number of projects to add large wood or spawning gravel at a number of sites. The Little Deschutes River also lacks instream habitat complexity and structure, particularly in the lower river where degraded riparian habitat, impacted by grazing and development, has contributed to some channel instability problems with increased fine sediments in the substrate.

Streambanks in this reach show signs of "frost heave", with soils loosened during low flows washing downstream when flows increase in the river during the beginning of irrigation season. At a flow of 30 cfs, half the stream channel is exposed to frost action cycles (USFS 1994). When the river is at the minimum flow of 20 cfs below Wickiup Dam, even more of the channel is exposed. Freezing in the river channel eliminates habitat for fish and aquatic invertebrates.

Fish habitat improves progressively in the Deschutes River below Fall River — though there is still icing and lack of channel complexity in the reach above Sunriver. Spawning gravels are also limited. Fall and Spring rivers provide some habitat in this reach, but lack abundant spawning gravel, instream wood structure, and pool habitat. Below Sunriver, lava formations in the mainstem create pools that support larger fish during low flows and provide rubble, cobble and boulder substrate that are important winter habitat for juvenile trout. The high gradient channel below Benham Falls and increased flow provides more fish and aquatic habitat than the upper reach. Both reaches, however, contain limited spawning gravel and large woody structure. From Bend to Big Falls, channel stability and habitat diversity in the Deschutes River are good, though instream wood material is often lacking or absent and good spawning habitat is also not abundant.

Many reaches of Tumalo Creek contain good instream habitat, including high quality spawning gravel. Habitat condition is reduced in lower Tumalo Creek below RM 2.5 where summer flows are diverted for irrigation. Pool habitat is also lacking in this reach, and in several upper reaches where forest fires reduced riparian and instream condition. Several artificial and natural barriers in lower and upper stream reaches also restrict fish movement.

Flows

Wickiup and Crane Prairie reservoirs store water for spring and summer irrigation. The altered flow pattern replaces the stable natural flows in the Deschutes River above Benham Falls with flows as low as 20 cfs in winter to under 1,600 cfs during high irrigation demand in summer months (Gorman 2004). Flows increase downstream with contributions from Fall, Spring and the Little Deschutes rivers.

Nearly all the water (90 percent) in the Deschutes is diverted near RM 164 during the high withdrawal months of June through September (Yake 2003). Flows between Bend and Lower Bridge reach as low as 30 cfs in hot summer months during the irrigation season (although historical short-term flows to 1 cfs have been recorded). Instream transfers and conservation work have recently brought the minimum up to 35 cfs (UDLAC 2003).

Flows in the Little Deschutes River are regulated for storage and release of water from Crescent Lake, which serves as an irrigation reservoir. Unlike in the upper Deschutes, however, stored water releases from Crescent Lake actually benefit summer flows in the Little Deschutes River in that minimum flows have increased (UDLAC 2003). Flow regulation has little effect on average winter flows in the Little Deschutes River.

Flow in lower Tumalo Creek (below RM 2.5) is substantially reduced by withdrawals for irrigation use. The lower two miles of the stream have become intermittent during the irrigation season in the past. In recent years, however, a live flow of 5.8 cfs has been maintained in the lower creek. The water savings has been largely due to conservation efforts by the Tumalo Irrigation District.

Water Quality

While most smaller streams and tributaries in the upper Deschutes watershed are in good condition, reaches of the Deschutes River and several tributaries experience seasonal temperature extremes (i.e. high summer temperatures and winter icing), high erosion rates, low dissolved oxygen and other problems. The mainstem Deschutes River from Steelhead Falls to Sunriver exceeds the temperature criterion for salmonid fish spawning between September 1 and June 30. Part of the reach, from Steelhead Falls to near Bend, also exceeds temperature criteria for salmonid rearing and pH levels. State dissolved oxygen levels for spawning are exceeded in the mainstem Deschutes River upstream of Bend (RM 168.2) to just below Wickiup Dam (RM 222.2). The river is also listed for exceeding cold water dissolved oxygen levels from Bend (RM 168.2) to below Sunriver (RM 189.4). Four segments of the Little Deschutes River are also listed as water quality limited streams on the 2002 ODEQ 303(d) list, all for temperature. In addition, sedimentation and turbidity reduce water quality in the upper Deschutes. Water clarity deteriorates rapidly below Wickiup Dam when turbidity levels increase as much as 30 times after spring water releases for irrigation (Yake 2003).

4.8. Cascade Highlands Assessment Unit

The eight-mile reach of the Deschutes River above Crane Prairie is the only reach of a total 252 miles where the flow regime remains unaltered by dams. The Odell Creek/Odell Lake complex, which is also part of this assessment unit, supports a remnant population of bull trout that is the only known resident, non-reservoir, adfluvial population remaining in Oregon.

4.8.1. Historic Conditions

The Deschutes River Highlands Assessment Unit lies in the high Cascade Mountains above 4,300 feet in elevation and was historically heavily forested. Historic habitat maps indicate that forests were almonst evenly divided between mixed conifer types (120,000 acres) and ponderosa pine and lodgepole pine forests (124,000 acres)(IBIS 2003).

Frequent seeps and springs in the highlands created a number of natural wetlands, including Crane Prairie a natural meadow where the Deschutes River, Cultus River, Quinn River, Rock Creek, Cold Creek, Deer Creek and Cultus Creek converged. The upper segment of the Deschutes River and most tributaries had fairly stable flows associated with natural spring sources, though flows fluctuated from year to year depending upon precipitation and climatic cycles. Deer and Cultus creeks depended primarily on snow melt and were frequently intermittent by late summer or fall. Streams generally had good riparian and instream cover, including large woody debris. Spawning gravel quality was limited by the general stable stream flows, a lack of flushing type flows and the naturally high levels of fine sediments in the stream substrate.

Odell and Davis lakes, received inflow from part of the high Cascades south of present day Wickiup and Crane Prairie reservoirs. They were isolated from the Deschutes River by a lava flow 5,500 years ago that impounded Odell Creek and formed Davis Lake (USFS 1994).

4.8.2. Current Conditions

Uplands

The headwaters of the upper Deschutes River collect flow from public forestlands managed by the U.S. Forest Service for recreation and timber harvest. Comparisons of historic and current maps indicate that many former areas of lodgepole pine and ponderosa pine forests have been replaced by mixed conifer forests. Pine forests have been reduced by 80 percent compared to historic estimates, while mixed conifer forests have increased a similar 80 percent (IBIS 2003).

The Deschutes River originates approximately 8.4 river miles north of Crane Prairie in Little Lava Lake, a spring-fed body of water. Timber harvest and grazing in the area has been limited. The area surrounding Odell Lake is also forested. Plant communities upslope of Odell Lake are primarily mountain hemlock or mountain hemlock/lodgepole pine. The watershed includes several recreation sites. with an extensive road network providing access to most streams, lakes and associated recreation sites.

Riparian Areas

Except for past grazing, recreation sites and transportation impacts — the upper section of the Deschutes remains relatively natural (ODFW 1996a). Healthy corridors border stream channels with lodgepole pine forests, riparian meadows, and grasses. Lupine, false hellebore and a variety of rushes and sedges are also present (USFS 1989). Mountain alder and spruce are found along with lodgepole pine (ODFW 1996a).

The riparian condition around the Odell Lake watershed is generally excellent, except for localized recreation sites where human influences have altered the form and function of riparian and floodplain areas (USFS and BLM 1999).

Instream Habitat

Much of the historic spawning gravel occurred in the area now inundated by Wickiup Dam and the reservoirs. The best remaining spawning and rearing habitat for redband trout lies in the Deschutes River between Crane Prairie and Little Lava Lake. Of the approximately 13.5 total miles of tributary habitat available in the Cultus and Deer Creeks and Cultus, Quinn, and Deschutes rivers, over three quarters of it is in the Deschutes River (ODFW 1996a). Other tributaries to Crane Prairie Reservoir provide varying amounts of trout spawning and rearing habitat for both reservoir and resident fish populations. According to 1989 Forest Service stream surveys, much available spawning gravel in these tributaries is embedded with naturally occurring fine sediments.

Trapper Creek is the only tributary to Odell Lake with a known spawning population of bull trout. Juvenile bull trout rear in Trapper Creek, Hemlock Creek, and Odell Creek, and likely use a number of other tributary streams intermittently. Habitat in Trapper Creek occurs in the lower 0.8 miles between the mouth and a 7.5-foot waterfall (USFWS 2002b). A 1996 USFS habitat survey found 35 percent of the total habitat units in Trapper Creek had bull trout-size spawning gravels; however, spawning habitat was limited by other factors, including water depth and velocity (USFWS 2002b). Low gravel and large wood levels also limit bull trout production in Trapper Creek. The 1996 survey found only five side channels for rearing, constituting only 5 percent of the total habitat area in the 0.8-mile reach of Trapper Creek (USFWS 2002b). High fine sediment levels in tributaries may limit salmonid spawning potential.

Flows

The Deschutes River originates at Little Lava Lake and flows south for approximately 8.4 miles before entering Crane Prairie Reservoir. In low water years, "Blue Lagoon" or "Blue Hole" — a massive spring located at RM 251 — appears to be the head of the Deschutes, although there are subterranean water flows moving south in the basin upstream from this spring area (ODFW 1996a). The result is a very stable hydrologic regime in which daily, monthly, and even annual fluctuations in water flows and temperatures are minimal compared to rivers dominated by surface runoff (Mathisen 1990). Unlike most streams in Oregon, flow is lowest in the winter and peaks in August to early September (ODFW 1996a).

Odell Lake is a natural lake in the Cascade Mountains. The lake covers 3,600 acres and has an average depth of 40 meters. Trapper Creek is the only tributary of Odell Lake that responds to runoff events (USFWS 2002b). Most of the basin exhibits fixed drainage patterns fed by spring releases. Davis Lake, a shallower natural lake (20 feet maximum depth), has no surface outlet; however, many seeps in the lava flow allow water into Wickiup reservoir (USFWS 2002b).

Water Quality

Water quality in the spring-fed Deschutes River above Crane Prairie remains good to excellent, though problems exist in some tributaries and lakes. High summer water temperatures associated with surface reservoir releases reduce water quality in reach between Crane Prairie Dam and Wickiup Reservoir. In addition, water temperatures in Lava Lake exceed cool water dissolved oxygen criterion. Cold water temperatures may also limit trout rearing potential in the Cultus River, Snow Creek and other tributaries and some lakes.

In 2002, ODEQ listed Odell Lake and parts of Odell Creek as water quality limited for pH and of concern for chlorophyll *a*. Odell Creek was also listed for exceeding water temperature criteria for spawning and rearing. Summer water temperatures in Odell Creek generally exceed 70°F as a result of the discharge of warm surface water from Odell Lake (USFWS 2002b).

Out-of-Subbasin Effects
Section 5

Environmental factors outside the Deschutes Basin also have a significant effect on each focal species. It also establishes assumptions for each external effect that will be used to calculate the effects of external conditions on the productivity and sustainability of fish and wildlife within the Deschutes Basin.

This section identifies factors outside the Deschutes Basin that have a significant effect on the focal species, with particular attention to bottlenecks.

5.1. Effects on Aquatic Species

Subbasin planning, by definition, is focused on the major tributaries to the mainstem Columbia and Snake rivers. However, many focal species migrate, spending varying amounts of time and traveling sometimes extensively outside of the subbasins. Salmon populations typically spend most of their lives outside the subbasin. Unhindered, sturgeon will spend short periods in the ocean. Lamprey typically spend most of their life as juveniles in freshwater, but gain most of their growth in the ocean. Planning for such focal species requires accounting for conditions during the time these populations exist away from their natal subbasin. Out-of-subbasin effects (OOSE) encompass all mortality factors from the time a population leaves a subbasin to the time it returns to the subbasin. These effects can vary greatly from year to year, especially for wide ranging species such as salmon. Out-of-subbasin factors can be natural in origin (e.g. ocean productivity), human-caused (e.g. fisheries) or a combination (e.g. mainstem survival is dependent on both mainstem flows and dam operations). Out of subbasin effects are described by the TOAST (2004).

The Ecosystem Diagnosis and Treatment model was used to assess the effects of subbasin conditions on anadromous salmon populations. The out-of-subbasin conditions and assumptions used by the EDT model are described by Marcot et al. (2002) and TOAST (2004). Model parameters roughly represent a 1990 – 1999 base period and these conditions remained constant throughout the EDT assessments. The EDT model includes parameters representing the effects of the hydropower system, estuary and ocean conditions, and harvest regimes during the base period. Additional parameters represent the biological effects of density-dependent interactions in the mainstem Columbia and genetic effects of hatchery fish inter-breeding with naturally-produced adults.

Ocean conditions strongly affect overall salmon survival. Salmon spend most of their life in the ocean and early ocean survival is widely considered a time of particularly high and variable mortality. In addition to the steady state conditions represented in the EDT model, three climatic patterns affect ocean and freshwater conditions and, consequently, salmon production in complex interactions.

Pacific Decadal Oscillation

In recent years, a growing body of evidence from field, tagging, and correlation studies has shown that Pacific salmon experience large year-to-year fluctuations in survival rates of juvenile fish making the transition from freshwater to marine environment (Hare et al. 1999). Climate-related changes have the most affect on salmon survival very early in the salmon's marine life history (Pearcy 1992, Francis and Hare 1994).

The Pacific Decadal Oscillation is a pan-Pacific, recurring pattern of ocean-atmospheric variability that alternates between climate regimes every 20-30 years (Hare et al. 1999). The PDO affects water temperatures off the coast of Oregon and Washington and has cold (negative) and warm (positive) phases (Hare et al. 1999). A positive PDO phase brings warmer water to the eastern North Pacific, reducing upwelling of nutrient-rich cooler water off the coast of North America and decreasing juvenile salmon survival (Hare et al. 1999). The negative phase of the PDO has the opposite effect, tending to increase salmon survival.

Climatic changes are manifested in both returns and harvests. Mantua et al. (1997) found evidence of an inverse relationship between harvests in Alaska and off the coast of Oregon and Washington. The negative phase of the PDO resulted in larger harvests off Oregon and Washington and in the Columbia River and lower harvests in Alaskan waters. In the positive phase, warmer water off Oregon and Washington were accompanied by lower harvests (and runs) in the Columbia River, but higher harvests in Alaska. Phase reversals occurred around 1925, 1947, 1977, and possibly 1999. The periods from 1925-1947 and from 1977-1999 were periods of low returns to the Columbia River, while periods from 1947-1977 and the current period are periods of high returns.

El Nino/Southern Oscillation

The El Nino-Southern Oscillation (ENSO), commonly referred to as El Nino and La Nina, like the PDO, affects water temperatures off the coast of Oregon and Washington and has both a cold (negative) and warm (positive) phase. ENSO events are much shorter than PDO events in that events typically occur every 2-7 years and last 12-18 months. Positive ENSO events occur more frequently during positive PDO phases and less frequently during negative PDO phases (Hare et al. 1999). ENSO events either intensify (during congruent negative or positive events) or moderate (when one cycle is positive and the other negative) the effects of the PDO cycle on salmon survival.

A positive ENSO (El Nino) event also results in higher North Pacific Ocean temperatures, while a negative ENSO (La Nina) results in lower temperatures. Positive ENSO events occur more frequently during positive PDO phases and less frequently during negative PDO phases (Hare et al. 1999).

PDO and ENSO also affect freshwater habitat of salmon. Positive PDO and ENSO events generally result in less precipitation in the Columbia Basin. Lower stream flows result in higher water temperatures and a longer out-migration period. It is likely that less water will be spilled over mainstem Columbia and Snake River dams to assist smolt out-migration (Hare et al. 1999).

Climate Change

Climate change on a longer term than the PDO could have a large impact on the survival of Columbia Basin salmon. Finney et al. (2000) used lake sediment elemental composition to find evidence of very long-term cycles of abundance of sockeye salmon in the Bristol Bay and Kodiak Island regions of Alaska over the past 300 years. No doubt there have been similar variations in the abundance of Columbia Basin salmon.

Computer models generally agree that the climate in the Pacific Northwest will become, over the next half century, gradually warmer and wetter, with an increase of precipitation in winter and warmer, drier summers (USDA Forest Service 2004). These trends mostly agree with observed changes over the past century. Wetter winters would likely mean more flooding of certain rivers, and landslides on steep coastal bluffs (Mote et al. 1999) with higher levels of wood and grass fuels and increased wildland fire risk compared to previous disturbance regimes (USDA Forest Service 2004). The region's warm, dry summers may see slight increases in rainfall, according to the models, but the gains in rainfall will be more than offset by losses due to increased evaporation. Loss of moderate-elevation snowpack in response to warmer winter temperatures would have enormous and mostly negative impacts on the region's water resources, forests, and salmon (Mote et al. 1999). Among these impacts are a diminished ability to store water in reservoirs for summer use, and spawning and rearing difficulties for salmon.

Climate models lack the spatial resolution and detailed representation of critical physical processes that would be necessary to simulate important factors like coastal upwelling and variation in currents. Different models give different answers on how climate change will affect patterns and frequencies of climate variations such as ENSO and PDO.

For the factors that climate models can simulate with some confidence, however, the prospects for many Pacific Northwest salmon stocks could worsen. The general picture of increased winter flooding and decreased summer and fall stream flows, along with elevated stream and estuary temperatures, would be especially problematic for in-stream and estuarine salmon habitat. For salmon runs that are already under stress from degraded freshwater and estuarine habitat, these changes may cause more severe problems than for more robust salmon runs that utilize healthy streams and estuaries.

While it is straightforward to describe the probable effects of these environmental patterns individually, their interaction (PDO, ENSO, climate change) is more problematic. The main question appears to be the duration of the present favorable (for salmon) PDO period and the timing and intensity of the subsequent unfavorable period. Prudence suggests planning for a shorter favorable period and a subsequent longer, if not more intense, unfavorable period.

5.1.1. Effects on Deschutes Subbasin Populations

We are unable to specifically calculate the within-subbasin and out-of-subbasin performance of the Deschutes Subbasin steelhead and Chinook salmon populations because of the lack of detailed population data. However, Deschutes River steelhead must pass only two mainstem Columbia River dams (Bonneville and The Dalles) compared to many Columbia River Basin populations. Consequently, the populations appear to be capable of at least maintaining or increasing their numbers. Wild steelhead returns in recent years are significantly greater and could be used to reach subbasin goals more rapidly, although the number of unmarked hatchery strays or stray wild fish may have inflated the recent escapement numbers.

Improved survival within the Deschutes River subbasin will likely have larger positive impacts on the naturally spawning populations than any likely changes outside the subbasin. Considering that anticipated future climate changes are likely to make summer rearing conditions less favorable than during the base period, strategies that improve summer rearing areas should receive higher priority than other restoration strategies.

5.1.2. Effects of Hatchery Strays

Summer Steelhead

The Interior Columbia Basin Technical Recovery Team identified two demographically independent Deschutes River summer steelhead populations and one historic, but unoccupied, habitat within the Deschutes Subbasin as ESA threatened species within the Mid-Columbia ESU. Rationale for this listing includes the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead. The incorporation of genetic material from large numbers of stray steelhead could have a long term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-basin strays also pose a threat to steelhead population health. About 5% of the hatchery stray steelhead have tested positive for whirling disease (Engleking 2002).

Many Snake and Upper Columbia River summer steelhead enter the lower Deschutes mainstem at least temporarily in summer to seek refuge from warm Columbia River mainstem temperatures, which often exceed 70°F in July and August. The influx of out-of-basin stray steelhead started in the early 1980's and appears to be related to an increase in the number of hatchery origin steelhead smolts released in the upper Columbia basin, and an increase in the number of steelhead smolts transported from upper Columbia River collection points for release below Bonneville Dam.

The annual estimated number of stray steelhead passing upstream from Sherars Falls to the Pelton Fish Trap averaged 8,592 (45%) fish from 1978 to 2002, with a range of 300 (5%) to 23,618 (73%) fish (Table 22). From 1978 to 1983, the average number of stray steelhead passing Sherars Falls annually was 360 fish. This number climbed to an annual average of 16,587 stray steelhead from 1997 to 2002 (French and Pribyl 2003).

An unknown, but probably significant proportion of these hatchery strays and Deschutes hatchery fish spawn in the wild (Cramer et al. 2001). More hatchery steelhead have been observed in tributary spawning areas. In 1970 and 1990, hatchery steelhead made up 17% of the steelhead spawning in Bakeoven and Buck Hollow creeks. This increased to 71% in 1996 and 1997 (French and Pribyl 2003).

Spring Chinook

A few stray hatchery spring Chinook are recovered annually in the Deschutes River sub-basin. They have included jacks and adults coded wire tagged and released as juvenile fish at sites located over a wide geographical area. Coded wire tags have been recovered from spring chinook released as juveniles in subbasins located in Washington and Idaho, as well as coastal subbasins that include the Rogue River in Oregon and the Trinity River in California (ODFW 1997). Initially, some out-of-subbasin stray hatchery spring chinook captured at the Pelton Fish Trap each year could potentially have been used for brood stock in the Round Butte Hatchery program if they were unmarked or marked with the same fin mark as Round Butte Hatchery origin returns. Hatchery brood stock identification measures have now been implemented to insure that stray fish are not incorporated into the hatchery brood stock. Only coded-wire tag verified Round Butte Hatchery origin adults have been used for the hatchery brood stock since 1995 (French and Pribyl 2003). The consequences of the past use of potential out-of-basin strays in the Round Butte Hatchery brood stock are unknown.

Fall Chinook

Few stray, out-of-subbasin origin fall chinook had been observed in the Deschutes River until the past two years. However, managers now believe there is substantial interaction between wild Deschutes fall chinook and other stray, hatchery origin summer or fall chinook within the lower reaches of the Deschutes River. This conclusion reflects recent radio telemetry data and an ongoing Tribal fall chinook study.

A Columbia Basin adult fall chinook radio telemetry study shows that a significant number of fall chinook stray into the Deschutes River. Of the adult salmon radio tagged and released at Bonneville Dam, 47% and 54% of the adults tagged in 2001 and 2002, respectively, entered the Deschutes River but most did not remain to spawn. In 2001, 13% of these “dip-ins” migrated upstream to or above Sherars Falls (Brun 2002; Brun 2001). Tribal biologists recovering fall Chinook salmon carcasses following spawning estimate that only about 1% of the carcasses examined were fin-marked, out-of-subbasin stray salmon during 2001 and 2002. Coded wire tag recoveries from these fin-clipped carcasses originated predominantly from Klickitat River and Lyons Ferry fish hatcheries (Brun 2003).

It is difficult to thoroughly evaluate the extent of straying by out-of-basin fall chinook since many Columbia Basin hatchery-origin fall chinook can not be distinguished with any external mark or tag. The population co-exists with wild and hatchery-origin summer steelhead and spring Chinook salmon, but there are no known adverse effects from this association. It will be impossible to accurately estimate the number of stray hatchery salmon spawning in the river or estimate their effect on the Deschutes River population until all Columbia Basin hatchery-origin fall chinook are distinctively marked.

Pacific Lamprey

Little is known about straying of lamprey in the Deschutes River subbasin, including the straying of lamprey from other subbasins into the Deschutes.

5.1.3. Effects of Dam Development and Operations

TOAST (2004) provided the following estimates for Chinook and steelhead survival while migrating through the Columbia River hydropower system.

Chinook Salmon

The Multi-Species Framework Assessment Report (Marcot et al. 2002) developed in-river juvenile and adult Chinook salmon survival rates. The juvenile survival rate, based on yearling survival data from 1993 to 1999 from Lower Granite Dam to the Bonneville Dam tailrace ranged from 31% to 51%. This equated to a survival rate per mainstem dam of 86% – 92%, or a point estimate of 88% per project.

Marcot et al.(2002) assumed in-river survival of sub-yearling Chinook from the head of Lower Granite Reservoir to the Bonneville Dam tailrace was 29% or a per dam survival rate of approximately 85% for active migrants. It was also noted that juvenile survival through the Columbia River reservoirs is affected by the time juveniles spend in each reservoir.

Adult Chinook survival past each Columbia River mainstem dam was assumed to average 93% (Peters et al. 1999).

The juvenile to adult Chinook ratios (JARs) used in the Multi-Species Framework Assessments were provided by Mobrand Biometrics. The rates are the total survival rate of juvenile fish from the mouth of the Deschutes River to their return to the Deschutes Subbasin as adults. Mobrand Biometrics (2003) estimated yearling Chinook out-migrant survival at 2% and sub-yearling survival at 0.9%.

Summer Steelhead

TOAST (2004) used smolt-to-adult ratio (SAR) survival estimates for steelhead populations above Lower Granite Dam (C. Petrosky 2004). The geometric mean for steelhead since 1992 has been 1.69%. The SAR ranged from 1.04% in the 1992 smolt year to 4.68% in the 2000 smolt year. It was assumed that steelhead smolts experienced the same per dam survival rate as that for spring Chinook salmon. It was then estimated that the average SAR for Deschutes summer steelhead is 3.76%, with a range of 2.31% to 10.4%.

Hydroelectric development on the Columbia River may have had some rather subtle adverse affects on Deschutes Subbasin summer steelhead. Summer steelhead adults begin entering the Deschutes River as early as July and then spawn the following year generally from March through May. ODFW steelhead life history studies in the river discovered, through tag and recapture and scale sampling, that Deschutes summer steelhead almost exclusively spawned only once, since none of the steelhead observed during research in the late 1960s and 1970s had made a second spawning migration.

Historically steelhead could spawn and then rapidly migrate downstream to saltwater, where the ocean environment helped to heal wounds and abrasions and treat fungus and parasites encountered during their time in freshwater. The sooner fish could find their way back to saltwater the greater were their chances of survival. This return journey to the ocean was typically expedited by high spring flow in the Deschutes and Columbia Rivers. The damming of the Columbia River has appreciably slowed river velocity, prematurely warmed the river water temperature and placed formidable obstacles to adult downstream passage. It is assumed most steelhead kelts now die before they can find their way to the ocean. The repeat spawning life history characteristic for Deschutes summer steelhead, and likely all summer steelhead originating upstream from The Dalles Dam, has been lost. The importance of the historical life history characteristic is unknown, but there could have been appreciable negative genetic implications to the steelhead population.

Sockeye Salmon

Sockeye SARs were estimated from three existing stocks (Fryer 2004). Estimated SARs for potentially re-introduced Deschutes Subbasin Sockeye averaged 3%, with a range of 0.9% to 9.9% (TOAST 2004).

5.1.4. Effects of Harvest

Because of their small size, there is little ocean harvest of Deschutes spring chinook. Coded wire tag recoveries from wild spring chinook tagged as juveniles in the Deschutes River from 1977-79 brood years, the only lower Deschutes River subbasin wild spring chinook to be coded wire tagged, showed that 33% of total harvest for those brood years was in the ocean, 24% in the Columbia River, and 43% in the lower Deschutes River (ODFW 1997). Since this time, however, ocean and mainstem Columbia harvest rates have dropped significantly.

5.2. Effects on Terrestrial Species

5.2.1. Effects of Out-of-Subbasin Harvest

Local populations of mule deer move between winter and summer ranges, which are not always located within the Deschutes Subbasin. Deer ranging outside the subbasin are subject to harvest in these watersheds during deer hunting season.

5.2.2 Effects of Disease Transmission

The potential for wildlife disease is an ongoing threat to subbasin wildlife populations. Confirmed mule deer deaths have been associated with viral hemorrhagic diseases. An outbreak of Adenovirus Hemorrhagic Disease was diagnosed in the Crooked River drainage in recent years. Blue Tongue, another viral hemorrhagic disease has been detected periodically at other locations within the subbasin. Both diseases can be carried into the subbasin by infected animals (Kohl 2004).

Chronic Wasting Disease is a form of transmissible spongiform encephalopathy affecting elk and deer in North America. This degenerative neurological illness has affected both farmed and wild cervids in the US. Disease outbreaks have generally appeared in or around captive game farming or ranching operations. The incidence of CWD in wild animals is of great concern. The disease was originally described in captive animals 35 years ago in Colorado. However, over the last five years, Chronic Wasting Disease has been found in wild herds in several surrounding states and Canada. In early 2002, Chronic Wasting Disease was detected in wild deer in South Dakota, Wisconsin and New Mexico. Researchers speculate that Chronic Wasting Disease could be transported long distances because of interstate shipment of infected animals (National Biological Information Infrastructure, 2004). There have been no confirmed cases of Chronic Wasting Disease in Oregon or the Deschutes Subbasin. However, the mobility of large wild ungulates, interstate commerce in captive big game animals and the presence of local game ranches could pose risks to subbasin wildlife.

Western Oregon has experienced deer losses in recent years from Hair Loss Syndrome. This malady is apparently caused by unusual lice concentrations plaguing animals to the point that they scratch or rub way most of their fir. This can result in hypothermia, especially during cold, wet winter weather. Losses from Hair Loss Syndrome have occurred west of the Cascade Mountains, but have not been observed in the Deschutes subbasin (Kohl 2004).

Environment/Population Relationships
Section 6

"Diversity is how the salmon cope with environmental variation"
(Independent Scientific Group 1996)

Fish populations develop unique life history strategies that reflect genetic adaptations to the ecological conditions, and changes, in their environments. Adult focal fish species return to spawn in areas of their origin because the environmental conditions in natal streams are most suited to their survival. This diversity in life history strategies allows a population to survive various environmental conditions and protects it against extinction.

Wildlife also develop life history strategies based on conditions in their environments. Mule deer, for example, often summer in higher elevation areas and move to lower areas, their winter range, as temperatures drop and snow begins to accumulate.

This section identifies the environmental attributes, or key environmental correlates, that are particularly important for survival of the focal species during various life stages. It defines the characteristics that constitute optimal conditions for species health and the ability of the environment to provide these characteristics. It also assesses the long-term viability of focal species and populations based on habitat availability and condition. In addition, it identifies key ecological functions that the species play in the Deschutes Subbasin, and key relationships between the species.

6.1. Key Environment — Aquatic Population Relationships

Certain environmental attributes — or key environmental correlates — are critical for the continual health and survival of fish during various life stages. These attributes define the environmental capacity of a stream reach, which limits the size of a fish population given finite space and food resources. They include physical stream features, condition of riparian areas and floodplains, stream flow, fine sediment and water quality. All of these attributes are connected, and influenced by upland conditions and ecosystem interactions. Identifying how key environmental attributes influence fish populations during different life stages allows us to project a stream's current and potential fish producing capability. It also allows us to identify and focus our efforts to improve fish productivity and performance within different drainages.

6.1.1. Key Environmental Correlates for Aquatic Species Survival

Several key environmental correlates (KECs), or critical environmental factors, are believed to most influence a species distribution, abundance, fitness and viability. The following factors are believed to be the KECs influencing fish survival and productivity in the Deschutes Subbasin.

Channel Stability

Channel substrate is often extremely important for salmonid and lamprey survival and productivity. Aquatic organisms use different areas in the substrate as sites to deposit or incubate eggs, over-winter, for refuge from floods, or for extended rearing (i.e. lamprey ammocoetes). As a result, disruption of the channel substrate can have a profound effect on survival and production of a variety of species. Scouring of bed materials during high flows can affect the survival of incubating salmonid eggs and over-wintering juveniles, and the production of juvenile lamprey and aquatic insects (Mobrand Biometrics 2003). Lateral stream channel scour can result in reduced water depth, extreme fluctuations in water temperature, and intermittent stream flow as water passes through, rather than over expansive areas of porous gravel. This condition can isolate fish and block adult and juvenile migration.

Fine Sediment

High-suspended sediment concentrations occur naturally in some streams, such as White River in the lower Deschutes Subbasin, where glacial melt is a major source of flow. Some watersheds, including Upper Crooked River, may have highly erodible clay soils that produce minute particles that tend to remain in suspension. In other streams, high suspended sediment concentrations may occur during and following thunderstorms and other high flow events due to streambank erosion or overland runoff, or as a result of land use actions, such as construction, mining, logging, and farming. Turbidity, a measure of water cloudiness, is often used to measure suspended sediment levels.

Chronically turbid waters, particularly during the spring, can substantially reduce fish productivity by reducing feeding success, growth, and competitive ability. Turbidity may also cause physical discomfort or injury to fish, depending upon the concentration and the duration of exposure. Adult fish may experience gill tissue damage from excessive turbidity that lasts between 5 and 10 days (ODFW 1996). High levels of turbidity can also act to concentrate fish in stream segments with reduced water velocity, which can make them more vulnerable to predation.

Fine sediment particles within the substrate of pool-tailouts, glides, and riffles can affect the survival of incubating salmonid eggs and alevins, and lamprey eggs, by altering oxygen exchange across the organisms and by entombment (Mobrand Biometrics 2003). Fish require clean gravel to spawn, and typically lay their eggs in graveled riffle areas where oxygenated water can flow through the gravel and allow the eggs and fry to breath. Fine sediment can plug these gravel nests, forming a cap over the redds and consequently suffocate the eggs and prevent juvenile salmonids and lamprey from emerging. High levels of suspended sediment can also reduce macroinvertebrate species diversity and abundance, which directly affects fish production.

Riparian Function

The riparian corridor provides a variety of ecological functions, which can generally be grouped into energy, nutrients and habitat as they affect salmonid performance (Mobrand Biometrics 2003). Riparian stream corridors are the natural buffer between streams and uplands and they act as filters to prevent sediment, pollutants and other items from reaching the streams. Riparian plants in this subbasin provide important overhead shade and cover, which helps to moderate stream water temperature extremes. The roots of riparian vegetation help to bind and stabilize stream banks to resist channel erosion. By slowing high stream flow, riparian corridors play an integral function in the recharge of groundwater and ultimately the moderation of late summer stream flow. Riparian corridors are generally very productive and naturally support the greatest biological diversity of any habitat type. Being the single most important wildlife habitat, these corridors also provide migration corridors and cover for a wide variety of wildlife species. The ability of the riparian corridor to provide these functions is dependent on the health of its vegetation — trees, brush, grass, and sedges.

Instream Habitat Diversity

Healthy stream systems contain a variety of physical features that provide for different needs during the fish life cycle. Instream habitat in the form of undercut banks, large woody debris, large boulders, and water turbulence and depth create complex instream cover for fish and other aquatic life. Overhanging vegetation can also provide important cover. Such habitat can be critically important in providing fish shelter and aquatic food production, and in promoting rejuvenation of natural river channels.

Large woody debris once provided much of the habitat complexity in Deschutes Subbasin streams, as well as throughout the Columbia River Basin. Along with riparian vegetation, large woody debris acts to provide diverse and stable channel habitat conditions. The structure produces habitat complexity and the water depth, duration, and temperature necessary for fish production. Such areas also contribute to aquatic food webs. Cover elements can be particularly important in providing physical shelter from high flow events or refuge during low flows.

Streamflow

Fish abundance is often directly related to the volume of water available in streams and rivers. Salmonids and lamprey require clean, cool water flowing at a natural rate for all stages of freshwater life. Fish populations native to different stream systems show unique life history strategies that reflect the natural flow regimes, low flows and typical high flow events that occur within their environments during various seasons. These natural changes in flows often trigger the timing of adult and juvenile salmonid migrations and spawning.

Alterations in natural flow patterns — whether within a day, year or between years — can impact fish production and survival during different life stages. Significant changes in flow over a short period, such as changes associated with flow regulation, water withdrawal or storm runoff, can result in displacement and stranding and loss of juvenile and adult fish. Low stream flow can restrict fish movement in the stream system or alter water quality by causing high temperatures, decreasing the amount of available dissolved oxygen, or increasing the concentration of pollutants. Seasonal flow reductions may also increase predation as fish are more concentrated and exposed to predators. Rapid flow changes can also affect other environmental attributes, including availability of instream structure, amount of streambank erosion, and quality of riparian habitat.

Summer Water Temperature

Since salmonid behavior is heavily influenced by water temperature, the thermal environment — perhaps more than any other aquatic habitat feature — influences the distribution, health and survival of our native salmonids (McCullough et al. 2001). Being cold-blooded, salmonids respond to an uncomfortable water temperature by moving from one spot to another to maintain their thermal comfort.

Salmonids have definite ranges of tolerance and optimal temperatures at different life stages. Shifts in maximum and minimum stream temperatures can have profound effects on species composition of both vertebrates and invertebrates (Mobrand Biometrics 2003). Bull trout are especially adapted to cold water and have more stringent temperature requirements than most other salmonids. Conversely, various non-game fish species thrive with higher water temperatures.

Channel Width

The shape of a stream channel at any location is a function of flow, the quality and character of the sediment moving through the section, and the character or composition of the materials making up the bed and banks of the channel (Leopold 1963). Channel width and depth are often directly linked to the condition of a stream's watershed and riparian vegetative corridor. How much a channel changes in response to natural or human influences is largely determined by the health and functionality of the associated floodplain and these other characteristics.

Stream channel width has direct implications for stream flow, temperature and water quality. Degraded channels frequently have a high width to depth ratio, which generally means more flow is required to meet various fish life history requirements than in a pristine channel. Streams channels suffering from lateral scour commonly experience seasonal flow and temperature extremes and low dissolved oxygen during periods of unusually high temperature.

Pathogens

Like all animals, fish have their full complement of diseases and parasites. There is no question that most fish die from such disorders, natural enemies other than man, or old age – certainly not from being caught by fishermen (Lagler 1966). The subbasin has a variety of fish diseases and parasites that likely have co-existed with the native fish populations and generally do not pose any particularly unusual risk of a pandemic fish kill. Indigenous fish populations have likely evolved some natural resistance to these diseases and parasites. However, it is apparent that anadromous fish can carry and introduce exotic fish diseases and parasites into the subbasin downstream from the Pelton Round Butte Complex. The incidence of large numbers of out-of-basin stray salmon and steelhead exacerbate this potential problem.

Two diseases of particular concern to subbasin focal fish species are Infectious Hematopoietic Necrosis (IHN) Type 2 and Whirling Disease, caused by a virus and a myxosporean parasite, respectively. IHN has been found in anadromous salmonids and anadromous salmonid strays carrying Whirling Disease spores have been found in the lower subbasin. The upstream distribution of the disease or carrier fish has been blocked by the Pelton Round Butte Complex. During the relicensing process, Portland General Electric contracted with the ODFW Fish Pathology Section and Oregon State University Department of Microbiology to evaluate the presence of pathogens downstream of the hydroelectric project and assess the risk that some or all of these diseases could have if they were to become established in the upper subbasin if fish passage is restored at the project.

Five fish hatcheries are located within the Deschutes Subbasin. The concentration of large numbers of various fish species within confined rearing spaces at a fish hatchery can lead to epizootics from any number of fish diseases or parasites. Hatchery managers, however, are constantly observant about any unusual loss of fish and utilize regular pathological examinations and prophylactic treatments to prevent or avoid disease outbreaks. There is also the potential for higher than normal concentrations of infective agents to enter subbasin streams in the effluent from the fish hatcheries. Nevertheless, there has been no recorded incident where an observable loss of native resident or anadromous focal fish species has been attributable to this source of infection.

Food

Subbasin focal fish species utilize a variety of food items ranging from microscopic plankton to macroinvertebrates to other fish. For example, Pacific lamprey and anadromous salmonid adults do not feed in freshwater. Lamprey ammocoetes are filter feeders that feed on plankton and tiny macroinvertebrates. Juvenile redband and bull trout begin feeding on plankton and small macroinvertebrates, but bull trout sub-adults and adults include small fish in their diet. Redband trout adults appear to feed primarily on aquatic and terrestrial insects, but will also include small mollusks (snail) and crustaceans (crayfish) in their diet. Sockeye salmon juveniles are strictly plankton feeders in natural lakes or reservoirs.

Streams with good year-long flow and high water quality generally support a more diverse assemblage of aquatic insect species with more abundant populations than streams that are flow and water quality limited. Food production can directly affect fish growth and productivity.

Predation

A wide variety of predatory species, including aquatic and terrestrial species, may prey on focal fish during some life stages within and outside the subbasin. Human influence and habitat modification within the subbasin over the last 150 years has influenced the traditional and historic predator-prey relationships. Freshwater life stages of most focal fish species are generally considered prey species. The notable exception is bull trout that generally evolve into efficient fish predators as sub-adults and adults.

The degradation of streams, including the loss of instream structure and complexity and the loss of riparian and emergent aquatic vegetation, coupled with appreciable reductions in seasonal stream flow and water quality, has generally favored predators over the subbasin focal fish species. Fish have been more susceptible to a variety of predators when concentrated in degraded habitat by low or intermittent flow.

Competition with Hatchery Fish

Subbasin fish managers have worked in recent years to minimize the potential competition between hatchery-reared fish and indigenous focal fish species. Initial releases of rainbow trout into subbasin waters began nearly 100 years ago. Hatchery rainbow trout were released into many streams and lakes and reservoirs until the last 20 years. Today hatchery trout releases are generally confined to subbasin lakes and reservoirs.

Past releases of exotic salmonids into subbasin waters has produced appreciable competition with redband and bull trout. Brown trout in the Middle Deschutes, Upper Deschutes and Cascade Highlands assessment units have effectively competed with redband trout as habitat conditions deteriorated. Redband populations are depressed in most streams within these assessment units. Brook trout have effectively competed with redband and bull trout in a number of headwater streams. In several instances (such as in Mill Creek, a Warm Springs River tributary) brook trout have displaced bull trout populations or are hybridizing with bull trout.

Fish managers have conscientiously worked to maintain the characteristics of the hatchery produced spring Chinook as close to the wild population as possible. As discussed in the Focal Species Section, most hatchery produced spring Chinook are released as smolt-sized fish that readily emigrate and have little opportunity to interact with wild fish. Steelhead reared at Round Butte Hatchery are also released as smolt-size fish that rapidly migrate from the river. Fall Chinook in the subbasin are supported strictly by natural reproduction

The large numbers of stray, out-of-basin, hatchery origin anadromous fish entering the lower Deschutes River and remaining to spawn with the Deschutes populations pose the largest risk to indigenous subbasin populations. The genetic implication of this invasion was a primary factor leading to the listing of Deschutes summer steelhead as an ESA threatened species.

Competition with Other Species

The deterioration of stream habitat, including reduced flow and elevated water temperature, has favored the more warm water tolerant subbasin fish species, including suckers and northern pike minnow. Redband trout generally declined or were extirpated in some stream reaches as flows diminished and temperatures and competitor numbers increased.

Unauthorized releases of cyprinids, including Three-Spine Stickleback and Tui chub have resulted in appreciable competition for indigenous salmonids in a number of subbasin lakes and reservoirs. The unauthorized releases of a number of centrarchids, including large and smallmouth bass, bluegill and green sunfish have established naturally reproducing populations in lakes, reservoirs and some stream reaches resulting in increased competition and predation with focal fish species.

Obstructions to Passage

Partial or total passage barriers due to waterfalls, cascades, debris jams or manmade structures (such as dams or culverts) can restrict fish movement. Some obstructions are only passable at a certain range of flows, which may only be available for a short time each year. Still in other streams, such as in the Crooked River system, low flows and high water temperatures may obstruct passage. Such obstructions may block fish from historically important spawning and rearing areas. The loss of connectivity can also cause fish to become isolated and fragmented, thus reducing the population’s productivity, genetic diversity and overall chances of survival.

6.1.2. Optimum Conditions for Aquatic Species Health

Migration

Adult salmonids generally return to natal spawning areas for reproduction. These returning spawners need adequate flows and water quality during their upstream migration. Migration for some anadromous species is rapid. For example, spring Chinook salmon generally begin entering the Lower Deschutes River in early April and immediately move upstream to the Warm Springs River or Shitike Creek where they hold through the summer before spawning. Summer steelhead enter the Deschutes River from early July through October and then hold in the river through the winter prior to spawning.

Some waterfalls or other physical barriers may only be passable at a specific range of flows that typically occurs during a short period of the year, and then only by fish that have particular physical capabilities for jumping or "scooting" over the barrier. The entire sequence of migration behavior must be properly timed to meet such windows of opportunity (Independent Scientific Group 2000).

Once they near spawning areas, large adult migrant fish can be highly visible and vulnerable to terrestrial (including human) and avian predators. The availability of deep resting pools, riparian canopy, undercut banks, and large woody debris in the proximity of spawning habitats can be critical for survival and successful reproduction of migratory salmonids, particularly those that venture far upstream and that are required to spend long periods holding in small river and stream environments. Cover and channel structural elements can provide particularly critical shelter during high flows, or refuge from low flows.

Spawning and Incubation

The season of spawning, egg incubation, and juvenile emergence varies by species and sometimes by population. The focal fish species generally have their own particular preferences for preferred spawning habitat, which includes water depth, velocity and substrate particle size. There is typically spatial and/or temporal separation between species during spawning. The relative success of spawning can vary, depending on climate and hydrologic regime, channel stability and sedimentation, water temperature patterns, the influence and availability of groundwater seeps or springs, and controls exerted by seasonal flow conditions and physical barriers that can restrict the ability of adult fish to gain access to spawning sites.

Adult fish search out and select high-quality habitat patches for spawning. These areas contain suitably sized gravel and cobble, with high rates of interstitial flow to modulate temperatures, oxygenate the eggs and carry away metabolic wastes. Lamprey and many smaller salmonids, such as spring chinook, bull trout, and some steelhead and redband trout spawn in smaller, headwater streams and in spring snowmelt-fed streams. These areas are generally protected from excessive peak flows and they provide a good environment for their eggs and offspring. Fall Chinook salmon spawn exclusively in the lower Deschutes River. They are able to utilize marginal quality substrate because of their ability to till the gravel, which flushes many fine sediments prior to egg deposition.

Water temperature can help to trigger the onset of spawning and it directly affects the time required for egg incubation. Warmer winter stream temperatures, associated with reservoir releases, could accelerate Chinook salmon hatching and emergence. Early emergence could increase mortality if alevins and fry are exposed to hostile conditions with reduced food availability.

Juvenile Growth and Feeding

Once young salmonids emerge from the gravel they generally seek nearby areas that provide food, good rearing habitat, and protection from predators. Since their mobility is still limited, suitable habitat and food must be near the spawning areas for successful first-year survival. Key habitat areas for juvenile growth and feeding include quiet-water side margins, off channel sloughs, backwaters, and spring-fed “seep” areas. The presence of large woody debris, bank structures and riparian vegetation or aquatic plants in these areas provides a steady supply of small food particles, and refuge from large predators.

Very young fry typically feed on plankton and small invertebrates and, in high quality alluvial habitats, they grow rather rapidly. As water temperature increases beyond about 59°F (15°C), metabolic costs escalate rapidly and available food resources support progressively lower densities of juvenile salmonids (Li et al. 1995b).

As they grow, juvenile salmonids move away from quiet shallow areas to deeper, faster waters. Some species, such as steelhead, retain a diversity of rearing strategies that allow them to persist in headwater stream reaches, even when opportunities for downstream migration are poor. Other species, such as fall chinook, begin moving progressively downstream after emergence, stopping to feed and grow in lower velocity habitats created by eddies in constrained reaches and, in particular, the complex habitats of floodplains.

Lamprey eggs hatch within 2-3 weeks, depending upon water temperature. The juveniles emerge from the spawning gravel at approximately 1 cm in length. The ammocoetes burrow into the soft substrate downstream from the nest and may spend up to six or seven years in the substrate. They are filter feeders that feed on algae and diatoms. The ammocoetes will move gradually downstream, moving primarily at night, seeking coarser sand/silt substrates and deeper water as they grow. They appear to concentrate in the lower parts of Subbasins before undergoing their metamorphism (Kostow 2002).

6.1.3. Watershed's ability to provide important environmental characteristics

Generally, fish habitat in much of the Deschutes Subbasin has deteriorated from historical conditions due to watershed alterations. These alterations have reduced the watershed's ability to capture and slowly release precipitation, resulting in altered hydrologic regimes in the mainstem and tributary drainages, with low or intermittent late spring, summer and fall flows; loss of riparian habitat and floodplain function; elevated stream temperatures; stream channel simplification; loss of instream cover and connectivity between habitat areas; sedimentation and increased predation. Efforts are currently underway to improve conditions within individual watersheds; however, these programs could be greatly expanded.

Habitat Evaluations Using EDT and QHA

Two methods were used to assess fish habitat — population relationships in the Deschutes Subbasin during the planning process. The Quantitative Habitat Assessment Method was used to evaluate conditions for resident species. The Ecosystem Diagnosis and Treatment model was used for anadromous species.

The QHA is essentially a spreadsheet that correlates stream segments (or small watersheds) with important population and habitat factors. The model provided a systematic means for recording data and making qualitative decisions concerning the relationship between environmental attributes and species survival. Information gained from the QHA assessment generally reflects past physical stream habitat surveys or professional judgment in the subbasin.

The EDT Model (Mobrand Biometrics, Inc.) was used to assess the fish habitat in the mid and lower subbasin within the current range of anadromous focal fish species and in historical habitat where plans are progressing for re-introduction of anadromous species. The EDT Model allowed planners to define different steelhead and Chinook salmon populations and then produce reports that combined population and habitat data (current, historic and future with restoration). Three scenarios involving low, moderate and extensive habitat restoration were modeled to determine potential affects on future salmon and steelhead production in subbasin plan assessment units.

The EDT habitat assessment summaries identified stream habitat deficiencies by fish life stage for each stream reach with current or potential anadromous fish production. Identified habitat deficiencies provided the primary guidance used to develop habitat restoration scenarios that included potential management strategies or actions that would individually and holistically help to restore degraded fish habitat. EDT scenario attributes included aggradations of similar or linked attributes rated in the habitat assessment process and summarized in EDT Diagnostic reports. For example “habitat diversity” addresses instream habitat complexity (i.e. pools, riffles, glides, structure and cover), “channel stability” includes consideration of channel scour, riparian function and flow variation and “predation” relates to predator abundance and stream cover and structure.

During the process, planners selected a twenty-five-year planning horizon for the EDT Model restoration scenarios, since appreciable habitat recovery in this subbasin and eco-province would require several decades. This extended recovery period is particularly important for potential restoration of riparian and floodplain function, as well as channel aggradations.

The preferred or moderate intensity habitat restoration scenario was deemed to have the best opportunity to meet the biological and habitat objectives of the subbasin plan in the twenty-five-year planning horizon. This preferred alternative was based on the percent of improvement for a number of habitat attributes. The actual habitat improvement percentage was based on the potential difference between the template and current, or patient, habitat condition. Habitat attribute improvement was not strictly a percentage based on the current habitat condition. For example, if a stream channel width had increased from 20 to 40 feet from the template to current condition, a 50 percent reduction in channel width would result in a channel 30 feet wide (i.e. 50% x 40’ – 20’ = 10 foot reduction in width and 40 foot channel minus 10 feet = a 30 foot channel width) when the objective was achieved. The same restoration scenario could be applied to all subbasin stream reaches, whether the current habitat was in poor, fair or good condition. The better the current stream condition the less habitat improvement would be required or projected.

The three potential habitat restoration scenarios were considered to meet the plan objectives and they are described in Table 6.1. The following habitat attributes and anticipated rate of change were generally considered for each scenario, if the restoration measures were implemented.

Table 6.1. EDT Habitat Restoration Scenarios

Habitat Attribute	Scenario Low Intensity Restoration (% change)	Moderate Intensity Restoration (% change) PREFERRED	High Intensity Restoration (% change)
Riparian Function	+25%	+50%	+75%
Channel Width	-25%	+50%	-75%
Minimum Stream Flow	+15%	+25%	+40%
Maximum Stream Temperature	-15%	-25%	-40%
Large Wood/Structure	+15%	+25%	+50%
Fine Sediment – Intragravel	-15%	-25%	-50%
Fine Sediment – embeddedness	-15%	-25%	-50%
Primary Pool Habitat	+10%	+20%	+30%
Fish passage at barriers	+100%	+100%	+100%

Watershed Ability to Provide Key Environmental Correlates

The environmental attributes, or correlates, that are currently limiting fish production reflect the geology, hydrology and climates of individual watersheds. In the Deschutes Subbasin — which contains a diverse array of environmental conditions shaped by geology, hydrology and climates — stream systems can generally be segregated into three distinct categories. These categories including:

- Ground water/spring fed streams, including the Metolius, Fall and Spring rivers and the upper Deschutes River system above Crane Prairie Reservoir. Streams generally display stable flows, riparian and instream habitat conditions, and water temperatures.

- Cascade Mountain, snowmelt driven streams, including the Warm Springs and White rivers, and Shitike and Squaw creeks. Snowmelt dominated runoff causes flows to peak in spring, taper off through summer, and drop to base flows in late summer or early fall.

- Streams draining the more arid portions of the subbasin, including Crooked River and Trout, Willow, Bakeoven, and Buck Hollow creeks. Stream flows peak in winter or early spring with runoff, and rapidly drop to low levels in summer. Streams are also subject to flash flooding during high intensity summer storms.

Results from the EDT and QHA habitat analyses show some commonality of habitat limiting factors across all three stream categories, but there were also generally marked differences in importance between the stream categories. The apparent limiting factor variations between the three stream categories are summarized in Table 6.2.

Table 6.2. Significance of Environmental Correlates as Limiting Factors to Focal Fish Species Production by Stream Category

Habitat Attribute	Groundwater / Spring-fed Systems	Cascade Snowmelt Systems	Semi-Arid Systems
Riparian function	Low to Moderate	Moderate to High	High
Channel width	Low	Low to High	High
Channel stability	Low	Moderate	High
Flow	Low	Moderate to High	High to Extreme
Temperature	Low	Low to High	High to Extreme
Obstructions	Low	Low to Moderate	High
Habitat diversity	Moderate to High	High	High
Pathogens	None	Low	Moderate to High
Predation	Moderate	Low to Moderate	Moderate to High
Fine sediment	Moderate to High	Low to High	Moderate to High
Food	Low to Moderate	Low	Low to Moderate
Competition (with hatchery fish)	Moderate	Low to Moderate	Low to Moderate

Examination of physical conditions and the past studies indicates that because of the physical nature of some watersheds, which may contain highly erodible soils and currently experience extreme stream flow fluctuations and erosion, restoration of riparian and instream habitat will not occur unless actions are also taken to improve overall watershed health. This is particularly true for habitats in semi-arid systems.

6.1.4. Long-Term Viability Based on Habitat Availability and Function

Analysis of environment/population relationships using the QHA and EDT models projected focal species performance and identified habitat limitations that need to be addressed.

Steelhead population data generated from the EDT Report 3 are summarized in Table 6.3. The data for the westside and eastside populations include the results of a moderate habitat restoration scenario, which used a 50 percent increase in riparian function, 50 percent reduction in channel width, 25 percent increase in instream structure, 30 percent reduction in fine sediments and a 20 percent increase in primary pool habitat over 25 years when comparing template to current conditions. The data generated from the scenario for the Mid-Deschutes also included results from fish passage restoration at Pelton Round Butte and artificial barriers on Squaw Creek and Lower Crooked River.

Spring Chinook population data generated from the EDT Report 3 are summarized in Table 6.4. The data for the Warm Springs River and Shitike Creek populations include the results of a moderate habitat restoration scenario, which used a 50 percent increase in riparian function, 50 percent reduction in channel width, 25 percent increase in instream structure, 25 percent reduction in fine sediments, 25 percent Increase in minimum flow, 25 percent reduction in maximum stream temperature and a 25 percent increase in salmon carcasses over 25 years when comparing template to current conditions.

The data generated from the scenario for Squaw Creek and the Metolius River included the results of a moderate habitat restoration scenario, which used a 50 percent increase in riparian function, 50 percent reduction in channel width, 25 percent increase in instream structure, 25 percent reduction in fine sediments, 25 percent Increase in minimum flow, 25 percent reduction in maximum stream temperature, 20 percent increase in primary pool habitat, restoration of fish passage at artificial barriers and a 25 percent increase in salmon carcasses over 25 years when comparing template to current conditions.

The data generated from the scenario for the Middle Deschutes River included the results of a moderate habitat restoration scenario, which included a 50 percent increase in minimum stream flow, 40 percent increase in instream structure, 100 percent increase in fish passage and a 50 percent increase in riparian function.

The data generated from the scenario for Crooked River included a habitat restoration scenario that included a 100 percent increase in minimum river flow and a 50 percent increase in tributary minimum stream flow, 50 percent increase in riparian function, 30 percent reduction in fine sediment, 25 percent increase in instream structure, 30 percent reduction in maximum stream temperature, 40 percent reduction in channel width and fish passage restoration at Pelton Round Butte and artificial barriers on Lower Crooked River and Ochoco Creek..

Table 6.3. Deschutes River TRT Steelhead Population Performance projected by EDT analysis (Newton 2004).

Deschutes River Steelhead Population Projections

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
	Deschutes River Westside Tributaries Steelhead Population				
TRT Steelhead DR West (4-25)	Current without harvest	89%	6.4	2,806	2,369
	Deschutes R West TRT Moderate Habitat Restoration	99%	9.0	3,117	2,770
	Historic potential	100%	28.9	7,198	6,949
	Deschutes River Eastside Tributaries Steelhead Population				
TRT Steelhead DR East (4-25)	Current without harvest	26%	1.6	3,870	1,447
	Deschutes River East TRT Moderate Habitat Restoration	57%	2.9	5,206	3,415
	Historic potential	98%	19.8	15,454	14,672
	Middle Deschutes River Tributaries Steelhead Population				
TRT Steelhead Middle Deschutes (4-26)	Current without harvest	21%	5.7	1,646	1,359
	Mid-Deschutes River TRT Moderate Habitat Restoration	74%	8.2	5,476	4,807
	Historic potential	99%	28.3	15,304	14,763

Table 6.4. Deschutes River Spring Chinook Salmon Population Performance projected by EDT analysis (Newton 2004).

Deschutes R. Spring Chinook Population Projections

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Warm Springs River Spring Chinook Salmon Population					
Warm Springs R. Spring Chinook (3-26)	Current without harvest	95%	5.4	2,458	2,001
	Warm Springs River Mod. Habitat Restoration	97%	6.6	2,843	2,409
	Historic potential	100%	12.0	4,576	4,195
Shitike Creek Spring Chinook Salmon Population					
Shitike Creek Spring Chinook (4-28)	Current without harvest	97%	5.0	860	690
	Shitike Creek Mod. Habitat Restoration	100%	6.3	989	831
	Historic potential	100%	12.4	1,666	1,531
Squaw Creek Spring Chinook Salmon Population					
Squaw Creek Spring Chinook (4-13)	Current without harvest	7%	4.0	277	208
	Squaw Creek Mod. Habitat Restoration	50%	3.4	403	285
	Historic potential	100%	12.5	1,792	1,649
Metolius River Spring Chinook Salmon Population					
Metolius River Spring Chinook (4-13)	Current without harvest	75%	5.4	1,676	1,364
	Metolius River Mod. Habitat Restoration	75%	5.5	1,706	1,399
	Historic potential	100%	10.2	1,394	1,256
Middle Deschutes River Spring Chinook Salmon Population					
Mid Deschutes Spring Chinook (4-18)	Current without harvest	0%	-	-	-
	Mid Deschutes Mod. Habitat Restoration	100%	4.6	217	170
	Historic potential	100%	9.7	317	285
Lower Crooked River Spring Chinook Salmon Population					
Crooked R Spring Chinook Salmon (3-26)	Current without harvest	0%	-	-	-
	Lower Crooked River Passage, Minimum Flow and Habitat restoration	93%	5.5	1,052	861
	Historic potential	100%	12.2	1,999	1,835

Fall Chinook population data generated from the EDT Report 3 are summarized in Table 6.5. The data for the Lower Deschutes River population include the results of a moderate habitat restoration scenario, which used 50 percent increase in riparian function, 50 percent reduction in channel width, 25 percent increase in instream structure, 25 percent reduction in fine sediments, 25 percent Increase in minimum flow, 25 percent reduction in maximum stream temperature and a 25 percent increase in salmon carcasses over twenty five years when comparing template to current conditions.

Table 6.5. Lower Deschutes River Fall Chinook Salmon Population Performance projected by EDT (Newton 2004).

Lower Deschutes River Fall Chinook Salmon Population					
Population	**Scenario**	**Diversity index**	**Productivity**	**Capacity**	**Abundance**
Deschutes Fall Chinook-3-26A	Current without harvest	53%	6.0	16,277	13,578
	Lower Deschutes River Mod. Habitat Restoration	60%	7.1	18,039	15,493
	Historic potential	92%	7.8	19,255	16,794

Many opportunities are available for improving fish habitat in the Deschutes River subbasin. These opportunities include flow recovery, riparian and floodplain function restoration and protection, restoration of instream structural diversity, installation of fish screens, and supplementation of spawning gravel. The following discussion suggests how environmental attributes may respond to restoration measure implementation.

- ***Riparian Function.*** Improvement potential will vary depending upon the presence or absence of soil, length of the growing season, native plant species present or found nearby, water table height or water availability, etc.

- ***Channel Width.*** Recovery depends upon physical channel type, presence or absence of riparian vegetation, channel and stream bank stability and watershed function.

- ***Minimum Stream Flow.*** Increase may depend upon recovery of upland watershed health, riparian and floodplain function, or water conservation or acquisition projects. State instream water rights, designated for many streams, were often developed to meet minimum fish life stage requirements with degraded stream channels that frequently had a high width to depth ratio. With channel stability and narrowing less flow can often satisfy these same fish habitat requirements.

- ***Maximum Stream Temperature.*** Reduction in peak stream water temperatures will depend on upland watershed improvements, increased minimum stream flow, channel narrowing, shading from riparian vegetation and recovery of the adjacent water table.

- ***Large Wood/Structure.*** Structural recovery may depend on placement of structure in-channel in the near term until riparian recovery progresses to the point where the stream corridor is naturally contributing large wood to the channel. Some streams or stream reaches may not retain wood, but large boulders could provide the habitat diversity.

- ***Fine sediment.*** Input of fine sediment to the stream channel will be influenced by watershed soil types and health, stream channel stability and anthropogenic causes. Restoration will depend upon stream flow variation or natural flushing characteristics combined with reduction in sediment sources.

- ***Primary Pool Habitat*.** Amount of primary pool habitat will depend upon the physical channel type and gradient, as well as instream structure, channel width to depth ratio, sinuosity and stream bank stability.

- ***Fish Passage at Barriers*.** Restoration of fish passage to historic habitat will depend upon the modification or removal of manmade structures built with no provision for upstream or downstream fish passage. Barriers in need of treatment could also include de-watered stream reaches or debris accumulation often associated with upland management practices (i.e. logging debris).

6.2. Key Environment — Terrestrial Population Relationships

6.2.1. Key Environmental Correlates for Terrestrial Species

Key environmental correlates for terrestrial species are also referred to as habitat elements in the IBIS planning system. These Key environmental correlates “refer to wildlife habitats, habitat elements, and other nonhabitat influences on the distribution and abundance of organisms,” and “those components of the environment believed to most influence wildlife species distribution, abundance, fitness, and viability” (Johnson, et. al. 2001).

KECs for the focal terrestrial species, optimal characteristics of the KECs, and environmental potential for the KECs are presented in Appendix III.

6.2.2. Long-term viability of focal species based on habitat availability and condition

Estimated long-term viability for focal species based on projected habitat availability and condition are presented in Table 6.6.

Table 6.6. Estimated Long-term Viability of Terrestrial Focal Species based on Habitat Availability and Condition (Hostick 2004).

Long-term Viability of Focal Species Populations	
Species	**Long-term viability**
American beaver	Increasing in areas where riparian habitat is recovering. Decreasing in areas where riparian habitat degradation continues.
Columbia spotted frog	Increasing in areas where riparian habitat is recovering. Decreasing in areas where riparian habitat degradation continues.
White-headed woodpecker	Stable or increasing in areas where restoration projects occur and habitat is recovering. Stable or declining in areas with continued loss of large-diameter ponderosa pine trees and snags due to increasing human population and more intensive forest management.
Mule deer	Decreasing. Continued loss and fragmentation of winter range capability due to human development.
Greater sage grouse	Decreasing. Continued vegetative succession is expected to degrade shrub-steppe habitat in the absence of vegetative management options such as controlled burning.
Golden eagle	Decreasing. Loss of cliff and large tree nest sites will occur to due increasing human population, and other sources of mortality will increase.
Sharp-tailed grouse	(presently extirpated) Continued absence, unless action is taken by wildlife and habitat managers to restore populations.

6.3. Key Ecological Functions

Anadromous and resident fish species and wildlife species provide a number of Key Ecological Functions (KEFs) that support the trophic structure of the ecosystems, including energy flow, food webs and nutrient cycling. The differing live history characteristics of the anadromous fish species distributed fish through streams varying in size from the Deschutes River to small headwater creek. Historically these species served as an important food source for a variety of animals, including man. Nutrients from fish carcasses helped to nourish aquatic invertebrates and vertebrates, which was important to the maintenance of their robust populations. The aquatic insect populations flourished with the readily available nutrients provided by the fish carcasses and they in turn provided a food source for other populations, including resident and juvenile anadromous fish, neo-tropical birds, bats, spiders and other predatory insects. Various terrestrial predators utilized the fish carcasses as food sources that were not always consumed in or adjacent to subbasin streams. Fish carcass remains and predator droppings left near streams provided nutrients that helped produce vigorous and diverse riparian vegetative communities that stabilized stream banks, while providing important habitat to a wide variety of wildlife species. The distribution of fish carcass-related nutrients to upland areas provided benefit to a variety of plant species, which in turn provided benefits to grazers and browsers. The extirpation of the anadromous species from the upper subbasin appreciably reduced this historic nutrient source.

Large anadromous fish routinely till the stream substrate during their spawning activities. This disturbance acts to flush fine sediment from the substrate for the benefit of incubating eggs and aquatic insects utilized the interstitial spaces in the substrate for feeding and refuge. The annual tilling of the substrate prevents or reduces the accumulation of fine sediment and the potential invasion of rooted aquatic plant species. The actual digging of the fish redd also dislodges aquatic insects that may then be preyed upon by opportunistic feeding fish.

Historically beaver populations were found throughout the subbasin. This species was instrumental to the maintenance of functional riparian vegetative communities and associated floodplains. Beaver dams slowed stream flow, recharged ground water and provided fish rearing habitat. The beaver activity acted to maintain perennial stream flow and moderate stream water temperature, while stabilizing stream banks. Beaver also helped to recruit large woody structure to the stream channels. Beaver populations provided important habitat for a diversity of aquatic and terrestrial wildlife populations. Ungulates benefited from sub-irrigated meadows and lush riparian vegetation maintained by high water tables. Predator species found abundant prey associated with these functional riparian and floodplain habitats.

Ecological functions are also performed by other focal wildlife species. The White-headed woodpecker consumes seeds and invertebrates, and disperses seeds and fruits through caching or ingestion. It is a primary excavator of cavities in snags or live trees. The greater sage grouse and Columbian sharp-tailed grouse consume foliage, fruit, and flowers, and terrestrial invertebrates. They disperse seeds or fruits through ingestion and may carry diseases into the system. The Columbia spotted frog is a consumer of vegetation and invertebrates, both terrestrial and aquatic. It is also prey for other “consumers” in the system. Mule deer provide prey for other consumers in the system. They also create runways for other users, feed on trees, shrubs, grasses, and forbs and may alter the vegetation in the environment by their foraging behavior. The golden eagle consumes terrestrial vertebrates and carrion, and salmon carcasses. The golden eagle is associated with aerial structures within the habitat in that it constructs large nests that may be used by other wildlife.

6.3.1. Functional Redundancy

Functional redundancy refers to more than one species performing an ecological function; therefore, if two or more species are shown with the same KEF, functional redundancy is indicated. Functional redundancy would be shown at the most specific end of the KEF hierarchy.

Subbasin focal fish species share a number of similar life history characteristics. All species prefer to spawn in clean gravel substrate in streams with good water quality. Juvenile fish generally feed on macroinvertebrates before beginning their ocean migration. Most of their growth occurs during their time at sea. Returning adults are recycling nutrients from the ocean to the subbasin. The fish provide an important food source for a variety of subbasin wildlife species.

The variety of anadromous fish species historically present in the subbasin provided the functional redundancy for the food web and nutrient cycling. If the numbers of one species were depressed, there was the opportunity that other species could compensate with the same or similar ecological functions. However, when anadromous species were extirpated from the upper portion of their historic range local resident species did not have the capability of fully compensating for the subsequent loss to the food web, and nutrient cycling.

The Columbia and Oregon spotted frogs and the American beaver are heterotrophic consumers, but this would not show a high degree of functional redundancy until carried down the hierarchy to the lowest level where both species are shown to be aquatic herbivores. The ecological function provided by beaver, however, is not duplicated by other species. When aggressive fur trapping in the early to mid-1800's led to a dramatic reduction in subbasin beaver numbers, it also contributed to the degradation of streams, floodplains, and in some instances sub-irrigated valleys. The resulting increased seasonal variation in stream flow adversely affected focal fish species and accelerated stream channel and stream bank erosion. There was no suitable redundant species to provide the same ecological functions and the ecosystem was adversely impacted by the reduction in beaver numbers and distribution.

Other wildlife species also provide similar functions in the ecosystem. For example, both sage grouse and sharp-tailed grouse are bud and catkin feeders. Functional redundancy for focal terrestrial species is identified in Appendix III.

6.3.2. Critical Functional Link Species

Critical functional link species are wildlife that are the only species or are one of only a few species that perform a particular key ecological function in a particular wildlife habitat. Of the focal species, American beaver was found to be a critical functional link species. The KEFs performed by the beaver are listed in Table 6.7.

Table 6.7. KEFs performed by American beaver, a critical functional link species, in habitats in the Deschutes Subbasin.

KEF Description	Wildlife Habitat	Other species that perform KEF
bark/cambium/bole feeder	Open water	Black bear
Creation of aquatic structures	Forest habitats	None
Impounds water by damming or diverting	Forests, wetlands, open water	None
Creation of ponds or wetlands by wallowing	Open water, forest habitats	Rocky Mountain elk

6.4. Interspecies Relationships

6.4.1. Aquatic Interspecies Relationships

All subbasin focal fish species prefer streams with perennial flow and good water quality. All species spawn in gravel substrate, although preferred particle size and location in the stream system may vary with species. All anadromous fish species have a freshwater juvenile life stage that prefers readily available hiding and escape cover. Juvenile anadromous species and redband trout rely heavily on a macroinvertebrate food source. Out-migration of juvenile anadromous fish generally occurs during the spring or early summer, after undergoing a physiological transformation that will allow them to successfully adapt from a freshwater to saltwater environment.

Redband trout and mountain whitefish generally compete for the same food items when they reside in the same stream reaches. Bull trout and brook trout prefer cold headwater streams for spawning and juvenile rearing. Interspecific spawning between bull and brook trout has serious genetic consequences, with hybridization a serious threat to bull trout survival. Bull trout are opportunistic feeders and include most other subbasin fish species as potential food items.

6.4.2. Wildlife Interspecies Relationships

The first indication of inter-specific relationships might be shared KEFs or KECs between two or more species. For example, both sharp-tailed grouse and white-headed woodpeckers share a KEF in that they both disperse seeds through ingestion or caching. Similarly, both golden eagles and white-headed woodpeckers share the KEC of utilizing snags.

Other indications of relationships might be more difficult to recognize. For example, one KEF for the golden eagle is that this species is a vertebrate consumer or predator. What this actually means is that the golden eagle could (and would) prey on all other six focal wildlife species, which would indicate a type of inter-specific relationship. This is also shown by the KEC information that shows all six other focal species as “prey for secondary or tertiary consumer.”

6.4.3. Key Relationships between Fish and Wildlife

The interaction between focal fish species and wildlife is generally a prey - predator type relationship. The fish species are food items for a wide variety of wildlife species, including birds, furbearers, and other predators.

Salmonids generally co-exist with beaver and benefit from the animal’s ability to modify the aquatic environment. The relationship between focal fish species and beaver was historically important in the smaller tributary streams. Beaver activities in these small streams helped to moderate stream flow and water temperature, while providing instream habitat complexity and often large wood structure recruitment, all of which are desirable for the focal fish species.

Limiting Factors and Conditions
Section 7

While many people are now more aware of how different land and water management actions influence stream habitats and overall watershed health, and are changing their management practices, anthropogenic influences since the mid-1850s have weakened the natural biophysical processes that create and maintain healthy habitats. Watershed conditions began to change as trappers aggressively removed beaver from subbasin streams. Ranchers, farmers and other settlers of European background followed the trappers, and their practices further modified the landscape. Human disturbances to aquatic and terrestrial environments in the Deschutes Subbasin are discussed in the Overview, Section 3.1.7.

This section discusses the factors that are leading to decline of Deschutes Subbasin aquatic and terrestrial species, including key limiting factors within the different assessment units of the Deschutes Subbasin and outside the subbasin. It also identifies the key limiting factors that can or cannot be addressed through human intervention.

7.1. Factors Leading to Decline of Aquatic Focal Species

Factors leading to the decline of the aquatic focal species are summarized below.

Low Streamflows

Seasonally low or intermittent stream flows and high water temperatures are probably the most significant factors limiting fish production in much of the Deschutes River subbasin today. The amount of stream flow affects all fish life stages including spawning, incubation, rearing, and migration. Degradation of the aquatic environment in the Deschutes River from Wickiup Dam to Lake Billy Chinook is primarily due to extreme seasonal flow fluctuations caused by irrigation releases and winter water storage in the reservoirs.

From Wickiup Dam to Bend, low winter flows in the Deschutes River impose the most serious limitations on fish production and their habitat. Low flows, particularly above Pringle Falls, concentrate fish into a few, generally coverless, pools where they are vulnerable to predation. High flows aggravate the lack of cover by pushing much of the remaining large woody debris to stream margins where it still provides cover for fish during high flows, but becomes unavailable once flows recede. As a result, many aquatic organisms must semiannually redistribute themselves, and find themselves in winter pools that lack adequate cover (ODFW 1996a). Low winter flows also leave the limited spawning gravel along the stream margins unavailable or barely usable by fall spawning fish (ODFW 1996a). Production is also lost because small fish and aquatic invertebrates become stranded in pools and side channels when flow recedes and they soon perish. Further, the freezing and thawing of exposed stream substrate and streambanks during low winter flows results in accelerated erosion and water turbidity when substantial irrigation flows are released downstream the following spring.

From Bend to Big Falls, summer flow in the Deschutes River is very low because of substantial upstream irrigation water diversions. Summer flows declined to about 30 cfs until recently when conservation efforts increased the minimum to 35 cfs.

Low summer flows also restrict fish populations in many Deschutes River tributaries. Some of these tributaries, such as Trout Creek, also have permitted water withdrawals that cumulatively exceed natural summer stream flow. For the most part, the best stream habitat in the upper Deschutes Subbasin remains in headwater portions of basin streams on Forest Service land. Many stream and river reaches below these headwaters areas have been severely degraded.

High Water Temperatures

The thermal environment also influences the distribution, health and survival of native salmonids. In many Deschutes River tributaries — where summer water temperatures may have been marginal to begin with — seasonal low streamflow associated with consumptive water uses, grazing pressure and other uses have altered the thermal qualities of stream waters. High water temperatures result in stress, disease or direct mortality of coldwater fish species and aquatic invertebrates. They also increase competition from more temperature-tolerant nongame species such as suckers, chiselmouth, and pikeminnow. In addition, high water temperatures can fragment fish populations. They can create a physical barrier that constrains life history possibilities and keeps salmonids from migrating to cooler, more favorable reaches. For example, as a result of water temperature and physical barriers most redband trout populations in the Crooked River system today are fragmented and isolated (Stuart and Thiesfeld 1994). Many of these isolated populations are thought to be depressed, while some populations have apparently been lost in the more severely degraded streams.

Most tributaries utilized by wild summer steelhead for spawning and rearing experience low summer flows and high summer temperatures, both of which are related to stream bank degradation, past stream channel alterations, poor riparian habitat conditions, loss of functional floodplains and poor upland watershed conditions. Small westside tributaries to the lower Deschutes River have similar habitat deficiencies.

Riparian and Floodplain Degradation

Stream bank and floodplain degradation are problems throughout the subbasin both in tributaries and in portions of the mainstem. Accelerated erosion has caused increased sedimentation and turbidity that reduce spawning habitat quality, egg survival, and production of aquatic insects and plankton. Sedimentation affects habitat quality by increasing the amount of fine sediments that cause embeddedness of the stream substrate.

Degradation of stream riparian vegetation frequently is associated with reduced stream cover and shade, which generally increases the likelihood of seasonal stream water temperature extremes. The loss of or lack of instream habitat complexity is also directly related to the health or functionality of the riparian corridor. Streams with compromised riparian corridors may experience either lateral or vertical channel scour, which can isolate the stream from its floodplain. This loss of contact with the floodplain can appreciably reduce groundwater discharge. Water tables adjacent to the stream can drop, which may further exacerbate the problems of extreme flow and water temperature variation.

Loss of Instream Habitat Complexity

The loss of large woody debris has also affected aquatic food production, trout cover, migration, and streambank protection. Large woody material helps to form pools that provide trout rearing habitat, traps and sorts spawning gravel, provides a refuge for fish during high flows, provides cover from predators, stabilizes streambanks, and provides structure for aquatic insect production. Large woody material has been removed from basin streams by historic log drives, exaggerated flow flows, artificial flow manipulation, fires, construction of upstream impoundments and removal by streamside landowners. Past logging operations in or adjacent to the riparian corridor removed trees that could have fallen into the stream channel as natural structural recruitment.

Large woody material is severely lacking in most of the Deschutes River from Wickiup Dam downstream to the river's mouth. Other streams with insufficient quantities of large woody material in the upper subbasin include the Deschutes River above Crane Prairie Reservoir, the Little Deschutes River below Gilchrist, lower Crescent Creek, Fall River, Spring River, Tumalo Creek, and Squaw Creek below the town of Sisters (ODFW 1996).

Natural recruitment of spawning gravel from upstream sources was eliminated by the construction of Wickiup and Crane Prairie dams, Bowman and Ochoco dams, and the Pelton Round Butte dam complex. Original gravels in the upper Deschutes River have been moved downstream by excessively high summer flows or deposited along stream margins that are dewatered during the fall spawning period. The primary sources of alluvial gravels in this upper section of river are the streambanks.

7.2. Key Factors In-Subbasin Limiting Aquatic and Terrestrial Populations

7.2.1. Lower Westside Deschutes Assessment Unit

- High glacial sediment loading degrades substrate habitat and precludes most steelhead and trout spawning in the Deschutes River downstream from White River confluence.
- Water quality, including elevated temperatures and pH seasonally exceeds water quality standards.
- River temperatures and dissolved oxygen levels immediately downstream from the Pelton Round Butte Complex do not meet State water quality standards.
- Two Beaver Creek tributaries, Coyote and Quartz creeks, occasionally contribute significant turbidity to the Warm Springs and Deschutes rivers.
- Degraded or the lack of riparian vegetation reduces bank stability and cover, especially in small tributaries.
- Instream habitat complexity is reduced or lacking in some reaches
- Predation has increased as riparian and instream habitat complexity has been reduced
- Intermittent flow in small tributary streams limits juvenile fish rearing habitat.
- Steelhead and trout access to small tributaries is frequently blocked by subsurface flow through alluvial deposits at the stream mouths.
- Fish migration may delayed by the sub-standard fish ladder at Sherars Falls.

- Road and railroad crossings at some small tributaries obstruct upstream fish passage.
- Large numbers of out-of-basin stray steelhead and fall Chinook salmon spawning with indigenous populations pose serious genetic risks.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.
- Conversion of ungulate winter ranges to other uses has degraded ungulate ranges, resulting in the decline or loss of ungulate populations such as bighorn sheep, mountain goat, black-tailed deer and mule deer.
- Conversion to home sites or other uses threatens cliff and rimrock habitats.
- Loss of native grassland habitat has precluded the restoration of wildlife species associated with this habitat, such as Columbian sharp-tailed grouse.
- Clearing of cottonwood and oak groves has resulted in a reduction of these habitats and associated wildlife.

7.2.2. Lower Eastside Deschutes River Assessment Unit

- Seasonal flow extremes limit juvenile fish rearing habitat.
- Steelhead and trout movement is generally blocked by intermittent flow or sub-surface flow through the stream substrate.
- Degraded, or the lack of, riparian vegetation reduces bank stability and cover.
- Stream channels have been altered and channelized, and stream length and sinuosity have been lost.
- Stream channels generally lack instream cover or complexity.
- Channel degradation has frequently resulted in lateral or vertical scour, which has produced high channel width-to-depth ratios, or channel incision and unstable banks.
- Fish are more vulnerable to predation because of reduced stream flow and the general lack of instream and overhead cover.
- Seasonal irrigation diversion structures/push-up dams obstruct fish passage.
- Water temperatures in Buck Hollow Creek, Willow Creek, and Bakeoven Creek (including Bakeoven Creek (mouth to Deep Creek), Salt Creek, Robin Creek and Deep Creek) exceed State water quality criteria for salmoinids production.
- The entire length of Trout Creek and a number of tributaries (Auger, Big Log, Bull Cartwright, Dick, Dutchman and Potlid creeks) exceed State water quality criteria for temperature and sedimentation.
- There are potentially serious genetic implications associated with large numbers of out-of-basin stray steelhead and fall Chinook salmon spawning with indigenous populations.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.
- Loss of large, contiguous blocks of native grassland habitat led to the loss of wildlife populations associated with this habitat, such as Columbian sharp-tailed grouse, and restricts restoration of these populations.

7.2.3. White River Assessment Unit

- Upstream fish passage is blocked at White River Falls (RM 2.0).
- Reduced summer flows — some lower basin tributaries have seasonally dry or intermittent reaches.

- The cumulative affect of a variety of watershed management actions, including timber harvest, livestock grazing and road construction and maintenance, has altered the natural stream flow regimes resulting in higher peak flows and lower low flows.
- Seasonal and permanent irrigation diversion structures block fish passage on tributary streams.
- White River has heavy, natural glacial sediment loads.
- Stream sedimentation from forest, range and crop land, and an extensive road system affects water quality and stream substrates.
- Large irrigation storage dams block fish passage on several tributaries.
- Water temperatures in lower White River and several tributaries often exceed State water quality standard for salmonid rearing during summer months.
- Tributaries Gate Creek and Rock Creek are also included on the State's 303(d) list for sediment concerns.
- Stream channel alterations, channelization and loss of sinuosity have degraded stream habitat.
- Stream reaches downstream from the national forest generally lack instream channel cover and/or complexity.
- Fish are exposed to increased predation because of reduced flow and instream and overhead cover.
- Most irrigation water withdrawals are unscreened.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.
- Some oak groves are threatened by clearing for other uses, and wildlife species such as Lewis' woodpecker are associated with these groves.
- Substantial losses of ponderosa pine forests have reduced habitat for species such as white-headed woodpecker.

7.2.4. Middle Deschutes Assessment Unit

- Terrestrial habitats such as aspen and cottonwood groves, ungulate winter ranges (mule deer), ponderosa pine forests, and late-seral stage forests with large diameter trees and snags are believed to be declining in the assessment unit.
- Loss of ponderosa pine and lodgepole pine forest since mid-1800s has reduced habitat available for species such as white-headed woodpecker.

Pelton Round Butte Complex

- The lack of fish passage at the Pelton Round Butte Complex has fragmented redband and bull trout populations and extirpated upstream anadromous fish populations.

Metolius River System

- Lack of instream structure, including large wood, limits habitat complexity and fish rearing potential in the upper half of the river.
- Riparian degradation reduces overhead stream cover and increases bank instability.
- Sedimentation from forest practices, catastrophic fire and extensive road system impacts stream substrate quality.
- Fish passage barriers are located on Link and Spring creeks.

- Most irrigation diversions are unscreened.
- Natural glacial silt and sediment may affect habitat quality in Whitewater River (tributary to Metolius River).
- Water temperatures in the lower Metolius River may restrict bull trout production during certain seasons of the year. Lake Creek temperature exceeds State water quality criteria for salmonid spawning and rearing.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

Middle Deschutes River

- Seasonally low flow in the upper reach results from upstream irrigation withdrawals.
- Natural topography limits riparian vegetation.
- Large boulders rather than large wood generally provide instream structure.
- Upstream reservoirs and flow reductions generally restrict appreciable gravel or large wood recruitment.
- Seasonal fish passage at Steelhead Falls is dependent upon adequate flow.

Squaw Creek System

- Seasonal low flows limit adult migration and spawning and juvenile fish rearing habitat below RM 25.
- Fish movement is generally blocked by intermittent flow or sub-surface flow in the middle stream reach (i.e. Sisters to Camp Polk Road).
- Degraded stream corridors and the lack of riparian vegetation reduces bank stability and cover.
- Stream channel alterations, channelization and loss of sinuosity have resulted in degraded fish habitat.
- The lower stream reaches generally lack instream channel cover, including large wood, or other structural complexity.
- Channel degradation and unstable banks are prevalent from RM 18.8 to 23.5
- Sedimentation, associated with stream bank erosion, impacts stream substrate quality.
- Fish are exposed to increased predation associated with general lack of instream and overhead cover and reduced stream flow.
- Irrigation diversion dams obstruct fish passage.
- Summer water temperatures frequently fail to meet State water quality standards.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

7.2.5. Lower Crooked River Assessment Unit

- The substantial loss of native grasslands, lodgepole pine forests, juniper forest, ponderosa pine forest, and shrub-steppe have resulted in less habitat for wildlife such as Columbian sharp-tailed grouse, sage grouse, golden eagle, and mule deer.

Lower Crooked River

- Low summer flow from Hwy 97 crossing to RM 53.8.
- Low winter flow from Bowman Dam (RM 68.2) to Hwy 97 crossing.

- Summer water temperatures in the lower Crooked River from the mouth to the Rice-Baldwin Dam (RM 0-51) do not meet State water quality criteria. The reach also does not meet criteria for bacteria (summer) and pH (all year).
- The reach from Rice-Baldwin Dam to Prineville Reservoir (RM 51-70) generally does not meet water quality criteria for total dissolved gases during periods of reservoir spill and/or substantial discharge.
- The river channel has been altered or simplified.
- The river channel isolated from floodplain in some reaches.
- Riparian vegetation has been degraded along most river reaches.
- Several artificial barriers lack provisions for fish passage or protective screening
- Spawning gravel of marginal quality and has limited distribution.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

McKay Creek System

- Degradation of upland watershed conditions, including loss of native grasslands, has contributed to a flashier stream flow regime.
- Low or intermittent summer flows are common in most reaches.
- Plant diversity and the condition of shrub-steppe habitat have degraded.
- Channel simplification, including bermed and channelized stream reaches has degraded fish habitat.
- There are some seasonal artificial barriers without fish screening or passage provisions.
- Stream reaches generally lack large wood or instream habitat complexity.
- Riparian corridors are generally degraded.
- Summer water temperatures frequently fail to meet State water quality standards.
- Sedimentation from stream channel erosion and upland sources affects the stream substrate.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

Ochoco Creek

- Low winter flow is associated with upstream water storage in Ochoco Reservoir.
- Summer water temperatures frequently fail to meet State water quality standards.
- Channel simplification, including bermed and channelized stream reaches, has degraded fish habitat.
- There is an artificial barrier without fish screening or passage.
- Large wood or other instream structure is generally lacking.
- The riparian corridor is generally degraded.
- Sedimentation from stream bank erosion affects stream substrate quality.
- Plant diversity and the condition of the shrub-steppe habitat have degraded.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

7.2.6. Upper Crooked River Assessment Unit

- Substantial loss of native grasslands, and reduction of shrub-steppe and ponderosa pine and lodgepole pine forests caused a major wildlife habitat shift in the assessment unit. These losses reduced habitat for wildlife such as

Columbian sharp-tailed grouse, sage grouse, white-headed woodpecker, mule deer, and golden eagle. Gains in juniper woodlands and mixed conifer forests created similar habitats for some wildlife species.
- Riparian habitats such as willow swamps are significantly below historic levels in the assessment unit. This reduces habitat for species such as Columbia spotted frog and American beaver.
- Terrestrial habitat components such as cottonwood groves and aspen groves are below historic levels, reducing the habitat available for wildlife species such as American beaver.

Upper Crooked River (Bowman Dam to the headwaters)

- Low or intermittent summer flow is typical of most stream reaches.
- High summer water temperatures in many reaches fail to meet State water quality standards. Standards for pH are also exceeded in Crooked River from Prineville Reservoir to N.F.Crooked River.
- Degraded watershed conditions contribute to the flashy stream flow regimes.
- The riparian corridor is degraded along most stream reaches.
- Channel simplification, including bermed and channelized stream reaches has adversely affected focal fish species habitat.
- Channel degradation, including lateral or vertical scour has contributed to the extreme variation in stream flow and temperature.
- Seasonal and permanent artificial barriers are present without fish screening or passage provisions.
- Natural waterfalls on North Fork Crooked River block upstream fish passage.
- Redband trout populations have been extirpated, fragmented or isolated by stream habitat conditions.
- There is a general lack of large wood or other instream structure.
- Sedimentation from bank erosion and upland sources has degraded stream substrate quality.
- Deteriorating habitat conditions have favored warm water tolerant fish species that compete with focal fish species.
- Fish are more vulnerable to predation because of reduced stream flow and cover.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.
- Loss of grasslands and reduction of ponderosa pine and shrub-steppe habitats have affected wildlife such as the greater sage grouse, and white-headed woodpecker.

Upper Ochoco Creek System (Ochoco Dam to headwaters)

- Seasonally low stream flows are common in most stream reaches.
- Lower reaches and lower tributary reaches have low or intermittent summer flow associated with water withdrawals.
- High summer water temperatures from the upper end of Ochoco Reservoir to RM 36.4 fail to meet State water quality standards.
- Channel manipulation and lack of stability has affected fish habitat quality.
- There are a number of seasonal and permanent artificial barriers without fish screening or passage.
- There is a general lack of large wood or other instream structure.

- Most riparian corridors have been degraded.
- Sedimentation from stream bank and upland erosion affects the quality of the stream substrate.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia spotted frog and American beaver.

7.2.7. Upper Deschutes River Assessment Unit

- Loss of lodgepole pine forests, native grasslands and shrub-steppe habitat reduced habitat for wildlife species such as sage grouse, golden eagle, and mule deer in the assessment unit.

Deschutes River System – Big Falls to North Unit Dam

- Low summer stream flow results from significant upstream irrigation withdrawals.
- Summer water temperatures and ph fail to meet State water quality standards.
- Natural waterfalls are fish passage barriers.
- There is a general lack of gravel and large wood recruitment because of upstream impoundments and flow manipulation.
- Tumalo Creek experiences low flow in the lower reach (below RM 2.5) during the irrigation season.
- Tumalo Creek has a fish passage obstruction at an irrigation diversion structure.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Columbia and Oregon spotted frog and American beaver.

Deschutes River System –North Unit Dam to Wickiup Dam

- This section of river has a seasonally reversed hydrograph with extreme low winter flow and high summer flow in upper stream reaches.
- Low winter water temperature can produce icing problems.
- Competition with exotic species has affected redband trout and other salmonid production.
- There is a general lack of good spawning habitat.
- Fish are more vulnerable to predation during periods of extreme low river flow.
- Dams in the City of Bend are total and partial fish passage obstructions.
- Fine sediments associated with bank erosion and reservoir sediment collection affect the river substrate.
- Eroding and unstable stream banks increase stream sedimentation and water turbidity.
- Loss of riparian vegetation and instream habitat complexity is associated with the extreme variation in flow.
- Loss of riparian vegetation contributes to reductions in wildlife habitat, such as for the Oregon spotted frog.
- Urban storm runoff may contribute to water pollution.
- There are no fish passage or screening facilities at Wickiup Dam.
- Loss of permanent stable water levels may have reduced or eliminated beaver colonies

Little Deschutes River System

- There has been a general loss of riparian vegetation and instream habitat complexity.

- Fine sediments associated with bank erosion and low stream gradient impact stream substrate quality.
- Summer water temperatures and dissolved oxygen in several reaches fail to meet State water quality standards.
- Discharge of industrial cooling water and process wastewater into the Little Deschutes at the town of Gilchrist may affect water quality.
- Low winter flows in some reaches are associated with upstream water storage.
- Winter icing problems are generally associated with low stream flow.
- There are fish passage obstructions and barriers.
- Competition with exotic species has affected redband trout and other salmonid production.
- Reduction in riparian vegetation contributed to the loss of wildlife, such as the Oregon spotted frog and American beaver.

Fall and Spring Rivers

- The stream substrate has a naturally high percentage of fine sediment associated with the stable spring-fed flow regime.
- There is a general lack of good spawning habitat.
- Instream habitat complexity is generally lacking.
- Fall River Falls is a fish passage barrier for most fish.
- The stream banks have some degraded riparian habitat.

7.2.8. Cascade Highlands Assessment Unit

Deschutes River System (upstream of Wickiup Dam)

- Flow manipulation between Crane Prairie Dam and Wickiup Reservoir results in seasonal flow extremes and most notably low winter flow.
- Summer water temperatures fail to meet water quality standards below Crane Prairie Dam.
- High natural fine sediment is a major component to the stream substrate.
- Riparian degradation is associated with some concentrated use at recreation sites.
- Stream reaches have experienced a general reduction in instream habitat complexity – loss of large wood.
- Loss of habitat complexity (large wood) in Crane Prairie Reservoir has reduced habitat quality.
- Competition with exotic species has affected redband trout and other salmonid production.
- There is a lack of fish passage and screening provisions at Crane Prairie Dam.
- Fish passage is obstructed at a number of road culverts.

Odell Creek System

- Summer stream water temperatures and pH in (Odell Creek) fail to meet water quality standards below Odell Lake.
- Fine sediment from road system drainage affects substrate quality.
- Riparian degradation from concentrated recreation site affects Trapper Creek habitat quality.
- Competition with exotic species has affected focal fish species.
- Some stream reaches have undergone channel manipulation and confinement.

- Fish passage obstructions at natural water falls (Trapper Creek), road culverts and temporary rock dams limits fish distribution.

7.3. Key Out-of-Subbasin Factors Limiting Aquatic and Terrestrial Populations

Key factors limiting Deschutes Subbasin aquatic and terrestrial populations outside of the Deschutes Subbasin include:

- Mortality of anadromous species associated with mainstem Columbia River dam passage.
- Migration delays in the Columbia River associated with large reservoirs and water quality.
- Predation associated with alterations of the mainstem Columbia River with large reservoirs and flow regulation.
- Disease associated with migration delay and the variation in Columbia River water quality.
- Fish harvest in the Columbia River and Ocean.
- Harvest of mule deer out of subbasin during hunting season.

7.4. Limiting Factors that Can or Cannot be Corrected Through Human Intervention

Most of the limiting factors identified above are being managed, or can be corrected, through human intervention. Changes in land management, for example, can improve upland and riparian conditions, and consequently increase channel structure and instream habitat diversity. Actions can also be taken to increase summer streamflows to levels that support salmonid production.

The management strategies identified in the Deschutes Subbasin management plan address all limiting factors identified above, except for providing fish passage around water falls and other natural obstructions, or eliminating natural glacial sediments in the White River system. The Oregon Department of Fish and Wildlife and the Confederated Tribes of the Warm Springs have not expressed desire to provide anadromous passage into portions of the subbasin that historically did not provide anadromous fish habitat.

A few factors cannot be addressed through human interventions. For example, humans cannot stop sedimentation caused by glacial runoff, which affect salmonid production in the White River system and lower Deschutes River, though they can reduce potential impacts by maintaining healthy riparian conditions. Humans also cannot control changes in the landscape caused by changes in climate. However, again, humans can reduce the impacts of climatic change by restoring watershed health.

Synthesis and Interpretation
Section 8

This section builds on assessment findings to form a holistic view of the subbasin's biological and environmental resources. This information provides a foundation for the development of scientific hypotheses concerning the ecological behavior and the ways that human intervention might prove beneficial. The section addresses the question:

What does the assessment imply regarding the health and functioning of the Deschutes subbasin ecosystem?

8.1. Key Assessment Findings

In some respects, the Deschutes Subbasin is data-rich. There are anadromous fish data strings for the lower subbasin that provide continuous data on estimated run size, in-river harvest and escapement for nearly forty years. There is also appreciable data for the redband trout, and to a lesser extent subbasin bull trout populations. These data provided some general insight into how changes in habitat may have affected various focal fish populations. The EDT Model estimated historic, current and potential future fish population production and life history and habitat capacity for steelhead (two populations and one extirpated population) and Chinook salmon (fall and spring races).

The QHA and EDT models provided information on the quantity and quality of stream and riparian habitat. The wildlife habitat assessment provided information about upland watershed habitat changes over the past 150 years. When the QHA/EDT and wildlife habitat information was considered together, it provided good insight into how the ecosystem has changed from the mid-1800's and why.

Information generated during the assessments showed that, as the ecosystems in the semi-arid segments of the subbasin unraveled from changes in land use and watershed health, some fish and wildlife populations became isolated, fragmented or extirpated. The important role that beaver played to maintain valley water tables, instream habitat and riparian and floodplain function grew more evident. It also became evident that as important upland habitat types were converted or lost a number of wildlife species were directly impacted, as were watershed characteristics that influence stream flow and water quality.

The QHA, EDT and the wildlife assessment processes helped to identify key factors that have limited, or are limiting, ecological function and biological performance. For example, a general reduction in summer stream flow combined with a general increase in summer water temperatures appreciably reduced fish populations and numbers in some stream systems. The development of extensive irrigation systems and hydroelectric projects placed seasonal and permanent barriers in a number of streams. Out-of-stream water use significantly diminished or altered the natural stream flow regimes. Watersheds degraded by western juniper and exotic plant invasions reduced capabilities to retain precipitation, and flashy stream flow regimes were often the result.

These shorter duration, higher peak, stream flows contributed to the scouring or incision of a number of stream channels and loss of natural water storage features.
The significant reduction, fragmentation or loss of some important upland habitat types associated with land management and development resulted in the extirpation of Columbia sharp-tailed grouse and the ESA-listing of the Greater sage grouse, as well as apparent reductions in numbers of other focal wildlife species.

Results from the assessments suggest that significant habitat restoration efforts are needed to meet fish, wildlife and habitat objectives in most of the assessment units. Examination of physical habitat conditions and past studies provides planners with further insight about restoration approaches that may provide the most benefit with a reduced rate of failure. Together, this information indicates that riparian and instream habitat restoration work will not be effective unless actions are also taken to improve overall watershed health.

8.2. Interpretation and Hypotheses

A working hypothesis summarizes a scientifically based understanding of the subbasin at the time the management plan is developed and begins to bridge the gap between the science and strategies. The hypotheses provide an explicit rationale for considering alternative biological objectives and strategies. They can be used to evaluate and derive biological objectives and strategies to achieve the subbasin vision. In addition, they provide the elements needed for scientific review of the plan.

8.2.1. Working Hypotheses for Aquatic Species

Each hypothesis has three main components. They identify 1) types of changes that have occurred in the subbasin, 2) how focal species have responded to these changes, and 3) most important, future changes that are expected to lead to achievement of the plan objectives and goals.

1. Important types of changes that have occurred in the subbasin.

- **Reduced fish distribution and connectivity**
  Artificial barriers have significantly reduced fish distribution and connectivity in the Deschutes Subbasin. Dams operated for hydroelectric power production, irrigation water diversion and storage, and flood control blocked historic fish passage at numerous sites in the subbasin and resulted in fish population fragmentation, isolation or extirpation. Stream channel alterations, road and railroad crossings and water withdrawal created effective seasonal or permanent barriers to fish passage in some stream reaches.

- **Conversion of native upland vegetation**
  Human activities on the uplands (such as timber harvest, crop production, roading, livestock grazing and development) converted native upland vegetation and led to the introduction of exotic plant species and invasion of western juniper. These changes reduced the watershed’s ability to collect, store, and slowly release runoff and maintain soil stability.

Changes in upland watershed health occurred throughout the system. They generally led to accelerated erosion, altered stream flow regimes - often with temperature and flow extremes (sometimes moving a perennial stream to an intermittent condition), lost natural floodplain and riparian function, channel scouring and/or incision.

- **Stream flow extremes, especially seasonally low or intermittent flows**

  Stream flow extremes, especially seasonally low or intermittent flows, are probably the most significant factors limiting fish production in much of the Deschutes River subbasin today.

  The quantity of stream flow affects all fish life stages including spawning, incubation, rearing, and migration. Reductions in stream flow are frequently associated with exaggerated peak stream flows that have generated lateral and vertical channel scour. Laterally scoured stream channels spread flow over a wide area as they often have a high channel width-to-depth ratio. Vertical channel scour, or incision, generally eliminates natural flow and temperature moderation affects of a high floodplain water table. Both forms of stream channel degradation can result in seasonally intermittent stream flow

- **Reduced water quality**

  Reduced water quality has limited the subbasin’s focal fish species distribution and productivity. It has also reduced connectivity between populations and in some cases fragmented populations. Presently, a number of subbasin stream reaches fail to meet State water temperature standards (ODEQ 2002). Salmonids have ranges of temperature tolerance and optimal temperatures. Exposure to temperatures above 25°C (77°F) for an extended period is generally lethal to coldwater salmonids. Egg survival is significantly impaired at temperatures above 16°C and there is little survival for eggs exposed to temperatures at or above 18°C (65°F) (Mobrand, 2003). Seriously elevated water temperatures can block fish movement resulting in population fragmentation or isolation. High temperatures can also increase the risk of disease and parasites for already stressed focal fish species and negatively impact other aquatic vertebrates and invertebrate prey species.

  Some stream reaches also regularly fail to comply with water quality standards for dissolved gases and pH (ODEQ 2002). Warm water associated with degraded stream channels or water discharged from great depths of large reservoirs can have dissolved oxygen deficiencies. Water spilled over high dam spillways or through pressurized penstocks can produce water that is super-saturated with nitrogen gas. Both extremes can have adverse to lethal implications for focal fish at all life stages.

- **Loss of riparian and floodplain function**

  Loss of riparian and floodplain function due to timber harvest, livestock grazing, agricultural production, channel alteration, and other land developments has reduced habitat complexity, contributed to water quality problems, accelerated erosion, reduced water quantity, lowered water tables, and reduced beaver numbers and distribution.

Riparian stream corridors create a natural buffer between streams and uplands, and act as filters to prevent sediment, pollutants and other items from reaching the streams. Riparian plants are particularly important in semi-arid parts of the subbasin, where they help moderate water temperatures by providing important overhead shade and cover. Riparian corridors are generally very productive and naturally support the greatest biological diversity of any habitat type.

During the EDT analysis, loss of riparian function arose as one of the critical factors limiting focal fish species production in many stream systems (see Environment/Population Relationship section). Focal fish species numbers and distribution declined in many reaches with the loss of riparian function. Riparian function directly influences water quality, water quantity, habitat diversity and vulnerability to predation.

- **Loss of instream habitat diversity**

  Flashy stream flow regimes associated with upland watershed degradation, loss of riparian and floodplain function and channel manipulation and clearance eliminated instream habitat variability from many stream reaches. Stream corridor manipulation associated with development, roading, agricultural and forest practices reduced the potential for natural recruitment of large wood into many stream reaches. The reduction in beaver numbers and distribution has also reduced another source of channel diversity.

  Instream structural habitat complexity, which may include large wood, boulders or emergent or aquatic vegetation is important for formation and maintenance of pools, braided channels and back waters. It also regulates the transport of sediment, gravel, and organic matter (Mobrand, 2003b). The loss of instream habitat complexity has reduced focal fish species carrying capacity because of degraded habitat conditions for all fresh water life stages.

- **Interactions with hatchery fish**

  The most serious issue related to interactions between Deschutes focal fish species and hatchery fish involves stray hatchery fish from the Upper Columbia River Basin. Deschutes River summer steelhead, which includes two demographically independent populations, are within the Mid-Columbia ESU, and have been designated as a threatened species under the federal Endangered Species Act. Rationale for this listing included the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead. The incorporation of genetic material from large numbers of stray steelhead could have a long term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-basin strays also pose a threat to steelhead population health. About five percent of the hatchery stray steelhead have tested positive for whirling disease, indicating that these fish were exposed to the disease earlier in their life and are carriers of whirling disease spores or infective agents (Engleking 2002).

  Managers believe there is substantial interaction between wild Deschutes fall Chinook and other stray, hatchery origin summer or fall Chinook within the lower reaches of the Deschutes River. This conclusion is based on recent radio telemetry data and an ongoing Deschutes River fall Chinook study being conducted by CTWS

(Brun, 2002). The initial indications of no appreciable straying into the Deschutes River were masked by the difficulty of identifying stray fish with no distinctive external markings. The potential for genetic intergression could have similar adverse affects to those described for summer steelhead.

The effect of stray, out-of-basin origin spring Chinook into the Deschutes Subbasin is unknown. There have been stray spring Chinook adults observed in the subbasin, but numbers have apparently been low. In the past, hatchery-produced spring Chinook from other locations in the Columbia Basin have been released without distinguishing tags or external marks. This has made it impossible to determine the origin of some adult salmon captured at the Pelton and Warm Springs River fish traps or to speculate on the incidence of straying (ODFW 1997).

Managers believe interactions between wild Deschutes salmonids and hatchery fish produced in the subbasin are minimal. Hatchery summer steelhead and spring Chinook salmon released in the lower Deschutes River from Round Butte Hatchery are from indigenous stocks. These hatchery fish are released as smolt-sized fish for rapid out-migration to minimize their potential interaction with wild fish. About 90 percent of the Deschutes stock spring Chinook produced at Warm Springs National Fish Hatchery are also released as smolt-sized fish for rapid migration. The remaining 10 percent are released as 0-age fall migrants that over-winter in the Deschutes.

- **Interactions with exotic species**

  Indigenous focal fish species have been negatively impacted by the introductions of a variety of exotic fish species. Brook trout are of special concern where they have displaced indigenous focal fish species (redband and bull trout), and particularly in headwater streams where they are hybridizing with remnant bull trout populations (U.S. Fish and Wildlife Service, 2002). Brown trout appear to effectively compete with redband trout, especially in areas with reduced water quality. Other exotic fish like three-spine stickleback and Tui chubs are efficient competitors with redband trout for food and space. Out-of-basin exotic introductions, such as walleye, are efficient predators affecting survival of juvenile anadromous out-migrants in the Columbia River.

- **Susceptibility to Predation**

  Existing habitat conditions in many subbasin stream reaches make focal fish species particularly vulnerable to predation, especially during periods of low stream flow. A number of streams in the eastern half of the subbasin are degraded and have undergone significant lateral or vertical channel scour, often resulting in a loss of instream habitat complexity (structure and pools), as well as seasonally low to intermittent flow. These conditions favor the predator over the prey species and a wide variety of predators benefit from the increased fish vulnerability. Reaches of the Deschutes River between Lower Bridge and Wickiup Dam also experience drastic seasonal flow fluctuation that may strand individual fish or concentrate fish in a few isolated pools during periods of very low flow, making them particularly vulnerable to a wide spectrum of predators.

  Stream reaches that have lost or degraded riparian vegetative stream corridors are often deficient in the important fringe habitat of emergent and terrestrial vegetation associated with the stream margins. This narrow band of complex cover, with reduced water velocities, is critical for survival of 0-age salmonids and their ability to avoid predators.

2. How focal species have responded to these changes.

Subbasin changes over the past 150 years have resulted in appreciable reductions in the number of populations, species abundance, diversity and habitat productivity. Robust populations of bull trout have been reduced to four known local populations within the lower Deschutes Core Area and one remnant population in the Odell Lake Core Area. Bull trout in the Deschutes Recovery Unit are at an intermediate threat of extinction category (USFWS 2002). In recent years, bull trout in the Metolius River habitat complex have responded favorably to habitat protection and harvest restrictions, and the population trends are upward.

Anadromous focal fish species experienced a loss of approximately half their historic range when water withdrawals and habitat degradation culminated with the construction of an impassable series of Deschutes River dams by the late 1960's. This drastic reduction in historic habitat — combined with degradation of much of the remaining habitat — appreciably reduced populations, species abundance, genetic diversity and habitat productivity. However, recent out-of-basin changes including reduced ocean harvest and increased ocean productivity have resulted in increased adult escapement to the river for all species, except Pacific lamprey. The long-term genetic implications from the intergression of significant numbers of out-of-basin stray fish with indigenous Deschutes Subbasin spawners have yet to be determined.

Some resident redband trout populations scattered throughout the subbasin were fragmented, isolated and extirpated as watershed health and summer stream flows deteriorated. Remnant populations declined because of competition from warm water tolerant fish species, exotic fish introductions and habitat deterioration associated with development of extensive irrigation systems, and stream flow, corridor and channel manipulation.

Fall Chinook salmon, which spawn and rear in the lower 100 miles of the Deschutes River, have been buffered against some of the other subbasin habitat issues. This population likely lost little habitat to the Pelton Round Butte Complex, but may have seen subtle adverse impacts from water quality and quantity variations associated with the hydroelectric project operation. Escapement to the river in recent years appears to approach potential historic levels, although spawning distribution has fluctuated between the upper and lower river reaches.

Extent of Lost Production from Historic to Current

The EDT Model gives some indication of how current production of summer steelhead and Chinook salmon differs from historic (pre-European influence) production. Findings shown in the EDT Diagnostic Reports (Appendix --) are discussed below.

- Summer steelhead, distributed through the three population areas identified by the NOAA Fisheries Technical Recovery Team, historically could have ranged between 36,000 and 38,000 adults annually returning to the subbasin (EDT Diagnostic Reports). In contrast, current production of indigenous steelhead results in annual runs of 4,000 to 9,000 adult fish to the river (French and Pribyl 2003).

- Spring Chinook, distributed between three subbasin plan assessment units, historically could have ranged between 10,000 and 12,000 adults annually returning to the subbasin (EDT Diagnostic Reports). In contrast, current natural production of spring Chinook salmon produces annual runs of 1,000 to 2,000 adult fish to the river (French and Pribyl 2003).

- Fall Chinook, confined to the mainstem Deschutes River, historically may have ranged between 16,000 and 19,000 adults annually returning to the subbasin. From 1999 to 2003, an average of 9,942 adult fall Chinook salmon returned to the river annually, and the adult run ranged from 4,388 to 13,668 fish (French and Pribyl 2004).

There are no known estimates of the historic production of sockeye salmon, Pacific lamprey or resident focal fish species within the subbasin. Anecdotal information suggests that these populations were generally robust and, with the exception of sockeye salmon, well distributed throughout the subbasin. Sockeye salmon were extirpated by 1940. Other anadromous focal fish species were extirpated upstream of the Pelton Round Butte Complex by 1968 because of habitat degradation and lack of fish passage. Today, redband trout populations are depressed through much of the subbasin, except for important core populations. These core populations are found in the lower mainstem of the Deschutes River, scattered reaches of the Deschutes River between Lake Billy Chinook and Little Lava Lake, the Metolius River, two reaches of Crooked River between Lake Billy Chinook and Bowman Dam and smaller headwater stream systems.

3) Important future changes leading to the plan objectives

Recovery of Habitat

Habitat recovery is underway throughout the subbasin. Collaborative programs involving a wide variety of subbasin stakeholders are moving ahead with a wide range of habitat restoration programs, some of which have already produced beneficial results. Ongoing and planned projects include: 1)substantial improvement or restoration of fish passage at manmade structures, 2) upland watershed improvement (re-establishment of native plant species, control of noxious weeds, exotic plants and invasive species), 3) riparian and floodplain restoration, 4) restoration of stream channel sinuosity and complexity, and 5) increased minimum stream flows and reduced maximum water temperatures – water conservation, water right conversions, leases and acquisitions.

Stream minimum flow recovery will be the single most important future change that will lead toward achievement of the subbasin plan's biological objectives. Some specific flow restoration projects have already been completed, while others are underway or in the final planning stages. Conversion, leasing and acquisition of water rights will provide instantaneous instream flow recovery – most notably in the Squaw Creek system. Water conservation projects throughout the subbasin, including more efficient water delivery and application practices will also return appreciable summer flow to a number of streams. Changes in Central Oregon land use from agriculture to urban/suburban may reduce the demand and need for irrigation water, which would translate into reduced water diversions from the Deschutes River and a reduction in the extreme flow fluctuations common to the Deschutes River from Lower Bridge to Wickiup Dam.

Restoration of fish passage at the Pelton Round Butte Complex and other smaller migration barriers could restore anadromous fish species to a large portion of their historical spawning and juvenile rearing habitat. Efficient fish passage would not only appreciably increase anadromous fish production, but would help to re-connect fragmented resident focal fish populations. The success of the sockeye salmon re-introduction program in the Metolius River system is directly dependent upon the re-establishment of fish passage at the Pelton Round Butte Complex.

Upland watershed restoration will be a tremendous challenge, because of the land acreage and ownership complexities involved, but the results could ultimately pay dividends in the form of increased retention and absorption of seasonal precipitation. This will translate into reduced erosion and stream sedimentation and increased summer stream flow.

Restoration of riparian and floodplain function is underway on a number of stream reaches through revised grazing management, land use restrictions, protection enclosures and development of alternative upland watering facilities. There are indications, based on summer steelhead and fall Chinook salmon escapement data, that these ongoing projects have already produced additional focal fish (French and Pribyl 2004). Similar future stream corridor restoration projects, coupled with fish passage restoration, increased minimum stream flows and improved upland watershed health will further increase focal fish species production.

Reductions in extreme stream water temperature variation — associated with the recovery of minimum stream flows, riparian and floodplain function and stream channel stability — will also increase fish production. Restored connectivity will increase production of currently fragmented fish populations.

Recovery of instream habitat diversity associated with riparian and floodplain recovery, upland watershed recovery, low flow recovery and stream channel recovery will improve the habitat fish production capacity. This fish production increase will result from the improved spawning and rearing habitat components, including escape and hiding cover to reduced vulnerability to predation.

Recovery of Listed Species

Summer steelhead and bull trout are the two ESA-listed focal fish species found in the subbasin. The EDT Model projections indicate that there could be appreciable recovery of steelhead population numbers, life history diversity and population productivity if a moderate amount of habitat restoration occurs over the next twenty-five years, and if fish access is restored to historic habitat in the Middle Deschutes and Lower Crooked River assessment units. However, the long-term recovery of the three NOAA Fisheries TRT identified Deschutes steelhead populations could be jeopardized by the genetic intergression resulting from large numbers of out-of-basin steelhead spawning with indigenous Deschutes populations.

The Deschutes Bull Trout Recovery Unit is one of 22 recovery units designated for bull trout in the Columbia River Distinct Population Segment. Current bull trout distribution is limited to the Odell Lake Core Area and the lower Deschutes Core Area, which includes the five local populations in Shitike Creek, the Warm Springs River, and the three Metolius River population complexes. Bull trout in the five Lower Deschutes Core Area populations appear stable or increasing as a result of protective angling regulations and habitat restoration and protection. The status of these populations will appreciably improve when fish passage at the Pelton Round Butte Complex and other manmade barriers restores historic population connectivity. Re-connecting these populations will also provide the opportunity for the expression of various life-history forms. However, hybridization with brook trout poses a threat for fish in a number of stream reaches, including upper sections of Shitike Creek and the Warm Springs River.

Bull trout in the Upper Deschutes Core Area were extirpated and fish in the Odell Lake Core Area are in very low numbers and are restricted to only the Odell Lake Habitat Complex population. Spawning is known to occur in only one small tributary to Odell Lake. The population is isolated from the remainder of the subbasin by a lava flow. The Odell Lake population is at a heightened risk because of the apparent small number of spawning fish in the population. The Odell Lake habitat complex population should be increased to a minimum of 500 fish to avoid long term genetic risks (USFWS, 2002).

Recovery of Non-listed Species

Fall Chinook salmon numbers have increased substantially in recent years. From 1977 to 2002, the run size of adult fall Chinook salmon into the lower Deschutes River averaged 6,536 fish and ranged from 2,813 to 20,811 fish annually (French and Pribyl 2003). This increase in population size may reflect better ocean survival associated with reduced harvest resulting from the U.S. / Canada Salmon Treaty, improved ocean productivity, restored riparian habitat along the mainstem of the lower Deschutes River, and enhanced juvenile downstream passage at mainstem Columbia River dams (ODFW, 1997). Proposed restoration of additional lower Deschutes River margin habitat could produce even larger returns to the river in the future.

Spring Chinook salmon returns to the subbasin have varied considerably from 1997 to 2002, ranging from 241 to 3,460 fish (French and Pribyl 2003). Moderate levels of habitat and minimum stream flow recovery, combined with fish passage at the Pelton Round Butte Complex and other manmade barriers in the Middle Deschutes and Lower Crooked River assessment units, will substantially increase subbasin spring Chinook salmon production. The EDT Model estimates that potential adult returns to the subbasin with moderate habitat restoration and fish passage at current manmade obstacles could range from 5,000 to 6,000 fish.

Redband trout populations will increase in numbers and range as minimum flows increase in stream reaches throughout the subbasin. Populations will also respond favorably to restoration of riparian and floodplain function, channel stability and instream habitat diversity. Population connectivity, associated with re-established fish passage at manmade barriers, will also boost the recovery of redband trout populations.

Successful re-introduction of sockeye salmon and the establishment of a naturally self-sustaining population is dependent upon fish passage at the Pelton Round Butte Complex. The stream habitat in the historic sockeye salmon production area remains some of the best quality habitat in the subbasin. If successful adult and juvenile fish passage is re-established, this species could once again flourish in the subbasin.

Pacific lamprey population numbers in the subbasin appear to be low. Lamprey limiting factors include erratic, intermittent or diminished stream flow, increased water temperatures, poor riparian areas, predation in all life stages, artificial barriers and the lack of appropriate water withdrawal screening. The lamprey juveniles or ammocoetes live in substrate burrows for up to seven years and are particularly vulnerable to pollution and erratic stream flows. Restoration of minimum stream flows, riparian and instream habitat complexity and re-establishment of passage at subbasin manmade barriers could result in appreciable recovery of lamprey numbers.

8.2.2. Working Hypotheses for Terrestrial Species

1. Important types of changes that have occurred in the subbasin

- **Loss and fragmentation of large blocks of ponderosa pine, lodgepole pine, and shrub-steppe habitats**

  Comparison of historic (mid-1860) and current habitat shows fragmentation of the large blocks of ponderosa pine, lodgepole pine, and shrub-steppe habitats that formerly existing in the subbasin (Maps 15-17) (IBIS 2004). Historically, broad bands of habitats ran north and south. Beginning on the west side of the subbasin, a band of mountain fir and hemlock forest habitat types existed in higher elevations of the Cascade Mountains. A band of ponderosa pine forest, mixed with some lodgepole pine forest, ran from the Columbia River southward, approximately along the eastern foot of the Cascades. At the southern end of this band of mostly ponderosa pine woodland, larger blocks of lodgepole pine forest began to break into the band of ponderosa pine. East of the Deschutes River, a band of mostly shrub-steppe habitat with interspersed interior grassland and Western juniper woodland areas again ran north to south. A large block of shrub steppe habitat covered the southeastern section of the subbasin, and a large block of Western juniper woodland existed southeast of Redmond. Along the east edge of the subbasin, ponderosa pine forests dominated the Blue Mountains east of Prineville,

  Today, a band of mixed conifer forests running north-south in the Cascade Mountains on the west side of the subbasin has encroached into the lower-elevation ponderosa pine and lodgepole pine forests along the eastern foothills of the Cascades. A large block of juniper woodland south and east of Redmond and Prineville has spread throughout the former shrub-steppe habitat running through the center and into the southeastern part of the subbasin, fragmenting the shrub-steppe habitat. Other conifer forest types have encroached into the former ponderosa pine forests in the Blue Mountains east of Prineville. The Wildlife Habitat Changes maps for Ponderosa Pine and Interior White Oak, Lodgepole Pine Dominant, and Shrub-Steppe show changes from historic condition.

- **Loss of riparian and herbaceous wetland habitats**

  There has been an appreciable reduction in the quantity and quality of riparian and herbaceous wetland habitats over the past 150 years. While there is a lack of historic or current riparian wetlands or herbaceous wetlands data in the subbasin, members of the wildlife technical team considered these two habitats to be the highest priority habitats for restoration or conservation in the subbasin. Other habitats also are not shown in large enough scale, or for other reasons are not considered to show significant results (Ibid). Canyon shrublands, for example, was a recent addition to the habitat type list, and could not be compared with historic data. There was also an unsuccessful attempt to display this habitat as a linear habitat and therefore is not discussed.

- **Loss of the grassland habitats**
  Comparison of historic and current habitats (Map 18) shows the loss of a large block of interior grassland habitat in the northeastern section of the subbasin southeast of The Dalles. The loss or conversion of over 600,000 acres of estimated historical interior grassland habitat in the subbasin, nearly all of the grassland habitat in the subbasin, is a large-scale shift in habitat types. This loss of grassland habitat in the subbasin can be partially attributed to encroachment by juniper woodland and conversion to agriculture.

- **Large-scale increases in habitats in the subbasin.**

  Increases in mixed conifer forests, juniper woodlands, and agriculture areas are large-scale changes in habitat in the subbasin. Encroachment of other forest types into historic ponderosa pine and lodgepole pine forests created a major habitat shift in the subbasin (Table 8.1.).

- **Loss of habitat in connected watersheds**

  The Deschutes Subbasin is part of the larger Columbia Plateau Ecoprovince, a group of eleven connected watersheds that includes the Deschutes Subbasin. Maps of wildlife habitats thought to occur historically and currently in the Columbia Plateau Ecoprovince show that some habitat changes that have occurred in the larger ecoprovince are similar to changes that have occurred in the Deschutes Subbasin (Maps 19-23). Specifically, historic and current data changes to the four focal habitats, shown by IBIS for the Deschutes subbasin, are also shown to have changed in a similar manner throughout the ecoprovince. Shrub-steppe and grassland habitats have been largely replaced by agricultural uses, and ponderosa pine and lodgepole pine habitats have been reduced and fragmented. Montane mixed conifer habitats have apparently increased, as have juniper woodlands.

Table 8.1. Current and Historic Wildlife-Habitat Acreage Changes, Deschutes Subbasin.

Habitat ID	Habitat Name	Current Acreage	Historic Acreage	Change from Historic	Percent change
1	Mesic Lowlands Conifer-Hardwood Forest	2,267	34,970	-32,703	n/a
3	Southwest Oregon Mixed Conifer-Hardwood Forest	173	0	173	n/a
4	Montane Mixed Conifer Forest	546,968	194,288	352,680	182%
5	Interior Mixed Conifer Forest	676,086	350,133	325,953	93%
6	Lodgepole Pine Forest and Woodlands	213,432	532,706	-319,274	-60%
7	Ponderosa Pine & Interior White Oak Forest and Woodlands	1,320,270	1,860,264	-539,994	-29%
8	Upland Aspen Forest		741	-741	n/a
9	Subalpine Parkland	38,839	25,361	13,478	n/a
10	Alpine Grasslands and Shrublands	14,636	12,425	2,211	n/a
12	Ceanothus-Manzanita Shrublands	2,996	0	2,996	n/a
13	Western Juniper Woodlands	1,347,101	790,348	556,753	70%
14	Interior Canyon Shrublands	82,856	0	82,856	n/a
15	Interior Grasslands	4,684	630,630	-625,946	-99%
16	Shrub-steppe	1,982,194	2,299,065	-316,871	-14%
17	Dwarf Shrub-steppe	127,843	5,683	122,160	n/a
18	Desert Playa and Salt Scrub Shrublands	3,225	1,418	1,807	n/a
19	Agriculture, Pastures, and Mixed Environs	337,369	0	337,369	n/a
20	Urban and Mixed Environs	22,026	0	22,026	n/a
21	Open Water - Lakes, Rivers, and Streams	57,774	76,139	-18,365	n/a
22	Herbaceous Wetlands	51,512	20,263	31,249	n/a
24	Montane Coniferous Wetlands	15,781	0	15,781	n/a
25	Interior Riparian-Wetlands	7,568	21,251	-13,683	n/a
	Total Acres:	6,855,591	6,855,680		

*Acreages are estimates only. Subbasin total acreage may vary slightly between Current and Historic due to mapping procedures.

*Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.

*Subbasin Habitat Acreages Generated by IBIS on 10/13/2003 11:45:52 AM.

2. How focal species have responded to these changes

The reduction in the quality and quantity of riparian and herbaceous wetland habitats has adversely affected beaver, Columbia and Oregon spotted frog populations, and other wildlife. Beaver numbers and distribution has declined throughout the subbasin, but particularly in areas where perennial streams have evolved into intermittent or ephemeral water courses. The Columbia and Oregon spotted frog populations have experienced precipitous declines associated with the losses and fragmentation of riparian and wetland habitats. Remnant Columbia spotted frog populations are now confined to small, disconnected habitats in the Lower and Upper Crooked River assessment units.

The reduction and fragmentation of lodgepole pine and ponderosa pine woodland habitats, combined with the reduction of shrub/steppe habitat has resulted in some reductions in mule deer populations. These changes in habitat type and availability particularly affect mule deer winter range and seasonal migration routes. The current status of the white-headed woodpecker is unknown, but the population may have also been affected by the reduced or fragmented ponderosa pine habitats.

The overall loss or conversion of much of the interior grassland habitat was generally responsible for the extirpation of the Columbia sharp-tailed grouse within the subbasin. Much of this habitat was converted to cropland, or evolved into Western Juniper woodland habitat as a result of livestock grazing and the control of wild fires.

The loss or conversion of shrub-steppe habitat, combined with range improvement programs, livestock grazing and more frequent wild fire in some areas has resulted in an alarming decline in greater sage grouse numbers in the southeastern portion of the subbasin.

The status of canyon land – rimrock habitat, which provides important golden eagle nesting sites was impossible to assess from satellite imagery, but is assumed to have seen some reductions in quantity and quality associated with human population growth and development. The subbasin golden eagle population status is unknown. However, 57 active golden eagle nesting territories were recorded in 2000, which may indicate that the population is generally stable.

3. Important future changes leading to the plan objectives

Recovery of Habitat

Some wildlife habitat recovery/restoration is underway in the subbasin. The Conservation Reserve Program and other incentive programs are converting marginal cropland to permanent grassland (Map 24). Western juniper are being thinned or removed to restore upland watershed function. Thinning and under burning is being employed in some areas to push back the mixed conifer forest invasion of historic ponderosa pine or lodgepole pine woodland habitat. Water conservation and riparian habitat restoration projects are underway or planned. Some long-term riparian and floodplain restoration projects have already shown beneficial effects to a variety of wildlife species. Land use laws and various landowner incentive programs are making impressive in-roads in the restoration of riparian and floodplain function along anadromous fish streams.

Recovery of Listed Species

Restoration of watershed, riparian and floodplain function will have wide ranging benefits to focal wildlife species. Restoration of the riparian and floodplain areas will directly benefit the Columbia spotted frog and beaver populations. The beaver could also become an active contributor to the recovery of these habitats, assuming that there are sufficient numbers to re-seed the potential or historic habitat. Recovery of riparian and floodplain function, in conjunction with the ponding of water associated with increased beaver numbers, will likely increase habitat and habitat connectivity for the spotted frog.

Restoration of shrub-steppe habitat that has been invaded by western juniper and or exotic plants will contribute to better watershed function, while also benefiting the depressed populations of greater sage grouse.

Some lost ponderosa pine habitat may be recovered with measures aimed at restoring upland watershed function, which could reduce rapid snow melt or storm run-off. However, appreciable recovery of old growth ponderosa will be limited by timber management and harvest rotation. White-headed woodpeckers are dependent on large pine seeds as food in late summer, fall and winter. The availability of this resource may be the habitat factor most limiting its population. Ponderosa pines produce good cone crops only every four to five years in the Pacific Northwest and no other suitable pine species exist in this portion of the woodpeckers range. Seed production by ponderosa pines is also related to the age and size of the trees and the density of the stand; almost all seeds are produced by large, dominant trees in open situations. As a result of logging and subsequent fire suppression, many ponderosa pine forests are now characterized by dense stands of young trees or mixed stands with other conifers, which is not conducive to good seed production.

Reduced snag densities after selective logging or various types of development likely reduce the quality of White-headed Woodpecker nesting habitat. When the birds try to adapt to marginal habitat conditions by nesting in low snags they are more susceptible to predation. The outlook for this woodpecker population within this planning horizon will likely not improve appreciably.

Recovery of Non-Listed Species

The conversion of dry land fields or uplands to permanent grass, as part of the Conservation Reserve Program, or the restoration of natural vegetation to improve watershed function, could be beneficial to wildlife species that prefer a grassland habitat. Recovery of grasslands may increase a variety of wildlife species and thus benefit predators, including the golden eagle.

Mule deer populations may benefit from restoration of riparian and herbaceous wetland habitat, but restoration of winter range, including the ponderosa and lodgepole pine woodland and shrub steppe habitat, would provide the greatest potential benefit. Unfortunately, some habitat fragmentation associated with growth and development may appreciably limit the opportunities that would benefit this species.

8.3. Desired Future Conditions

This section discusses changes in species abundance and productivity, and habitat condition that assessment findings indicate will likely be achieved in a twenty-five-year planning horizon.

8.3.2. Desired Future Conditions for Aquatic Species

Listed Species

The NOAA Fisheries Interior Columbia River Basin Technical Recovery Team (TRT) identified seven Ecologically Significant Units (ESUs) containing ESA-listed anadromous fish populations in this recovery domain. The Deschutes Subbasin was included in the Mid-Columbia Steelhead ESU, which contains 16 populations in four major groupings and one unaffiliated area. The TRT determined from 1) genetic information, 2) geography, 3) life history traits, 4) morphological traits and 5) populations dynamics that the Deschutes subbasin contains two demographically independent summer steelhead populations and one unoccupied population habitat area. The Mid-Columbia ESU steelhead populations will ultimately be combined to determine alternative ESU viability scenarios.

The TRT concluded that the Mid-Columbia steelhead populations have been impacted by harvest, habitat alterations, inadvertent negative affects of hatchery practices and dam construction. The populations were listed as threatened in March 1999.

The EDT model projects that with moderate habitat restoration the number of wild Deschutes summer steelhead spawners in the existing subbasin steelhead habitat could range from 6,000 to 7,000 fish. Restoration of fish passage at the Pelton Round Butte Complex and access to historic habitat in the Middle Deschutes and Lower Crooked River systems could add an additional 4,000 to 5,000 summer steelhead to the subbasin, for a subbasin total of 10,000 to 12,000 fish.

Increases in summer steelhead production, as projected by the EDT model, meet the targets set by NOAA Fisheries. NOAA Fisheries has established an interim abundance target for the two Deschutes subbasin steelhead populations below the Pelton Round Butte Complex of 6,300 fish. This number was established to include eight years, or approximately two generations, and represents the mean of annual spawner numbers. Subbasin planners were unable to segregate existing Deschutes Subbasin steelhead population data for each of the TRT identified summer steelhead populations. The assessment units used for subbasin planning differ from the summer steelhead population and habitat areas identified by the TRT. Consequently, the copious quantity of steelhead data collected in the subbasin over the past forty years was accumulated for one population. The data presented in this plan, with the exception of the projected EDT habitat capacity, and population productivity and diversity data (Appendix I), reflects this one steelhead population assumption.

Inclusion of Deschutes River hatchery and out-of-basin stray hatchery fish into the spawning population calculations would substantially inflate current and future spawner escapement numbers. The total escapement estimates for all steelhead passing above

Sherars Falls (RM 43) for the 1997-98 through 2001-02 run averaged 26,418 fish. Total escapement during this five-year period ranged from 18,920 to 40,533 steelhead (French and Pribyl, 2003). Past Deschutes steelhead studies have confirmed that some stray hatchery fish passing above Sherars Falls drop out of the system and continue their migration to the upper Columbia River basin. Some Deschutes and stray hatchery steelhead are also removed from the system at the Pelton and Warm Springs fish traps. However, ODFW biologists have observed that hatchery origin steelhead comprise 40 to 50 percent of steelhead spawning in several eastside Deschutes River tributaries (French, 2004).

The potential increase in indigenous subbasin steelhead numbers up to 10,000 to 12,000 fish is directly dependent upon substantial habitat restoration. Restoration of steelhead access to historical habitat in Squaw Creek and the Middle Deschutes and Crooked rivers is essential to reach this population objective. Increased minimum stream flow in many mid and lower Deschutes tributaries is also critical to population recovery. Recovery of stream channel stability, habitat complexity, riparian and floodplain function and watershed health will also help to insure that steelhead numbers increase in subbasin streams. The genetic and disease risks associated with out-of-basin stray steelhead could ultimately determine the success of population restoration measures.

The EDT Model projected that life history diversity for the Deschutes River westside steelhead population could increase from 89 to 99 percent, and productivity could increase from 6.4 to 9.0 with moderate habitat restoration over the next twenty-five years. The model projected that the Deschutes River eastside population could see life history diversity increase from 26 to 57 percent, and productivity increase from 1.6 to 2.9 during the same period.

The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout (*Salvelinus confluentus*) as a threatened species under the Endangered Species Act on June 10, 1998 (63 FR 31647). The Deschutes Recovery Unit forms part of the range of the Columbia River population. The USFWS Deschutes Recovery team identified the Lower Deschutes River Core Area and the Upper Deschutes River Core Habitat, which are separated by Big Falls (RM 132). The recovery team estimated the current population of bull trout in the Lower Deschutes Core Area at 1,500 to 3,000 fish. Bull trout were extirpated from the Upper Deschutes Core Habitat. The only other subbasin bull trout population is found in the Odell Lake Recovery Unit and is comprised of very low numbers of fish that apparently spawn in a short reach of Trapper Creek.

Lower Deschutes bull trout populations appear to be stable or increasing. Restoration of fish passage at the Pelton Round Butte Complex would restore connectivity for populations isolated by this series of impassable dams. Restored population connectivity would increase opportunity for genetic exchange and population diversity, and potentially the expression of all life history forms. If fish passage is restored at the Pelton Round Butte Complex additional fish passage obstacles should be modified to provide access to historic habitat in Squaw Creek and the Metolius and lower Crooked River systems. Stream habitat restoration described for recovery of subbasin summer steelhead populations (above) would also benefit bull trout populations. Aggressive measures may need to be implemented to reduce or eliminate brook trout from current and historic bull trout habitat to minimize competition and further hybridization.

Non-listed Species

The EDT Model projects that with moderate habitat restoration the number of Deschutes spring Chinook salmon spawners in the existing subbasin habitat could range from 2,500 to 3,000 fish. Restored fish passage at the Pelton Round Butte Complex and access to historic habitat in the Middle Deschutes, Metolius and Lower Crooked River systems could add an additional 2,000 to 2,500 spring Chinook salmon to the subbasin, for a subbasin total of 4,500 to 5,500 fish. Increased spring Chinook production in the lower subbasin depends upon restoration of riparian and floodplain function, improved in-channel habitat diversity, and reductions in fine substrate sediment. Increases in minimum stream flow combined with reductions in peak stream temperatures will also aid in the population recovery. The EDT Model projected that restoration of the lower Deschutes spring Chinook salmon population could improve life history diversity from 95 to 96 percent, and population productivity from 5.4 to 6.0.

The EDT Model projected that lower Deschutes fall Chinook salmon numbers would increase by approximately 1,700 fish with moderate habitat restoration over the next twenty-five years. Increased fall Chinook production would require restoration of instream habitat diversity and riparian function. Increases in minimum stream flow, combined with reduction in peak stream temperatures, will also aid in the population recovery. Aside from increasing the population size, habitat restoration could increase life history diversity of the population from 53 to 60 percent, and productivity from 6.0 to 7.1.

The objective of re-establishing a self-sustaining subbasin sockeye salmon population is entirely dependent upon restoration of fish passage at the Pelton Round Butte Complex. Habitat conditions in the Metolius River/Suttle Lake complex have changed little in the sixty plus years since the indigenous Sockeye salmon population was extirpated. The additional juvenile rearing habitat available in Lake Billy Chinook could increase production above historic levels. Potential habitat restoration measures, including providing fish passage and screening at several obstructions and increasing instream and riparian complexity, would be beneficial to a re-introduced sockeye salmon population.

Redband trout numbers and distribution would increase throughout most subbasin streams with habitat restoration. Increases in minimum stream flow and improved instream, riparian, floodplain and upland watershed conditions are prerequisites for significant population recovery. In addition, restoration of population connectivity associated with increased stream flow, improved water quality and restored fish passage at artificial barriers would contribute to increased population diversity and productivity.

Pacific lamprey numbers are likely at all time low levels. Habitat restoration, including increased minimum flow and improved water quality would encourage population recovery in subbasin streams. Restoration of fish passage at the Pelton Round Butte Complex and other artificial barriers would provide access to historic range and contribute to substantial population recovery. Habitat restoration measures designed to increase resident and anadromous salmonid production in subbasin streams will also benefit lamprey production.

Habitat

The quality of aquatic habitat is directly dependent on the amount of stream flow present in subbasin streams. Restoring stream flows to meet state instream water rights is a long-term goal, but it will likely not be achievable within this planning horizon. Implementation of collaborative restoration projects directed at restoring upland watershed, riparian and floodplain function will help restore perennial flow to subbasin streams. Perennial stream flow and recovering watersheds and riparian and floodplain habitats will reduce extreme seasonal and daily stream temperature variation and improve overall water quality.

This plan sets habitat restoration objectives that call for a percent recovery of individual habitat attributes. Achieving these objectives could be compared to reaching a highway milepost, but it is not intended to be the end of the journey. The habitat restoration objectives of this plan are presented as objectives that realistically can be met within the next twenty-five years if remedial measures are implemented. However, considering that most subbasin habitat degradation has occurred over the last one hundred-fifty years, it is unrealistic to assume that desired future conditions can be achieved in twenty-five years or less. Working towards or achieving habitat objectives within this plan should be considered an important interim accomplishment or milepost.

8.3.2. Desired Future Conditions for Terrestrial Species

Listed Species

Restoration of the Columbia and Oregon spotted frog populations to historical range is an ambitious objective. Achieving this objective is dependent upon restoration of suitable riparian and herbaceous wetland habitats. However, other than recovery of habitat, the most important limiting factor may be predation from the exotic bull frog. Restoration of the spotted frog populations may well depend on control or eradication of the bull frog.

The white-headed woodpecker is limited by suitable habitat, defined by large pine trees that have large cones and seeds for feeding and snags for nesting cavities. The status of the population within the subbasin is unknown. Current forest management and development generally limit the opportunities for providing an appreciable increase in large, or old growth, pine. The woodpecker population could remain stable or decline depending on future timber harvest and management activities on private and public timberlands.

Greater sage grouse numbers have declined because of the loss or conversion of shrub-steppe habitat and the corresponding reduction in sagebrush and associated herbaceous vegetation within the subbasin. Restoration of this population is dependent upon recovery of this habitat. Habitat recovery may include control or removal of invading western juniper and exotic plants and revisions in livestock grazing practices.

Non-listed species

Beaver numbers and distribution would increase in number and distribution throughout their historic habitat. This increase would be in response to riparian and floodplain restoration projects. The beaver could also act as an important tool to aid in the recovery of streams and associated focal fish populations.

Mule deer populations will fluctuate with climatic and local weather conditions. Loss, fragmentation or degradation of winter range, accidents and harvest will limit deer numbers. Numbers may increase in some areas as animals adapt and utilize developed rural/suburban areas where harvest opportunities are limited by development and safety concerns.

Golden eagle numbers are likely to remain static for the foreseeable future. The availability of desirable nesting habitat associated with roughed canyons and rim rock may limit population growth. However, restoration of upland grassland and shrub-steppe habitat may increase food sources and provide opportunities for increased population distribution and use of other suitable nesting habitat.

Habitat

The conversion of large blocks of former cropland back into permanent grass in the north and eastern portion of the subbasin has not only improved watershed health, but has reduced erosion and provided a substantial increase in grassland habitat. Grassland habitat restoration provides added benefit to a variety of wildlife species when native grass species are incorporated into the initial re-seeding mixture. Similarly treatment of large tracts of invading Western juniper will also help to restore grassland and shrub-steppe habitat important for sage grouse and mule deer. Both upland habitat restoration scenarios indirectly provide the opportunity to increase numbers of beaver and spotted frogs, in response to improved stream flows. The golden eagle and other predators can also benefit from increases in numbers of preferred prey species that respond to the change in habitat type.

Ongoing forest management restoration, aimed at reversing the pine woodland habitat invasion by mixed conifer species through selective harvest, thinning and under burns could help to stabilize the area currently designated as Ponderosa and Lodgepole pine woodlands. These measures may help to stabilize the white-headed woodpecker population or increase their numbers and distribution. However, the long-term outlook for old growth pine trees is dependent upon future subbasin development, forest management priorities and commodity valuation.

Riparian habitat restoration is a high priority throughout the basin. There are numerous examples of past and ongoing treatment projects that have already shown stream, fish and wildlife benefits. More projects are ongoing or in the planning phase. This projected recovery of this single-most important wildlife habitat will have far-reaching benefits to a wide variety of wildlife species. In addition, there are a number of state and federal incentive programs providing funding and technical support for many of these projects. This helps to insure the restoration and maintenance of this important habitat.

8.4. Near-term Opportunities

Based on analyses conducted during this planning process, resource managers concluded that for depressed, fragmented or isolated resident focal fish populations the most effective habitat and population restoration strategy is to begin with recovery of core populations and core habitat. Habitat restoration will preferably occur in a reverse domino effect. Core habitats will be expanded downstream to build on the benefits of previous restoration work. In areas where headwaters are degraded — or where the system is influenced by flashy or uncontrolled stream flows — habitat restoration for focal fish populations will take place progressively from the upper-most degraded reaches downstream, and restoration projects will include upland restoration work to maintain a ridge top-to-ridge top approach. Where headwater areas are in good condition, habitat restoration will begin in at the upper end of a degraded priority reach and work progressively downward. In areas where the system is hydrologically stable and habitat restoration is not at risk of loss from an uncontrolled flow situation, the most cost effective habitat restoration opportunities for restoring core fish populations may exist in lower watersheds. Substantial gains in fish potential production in lower reaches may be achieved if stream reaches are not subject to extremely flashy flows and opportunities become available to work with cooperating landowners.

Habitat restoration projects will focus on the focal fish limiting factors identified in the subbasin assessment. Remedial measures implemented to restore vegetative diversity and recovery of stream channel stability and diversity will require many years or decades to achieve the desired objective. Restoration of fish passage at manmade obstructions or unusual debris jams will frequently produce rapid response when fish begin to access historical habitat. The time required to implement these remedial fish passage projects could be substantially less than the time required for measurable stream or upland habitat recovery to produce measurable increases in fish production.

8.4.1. Habitat for High Priority Protection

EDT and QHA results indicated that a number of stream reaches provide core habitat for focal species, including important spawning and rearing habitat, and key habitat for ESA-listed species. The fish technical team determined that these stream reaches deserve high priority protection because of their importance in meeting desired biological objectives during the 25-year planning horizon. Stream reaches with high protection values for the Deschutes Subbasin are listed in Table 8.2 and displayed in (Map 25).

Further, twenty-one of the high priority protection reaches were identified as high candidates for future monitoring and evaluation. These twenty-one reaches display desired stream habitat conditions for the Deschutes Subbasin and will serve as reference reaches for monitoring and evaluation (Map 26). The list of reference reaches (Table 8.3) generally includes streams identified by the QHA and EDT habitat assessment procedures as assessment unit streams that had high habitat protection value. Streams were selected for each of the eight subbasin plan assessment units based from three broad stream type categories – Cascade Foothill - snowmelt driven; Groundwater or spring-fed; and Draining semi-arid landscapes. Reaches were also selected from a range of elevations and upland habitat types. Focal fish species use of these reaches was also considered. Some assessments units generally lacked good representative reaches and in these instances reaches were selected that may provide examples of some desirable attributes, rather than the complete ecosystem package.

Table 8.2. Deschutes Subbasin - Priority Protection Stream Reaches.

Reach Name	Reach Description	Importance
Lower Deschutes MS-2 to MS-8	From lower Moody Rapids to Buck Hollow Creek	Fall Chinook spawning/rearing, steelhead, spring Chinook rearing and migration corridor
Buck Hollow Cr-1 to Buck Hollow Cr-3	From mouth to Macken Canyon	Summer steelhead spawning/rearing
Little Badger Creek	From mouth to headwaters	Core redband population
Jordan Cr-3 to Jordan Cr-4	From Jordan Creek Falls to headwaters	Core redband trout population
Tygh Cr-5	From Tygh Creek Falls to headwaters	Core redband trout population
Threemile Cr-3	From irrigation upper diversion to headwaters	Core redband trout population
Boulder Cr-4 (White)	From irrigation diversion to headwaters	Core redband trout population
Bakeoven Cr-1 to Bakeoven Cr-4	From mouth to Deep Creek	Summer steelhead spawning/rearing
Deep Cr-1	Mouth to Cottonwood Creek	Summer steelhead spawning/rearing
Cottonwood Cr-1	Mouth to Ochoco Gulch	Summer steelhead spawning/rearing
L Deschutes MS-13 to L Deschutes MS-21	From Bakeoven Creek to Pelton Reregulation Dam	Fall Chinook, steelhead, redband trout spawning and rearing
Warm Springs R-3 to Warm Springs R-9	Warm Springs Hatchery Dam to Trapper Springs Meadow	Bull trout, Spring Chinook, steelhead spawning/rearing
Beaver Cr-1 to Beaver Cr-6	Mouth to headwaters	Spring Chinook and summer steelhead spawning/rearing
Mill Cr-1 to Mill Cr-3	Mouth to headwaters	Spring Chinook adult holding, spawning and rearing
Badger Cr	Mouth to falls	Spring Chinook and summer steelhead spawning/rearing
Trout Cr-5 and 6	From Antelope Creek to Little Trout Creek	Summer steelhead and redband trout spawning and rearing.
Trout Cr-11 to 15	From Amity to Potlid Creek	Summer steelhead and redband trout spawning and rearing.
Board Hollow Creek	Mouth to headwaters	Summer steelhead and redband trout spawning and rearing.
Foley Cr-1 and 2	Mouth to falls	Summer steelhead and redband trout spawning and rearing.
Big Log Cr-1 and 2	Mouth to headwaters	Summer steelhead and redband trout spawning and rearing.
Dutchman Cr	Mouth to headwaters	Summer steelhead and redband trout spawning and rearing.
Little Deschutes R-1 and 2	From mouth at U Deschutes R to Gilchrist Mill Pond Dam	Remnant redband trout population
Crescent Cr-1 and 2	From mouth at Little Deschutes to Big Marsh Creek	Remnant redband trout population
Odell Cr-1	From mouth at Davis Lake to outlet of Odell Lake	Redband trout spawning/rearing, bull trout rearing and foraging
Maklaks Cr	From mouth Odell Cr to headwaters at 5000 ft level	Potential bull trout spawning and rearing
Crystal Cr-2	From edge of Odell Lake to headwaters at 5500 ft level	Potential bull trout spawning and rearing
Trapper Cr-1	From mouth at edge of Odell Lake to falls near footbridge and 4920 ft level	Bull trout spawning/rearing
Jefferson Cr	Mouth to headwaters	Bull trout spawning/rearing
Candle Cr	Mouth to Cabot Creek	Bull trout spawning/rearing
Abbot Cr	Mouth to headwaters	Bull trout spawning/rearing
Canyon Cr-1 (Met)	Mouth to Roaring Creek	Bull trout and spring Chinook spawning/rearing

Reach Name	Reach Description	Importance
Roaring Cr	Mouth to headwaters	Bull trout spawning/rearing
Jack Cr-1	Mouth to Heising Spring	Bull trout and spring Chinook spawning/rearing
Heising Springs	Jack Creek to head spring	Bull trout and spring Chinook spawning/rearing
Jack Cr-2	Heising Spring to headwaters	Bull trout spawning/rearing
First Cr	Mouth to headwaters	Redband trout spawning
Metolius MS-12 to Metolius MS-14	From First Creek to head of the Metolius	Redband, bull trout and spring Chinook spawning/rearing
Lake Cr MF-1 and 2	From mouth to SF divergence	Steelhead and redband trout spawning/rearing
Lake Cr SF	From reconnection at MF Lake Cr to divergence from the MF of Lake Cr	Steelhead and redband trout spawning/rearing
Lake Cr-1	From SF/MF divergence from Lake Cr to Suttle Lake Dam #52262	Steelhead and redband trout spawning/rearing
Link Cr-1	From mouth at Suttle Lake to Blue Lake Outlet Dam #50324	Sockeye salmon spawning
Crooked MS-2 and 4	From Lake Billy Chinook to Highway 97	Bull trout, redband rearing
McKay Cr-3	From Little McKay Cr to spring at Harvey Gap	Redband trout core population
Ochoco Cr-1	From mouth at Crooked R to Ochoco Dam #50354	Redband trout core population
Mill Cr-2 (Ochoco)	From Nat'l Forest boundary at section line 10/15 to EF/WF confluence	Redband trout spawning and rearing
Mill Cr EF (Ochoco)	From confluence with WF and mainstem Mill Cr to spring near Whistler Point	Redband trout spawning and rearing
Mill Cr WF (Ochoco)	From confluence with EF and mainstem Mill Cr to Rock/Hawthorne Spring	Redband trout spawning and rearing
Marks Cr-4	From Res. Dam #50356 in section to spring NW of Ochoco Pass	Redband trout spawning and rearing
Ochoco Cr-6	From Marks Cr to Canyon Cr	Redband trout spawning and rearing
Canyon Cr (Och)	From mouth at Ochoco Cr to 5800 ft level	Redband trout spawning/rearing
Ochoco Cr-7	From Canyon Cr to Ahalt Cr	Redband trout spawning/rearing
Crooked MS-12 and 14	From Ochoco Irrigation Diversion to Bowman Dam	Redband trout, spring Chinook and steelhead spawning/rearing
Crooked NF-6 and 7	From Upper Falls in section 21 to lower end of Big Summit Prairie just W of Nelson Road	Core redband trout population
Deep Cr-1 and 2 (Crooked)	From mouth at NF Crooked R to Happy/Jackson Cr confluence	Core redband trout population
Little Summit Cr	From mouth at Deep Cr to junction of FS roads 12 and 4270 in section 20	Core redband trout population
Jackson Cr	From mouth at end of Deep Cr to Double Corral Cr	Core redband trout population
Double Corral Cr	From mouth at Jackson Cr to Blevins Springs	Redband trout spawning and rearing
Crooked NF-10 and 11	From upper end Big Summit Prairie at section line 29/32 to headwaters at Sera Springs	Redband trout spawning and rearing
Lookout Cr	From mouth at NF Crooked R to 6000 ft level	Redband trout spawning and rearing
Wolf Cr	From mouth at Beaver Cr to headwaters at Wolf Spring	Core redband trout population
Beaver Cr NF (SF Crooked)	From confluence with SF/mainstem Beaver Cr to headwaters at Hawk Res.	Core redband trout population
Beaver Cr SF-2 through 4(SF Crooked)	From Swamp Cr to headwaters at spring below 6000 ft level	Core redband trout population
Dobson Cr	From mouth at SF Beaver Cr to headwaters at Dobson Spring	Core redband trout population

Reach Name	Reach Description	Importance
Freeman Cr	From mouth at SF Beaver Cr to headwaters at spring below 6000 ft level	Core redband trout population
Squaw Cr-1	From mouth at Deschutes R to Alder Springs	Bull trout foraging, redband trout, steelhead, spring Chinook spawning/rearing
M Deschutes MS-10	From Steelhead Falls to Big Falls	Bull trout foraging, redband trout, steelhead, spring Chinook spawning/rearing
U Deschutes MS-9 through U Deschutes MS-15	From upstream end of Mill Pond/Southern Crossing bridge to Spring R	Core redband trout population
Odell Cr-1 and 2	From mouth at Davis Lake to outlet of Odell Lake	Redband trout spawning and rearing, bull trout foraging
Maklaks Cr	From mouth Odell Cr to headwaters at 5000 ft level	Bull trout foraging, potential spawning
Crystal Cr-2	From edge of Odell Lake to headwaters at 5500 ft level	Bull trout foraging, potential spawning
Trapper Cr-1 and 2	From mouth at edge of Odell Lake to 5200 ft level	Bull trout spawning and rearing

Table 8.3. Subbasin Reference Stream Reaches.

Stream Segment	Description / Location	Attribute	Fish Use	Other
Shitike Cr-3 and 4	Upper road crossing to headwaters	Pristine stream and riparian conditions, mid-elevation	Spring Chinook, Pacific lamprey and Bull trout Spawning and rearing	Steelhead and redband trout spawn downstream
Lower Deschutes MS-1	From Shitike Creek confluence to Pelton Reregulation Dam	Spawning and rearing habitat, stable flow, good riparian diversity, low elevation	Fall Chinook, Steelhead and redband trout spawning and rearing	Migration corridor if fish passage is restored at the Pelton Project
Trout Cr-14 though 16	From Cartwright Cr confluence to headwaters	Spawning and rearing habitat, good riparian diversity, mid-elevation	Summer steelhead and redband trout spawning and rearing	Part of ongoing habitat recovery project
Trout Cr-5	Antelope Cr to Tub Springs Cr	Adult holding, spawning and rearing habitat, low elevation	Summer steelhead and redband trout	Part of ongoing habitat recovery project
Tygh Cr-1	From mouth to Badger Cr confluence	Spawning habitat, riparian vegetation, low elevation	Redband trout – genetically unique population	Past habitat recovery project, some habitat deficiencies remain
Badger Cr-4	Highland Diversion to Pine Cr	Pristine, wilderness stream, mid-elevation	Redband Trout	Diverse instream and riparian habitat
Middle Deschutes R-8 and 10	From Lake Billy Chinook to Big Falls	Natural, canyon reach with good spawning gravel and instream structure	Redband trout and potential steelhead and spring Chinook spawning and rearing	Flow is mostly spring-fed, anadromous fish use dependent on Pelton fish passage
Metolius MS-14	Lake Cr to Head of Metolius Spring	Large spring-fed, constant flow, high water quality, mid elevation	Redband trout spawning and rearing, bull trout foraging, potential Chinook and steelhead spawning and rearing	Anadromous fish use dependent on Pelton fish passage
Mill Cr EF (Ochoco)	From confluence of East and West forks to headwaters	Natural Ochoco Forest stream, mid-elevation	Redband trout spawning and rearing	
Ochoco Cr-7	From Ahalt Cr to source.	Natural Ochoco Forest stream, mid-elevation	Redband trout spawning and rearing	
Canyon Cr (Ochoco)	From Ochoco Cr to headwaters	Natural Ochoco Forest stream, mid-elevation	Redband trout spawning and rearing	

8.4.2. Habitat to Reestablish Access

A number of manmade structures are obstacles or barriers to focal fish passage within the subbasin. Table 8.4 shows obstructions in the subbasin with a high priority for remedial measures to provide passage and protective screening, where needed. Stream Fish Passage Limitations in the subbasin are shown on Map 27.

8.4.3. Habitat for Restoration

Subbasin High Priority Stream Reaches

Ten high priority fish habitat restoration projects or scenarios were identified in the Deschutes Subbasin (Table 8.5). The reaches were selected based on several criteria. Those criteria included 1) consideration of priority ranking developed by the EDT habitat assessment model for Chinook salmon and summer steelhead and the QHA model for redband and bull trout in the eight subbasin assessment units; 2) the obvious benefits to be realized from restoration of fish passage at artificial barriers; 3) the number and significance of focal fish species that would benefit from project completion; 4) location in the subbasin in relation to identified core fish populations and habitats; and 5) location in relationship to remnant functional watershed, riparian and wetland habitats - usually in the uppermost stream reaches in a drainage, or downstream from a significant hydraulic control (i.e. reservoir dam or lake outlet).

For example, restoration of fish passage at the Pelton Round Butte Complex would re-establish access to appreciable historic anadromous fish habitat, connectivity for resident fish populations and thus benefit most focal fish species. Substantial planning and design work to provide passage has already been completed by Portland General Electric and the Confederated Tribes of Warm Springs, who are required by their federal hydroelectric license to restore fish passage.

Restoration of riparian and instream habitat along the lower Deschutes River is proposed for a stream segment below a three dam complex with generally stable flows. The QHA and EDT models both ranked these river reaches a high priority for restoration. The project would benefit all focal fish species by providing a migration corridor, adult holding, and spawning and/or rearing habitat.

It is also important to note that several high priority habitat restoration projects identified above the Pelton Round Butte Complex received their high ranking based on the assumption that fish passage will be restored. The priority of these projects would likely be significantly reduced if attempts to restore fish passage at the hydroelectric project are unsuccessful.

Stream Reaches with High Restoration Value

Other stream reaches with high restoration values in the Deschutes Subbasin are identified in Table 8.6 and displayed in Map 28. Stream reaches with high restoration value reflect historical focal fish species use and potential for increasing focal fish production, distribution and re-establishing population connectivity. Some stream reaches appear on both the Conservation and Restoration lists because — while they still provide critical habitat — they have experienced some past degradation. Although the habitat is important, restoration for some habitat attributes is needed to maintain or increase habitat quality.

Table 8.4. Deschutes Subbasin fish Passage Obstructions/Barriers.

Stream Reach	Description	Details
L Deschutes MS-10	Sherars Falls - #50360, Deschutes River RM 43	Important for upstream focal fish passage. Old, below standard fish ladder
Tygh Cr-1 through 3	Mouth to Tygh Creek Falls	Redband trout population connectivity Two seasonal stop-log and three push-up dams, no ladder or screen
Badger Cr-1 through 3 (Tygh)	Mouth to diversion dam/weir in section 29	Redband trout population connectivity. One permanent and one seasonal stop-log dam, one push-up dam, no ladder or screen
Badger Cr-6 (Tygh)	Badger Lake Dam #51837	Permanent earth-fill dam. No upstream fish passage or screening
White R MS-4	From Tygh Cr to Threemile Cr	Redband trout population connectivity. Unscreened diversion, no ladder or screen
Threemile Cr-2	Diversion Dam in NE corner of section 10	Redband trout population connectivity. Two permanent stop-log dams, no ladder or screen
Gate Cr-2	Diversion Dam in NE corner of section 21	Redband trout population connectivity. One permanent stop-log dam, no ladder or screen
Rock Cr-3	Rock Cr Res. Dam #50362	Redband trout population connectivity. One permanent earth-fill dam, no ladder or screen
Forest Cr-2	Diversion Dam near road crossing in NW corner of section 35	Redband trout population connectivity. One permanent stop-log dam, no ladder or screen
Boulder Cr-3 (White)	Diversion Dam at section line 27/26	Redband trout population connectivity. One permanent stop-log dam, no ladder or screen
Frog Cr-2	Diversion Dam in NE corner of section 34	Redband trout population connectivity. One permanent stop-log dam, no ladder or screen
Clear Cr-3	Diversion Dam in middle of section 10	Redband trout population connectivity. One permanent stop-log dam, no ladder or screen
Clear Cr-5	Wasco Dam #51292 at Clear Lake	Redband trout population connectivity. One permanent earth-fill dam, no ladder or screen
Nena Cr-2	Falls - #53183 just above 1200 ft level	Summer steelhead, redband trout population connectivity. Natural cascade, partial barrier at some flows.
Warm Springs MS-3	From National Fish Hatchery Dam at section line 19/24 to Beaver Cr	Operational fish ladder fish trap and screening
Mud Springs Cr-2	Culvert - RR #53204 in section 15	Summer steelhead, redband trout population connectivity. High gradient concrete box culvert with 10' drop
Mud Springs Cr-5	Culvert - just upstream of Clark Drive crossing in the town of Gateway	Redband trout population connectivity. Concrete dam, no ladder or screen
Hay Cr-2	Falls - #53202 at gradient change in SW corner of section 17	Summer steelhead, redband trout population connectivity. Cascade from stream relocation
Antelope Cr-1	From mouth at Trout Cr to Ward Cr	Summer steelhead, redband trout population connectivity. One seasonal push-up dam screened, no upstream passage
Trout Cr-7 through 11	From Little Trout Cr to Board Hollow Cr	Summer steelhead, redband trout population connectivity. Numerous seasonal push-up and one stop-log dam, no upstream passage, except at stop-log dam, all screened
Clover Cr	From mouth at Trout Cr to tributary just above 3400 ft level	Summer steelhead, redband trout population connectivity. One seasonal push-up dam, no screen or upstream passage
Foley Cr-3	Falls - just upstream of road crossing in the center section 28	Summer steelhead, redband trout population connectivity. Debris jam, no upstream passage
L Deschutes MS-22	Pelton Reregulation Dam #50363	No fish passage or screen
M Deschutes MS-1	Pelton Dam # 50364	No fish passage or screen
M Deschutes MS-3	Round Butte Dam #50308	No fish passage or screen

Table 8.4. Deschutes Subbasin fish Passage Obstructions/Barriers (Continued)

Stream Reach	Description	Details
Willow Cr-3 through 6	From City limits of Madras to road crossings in headwaters section 20	Redband trout population connectivity. Several seasonal push-up dams, no screen or upstream passage
Willow Cr-5	Morrow Res. Dam	Redband trout population connectivity. No fish passage or screen
Spring Cr-2 (Met)	Barrier at top of pond in section 10	No fish passage or screen
Lake Cr MF-1	From mouth at Metolius R to SF Lake Cr	Redband trout, steelhead and sockeye population connectivity. Diversions with no screens and restricted passage.
Lake Cr SF	From reconnection at MF Lake Cr to divergence from the MF of Lake Cr	Redband trout, steelhead and sockeye population connectivity. Diversions with no screens and restricted passage.
Lake Cr MF-2	From reconnection of SF Lake Cr to area where SF diverges from MF Lake Cr	Redband trout, steelhead and sockeye population connectivity. Diversions with no screens and restricted passage.
Lake Cr-2	Suttle Lake Dam #52262	Redband trout, steelhead and sockeye population connectivity. Limited passage.
Link Cr-2	Blue Lake Outlet Dam #50324	Redband trout, steelhead and sockeye population connectivity. No passage or screens.
Crooked MS-3	Opal Springs Dam #50346	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Restricted passage, no screens.
Crooked MS-6	North Unit Irrigation District flume crossing to McKay Cr	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Seasonal diversion dam, no passage or screen
McKay Cr-1	From mouth at Crooked R to Allen Cr	Redband trout, steelhead and Pacific lamprey population connectivity. Seasonal diversions
Allen Cr (Crooked MS)	From mouth at McKay Cr to confluence of Fall Cr	Redband trout, steelhead and Pacific lamprey population connectivity. Seasonal diversions
McKay Cr-2	From Allen Cr to Little McKay Cr	Redband trout, steelhead and Pacific lamprey population connectivity. Seasonal diversions
Ochoco Cr-1	From mouth at Crooked R to Ochoco Dam #50354	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. One permanent dam no passage or screen
Ochoco Cr-2	Ochoco Dam #50354	Large earth-fill dam, no passage or screens
Mill Cr-1 (Ochoco)	Mouth to National Forest boundary	Redband trout population connectivity. One permanent dam no passage or screen
Ochoco Cr-5 and 6	Ochoco Reservoir to Canyon Creek	Redband trout population connectivity. Three permanent dams, one with no passage or screen, numerous push-up dams
Crooked MS-9	Peoples Irrigation Dist Diversion #50348 in SW corner of section 8	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Permanent structure no passage.
Crooked MS-11	Ochoco Irrigation District Diversion just below Dry Cr	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Permanent structure no passage.

Table 8.4. Deschutes Subbasin fish Passage Obstructions/Barriers (Continued)

Stream Reach	**Description**	**Details**
Crooked MS-13	Rice-Baldwin Diversion #50350 just upstream of Dry Cr	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Permanent structure no passage.
Crooked MS-14	Rice-Baldwin Diversion #50350 to Bowman Dam	Redband trout, steelhead, spring Chinook and Pacific lamprey population connectivity. Permanent structure no passage.
Crooked MS-15	Arthur R Bowman Dam #50352	Large earth-fill dam. No passage or screening.
Bear Cr-2	From edge of Prineville Res. in section 19 to Little Bear Cr	Redband trout population connectivity. Channel incision with resulting waterfall.
Little Bear Cr	From mouth at Bear Cr to tributary at 4480 ft level	Redband trout population connectivity. Channel incision with resulting waterfall.
Bear Cr-4	Antelope Flat Dam #52019	Redband trout population connectivity. Large earth-fill dam. No passage or screening.
Crooked MS-18 through 21	Prineville Reservoir to Beaver Creek	Redband trout population connectivity. Numerous seasonal push-up dams. No passage or screening.
Horse Heaven Cr-2	Bonnie View Dam #51887 at Horse Heaven Res.	Redband trout population connectivity. Large earth-fill dam. No passage or screening.
Newsome Cr	Mouth to headwaters	Redband trout population connectivity. Road culvert seasonal barrier.
Pine Cr-2 (Crooked)	Pine Cr Res. Dam	Redband trout population connectivity. Earth-fill dam. No passage or screening.
Crooked NF-1	Mouth to lower falls	Redband trout population connectivity. Two permanent diversions, no passage or screens.
Crooked NF-8 and 9	From lower end Big Summit Prairie just W of Nelson Road to upper end of Big Summit Prairie	Redband trout population connectivity. Series of large check dams, passage only at high stream flow.
Howard Cr-1	From mouth at NF Crooked R to Allen Cr	Redband trout population connectivity. Series of large check dams, passage only at high stream flow.
Allen Cr-1 (NF Crooked)	From mouth at Howard Cr to Allen Cr Res. Dam #50343	Redband trout population connectivity. Series of large check dams, passage only at high stream flow.
Allen Cr-2 (NF Crooked)	Allen Cr Res. Dam #50343	Redband trout population connectivity. Earth-fill dam no passage or screens.
Crooked NF-11	Lookout Creek to headwaters	Redband trout population connectivity. Channel incision, headcuts are low flow barriers.
Camp Creek	Mouth at Crooked River to headwaters at Double Cabin Pond	Redband trout population (extirpated) connectivity. Permanent barrier dam at RM 3, no passage or screens.
Beaver Cr-1 and 2(SF Crooked)	From confluence with SF Crooked R to NF/SF confluence	Redband trout population connectivity. Seasonal push-up dams no passage or screens.
Wolf Cr	From mouth at Beaver Cr to headwaters at Wolf Spring	Redband trout population connectivity. Seasonal push-up dams no passage or screens.
Beaver Cr NF (SF Crooked)	From confluence with SF/mainstem Beaver Cr to headwaters at Hawk Res.	Redband trout population connectivity. Diversions and check dams passable only ay high flow, no screens.

Table 8.4. Deschutes Subbasin fish Passage Obstructions/Barriers (Continued)

Stream Reach	Description	Details
Beaver Cr SF-1 and 2 (SF Crooked)	From confluence with NF/mainstem Beaver Cr to Dobson Cr	Redband trout population connectivity. Seasonal push-up dams, permanent dams passage at high flow or no passage, no screens.
Dobson Cr	From mouth at SF Beaver Cr to headwaters at Dobson Spring	Redband trout population connectivity. Seasonal push-up dams no passage or screens.
Twelvemile Cr-2	Williams Res. Dam #50329	Redband trout population connectivity. Earth-fill dam no passage or screens.
Crooked SF-4	Logan Res. Dam #53322	Redband trout population (extirpated) connectivity. Large dam no passage or screens.
Squaw Cr-4	Sokol Diversion Dam in section 17	Steelhead and spring Chinook (extirpated) redband and bull trout connectivity, Permanent diversion no passage or screen
Squaw Cr-6	Squaw Cr Irrigation District Diversion in section 21	Steelhead and spring Chinook (extirpated) redband and bull trout connectivity, Permanent diversion no passage or screen
M Deschutes MS-9	Steelhead Falls	Steelhead and spring Chinook (extirpated) redband and bull trout connectivity, passage at high flow and old fish ladder.
Tumalo Cr-1 and 2	Mouth to Tumalo Feed Canal Dam #51308	Redband trout connectivity. Marginal upstream passage at higher flow
U Deschutes MS-1	North Unit Main Canal Dam #50317	Redband trout connectivity. No upstream passage, screened
U Deschutes MS-3	Steidl Dam (N Unit Div) #52147 at section line 29/32	Redband trout connectivity. Upstream passage limited by hydraulic conditions
U Deschutes MS-5	Bend Diversion Dam #50319 (Powerhouse)	Redband trout connectivity. No upstream passage
U Deschutes MS-7	Colorado Street Dam	Redband trout connectivity. Marginal upstream passage limited by marginal denil fishway
Crescent Cr-5	Crescent Lake Dam #51297	Redband trout connectivity. No upstream passage or screens
Little Deschutes R-3	Gilchrist Mill Pond Dam	Redband trout connectivity. Poor upstream passage, no screens
U Deschutes MS-19	Wickiup Dam #50322	Redband trout connectivity. No upstream passage, no screens
U Deschutes MS-24	Crane Prairie Dam #50323	Redband trout connectivity. No upstream passage, no screens
Odell Cr-1 and 2	Davis Lake to Odell Lake	Redband and bull trout connectivity, partial passage barrier at road culvert and rock dam at lake outlet.
Maklaks Creek	Mouth to headwaters	Potential bull trout habitat. Road culvert partial barrier.
Crystal Cr-2	Mouth to headwaters	Potential bull trout habitat. Railroad culvert partial barrier.
Deer Creek	Mouth to Little Cultus Lake	Redband trout connectivity. Partial passage at three road culverts and lake outlet.

Table 8.5. Top Ten Habitat Restoration Priorities for the Deschutes Subbasin.

Stream Reach(s)	Species Affected	Strategies	Feasibility	Cost
Trout Creek Riparian and Instream Habitat Restoration: Trout Cr-1 through 16	Summer Steelhead, Redband Trout, Pacific Lamprey, Bull Trout	• Increase minimum stream flow • Restore fish passage to historical habitat • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	Good chance of success, some reaches are responding to treatment from ongoing project	**Low to moderate**
Squaw Creek Riparian and Instream Habitat Restoration: Squaw Cr-1 through 6	Summer Steelhead (extirpated), Spring Chinook (extirpated), Redband Trout, Pacific Lamprey (extirpated), Bull Trout (extirpated)	• Increase minimum stream flow • Provide fish passage and screening at diversions • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	Good chance of success, collaborative projects planned and under way, broad-based support, anadromous species dependent on Pelton Passage	**Moderate**
Middle and Upper Deschutes River Instream and Riparian Habitat Restoration: M Deschutes MS-10 through MS-15 and Upper Deschutes MS-1 through MS-18	Redband Trout, Bull Trout (extirpated)	• Increase minimum stream flow • Provide fish passage and screening at diversions • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore riparian function • Reduce maximum water temperature extremes • Reduce channel width • Reduce fine sediments in substrate	Good chance, but dependent upon significant water conservation measures for irrigation water transport and application	**High** (i.e. canal lining or piping)

(Table 8.5. Top Ten Habitat Restoration Projects in Deschutes Subbasin continued)

Stream Reach(s)	Species Affected	Strategies	Feasibility	Cost
Lower Crooked River Instream and Riparian Habitat Restoration: Crooked MS-5 through 14 McKay Cr-1 through 3 Allen Cr Little McKay Cr Ochoco Cr-1	Redband Trout, Summer Steelhead (extirpated), Spring Chinook (extirpated), Bull Trout, Pacific Lamprey (extirpated)	• Increase minimum stream flow • Provide fish passage and screening at diversions • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	Success depends on collaborative restoration projects, including water allocation from Prineville Reservoir, anadromous species dependent on Pelton Passage	**Moderate to High** (i.e. fish passage and screening at diversion structures)
Lake Creek and Link Creek Fish Passage Improvement: Lake Cr-2 and Link Cr-2	Redband Trout, Bull Trout, Sockeye Salmon (extirpated), Summer Steelhead (extirpated)	• **Modify or breach dams to provide fish passage** • **Provide protective fish screening**	**High** Plans are underway to modify the Link Creek Dam. Lake Creek Dam is small structure	**Low to moderate**
North Fork Crooked River Instream and Riparian Habitat Restoration: Crooked NF-6 upstream to headwaters	**Redband Trout**	• Increase minimum stream flow • Provide fish passage and screening at diversions • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	**Moderate to High** Success depends on collaborative restoration projects with good landowner cooperation	**Moderate**

Table 8.5. Top Ten Habitat Restoration Projects in Deschutes Subbasin continued)

Stream Reach(s)	Species Affected	Strategies	Feasibility	Cost
Beaver Creek (Warm Springs) Instream and Riparian Habitat Restoration: Beaver Cr-1 through 5	Spring Chinook, Summer Steelhead, Redband Trout, Pacific Lamprey	• Increase minimum stream flow • Restore channel length and sinuosity • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	**Moderate to High** (i.e. could include relocation of Highway 26)	**Moderate**
Tygh and Badger Creek Instream and Riparian Habitat Restoration: Tygh Cr-1 and 2, Badger Cr-1 and 2	Redband Trout	• Increase minimum stream flow • Provide fish passage and screening at diversions • Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Restore upland watershed, riparian and floodplain function • Reduce maximum water temperature • Reduce channel width • Reduce fine sediments in substrate	**Good** Depends on significant water conservation measures including canal lining or piping.	**Moderate**
Riparian and Instream Habitat Restoration Lower Deschutes River: L Deschutes MS-5 through 21	Summer Steelhead, Spring Chinook, Fall Chinook Sockeye Salmon (extirpated), Redband Trout, Bull Trout, Pacific Lamprey	• Restore/increase riparian habitat diversity/complexity • Increase instream habitat complexity • Reduce channel width • Reduce fine sediments in substrate from Reregulation Dam to White River	Good chance of success, some reaches are responding to treatment	**Low to moderate**
Restore Fish Passage at Pelton Round Butte Project: L Deschutes MS-22 and 23, M Deschutes-1to 3	Summer Steelhead, Spring Chinook, Sockeye Salmon (extirpated), Redband Trout, Bull Trout, Pacific Lamprey	• Install multi-level outlet structure at Round Butte Dam • Efficiently collect and transport downstream migrants around the hydro project • Collect and transport upstream migrants from Reregulation Dam to Lake Billy Chinook • Prevent out-of-basin stray fish from passing above project	Model shows good feasibility, difficult engineering and hydrological problems	**HIGH** [Project licensee's responsibility]

Table 8.6. Deschutes Subbasin - High Priority Restoration Stream Reaches.

Reach Name	Reach Description	Importance
L Deschutes MS-2 through MS-8	From Lower Moody Rapids just upriver of mouth at lower end of second island to Buck Hollow Cr	Fall Chinook spawning/rearing, steelhead, spring Chinook rearing and migration corridor
Buck Hollow Cr-1 to Buck Hollow Cr-4	From mouth to Thorn Hollow	Summer steelhead spawning and rearing
Thorn Hollow	From mouth at Buck Hollow Cr to spring in section 23	Summer steelhead spawning and rearing
L Deschutes MS-12	From White R to Bakeoven Cr	Fall Chinook spawning/rearing, steelhead and redband trout spawning and rearing, bull trout foraging
Bakeoven Cr-1 to Bakeoven Cr-4	From mouth to Deep Creek	Summer steelhead and redband trout spawning and rearing
Deep Cr-1	Mouth to Cottonwood Creek	Summer steelhead and redband trout spawning and rearing
Cottonwood Cr-1	Mouth to Ochoco Gulch	Summer steelhead and redband trout spawning and rearing
L Deschutes MS-15 through MS-20	From Wapinitia Cr to Shitike Cr	Fall Chinook spawning/rearing, steelhead and redband trout spawning/rearing, bull trout foraging
Warm Springs MS-1 and 3	From mouth at Deschutes R to Beaver Cr	Spring Chinook spawning and rearing, bull trout rearing and foraging
Beaver Cr-1 through 5 (WS)	From mouth at Warm Sp R to Wilson Cr	Spring Chinook and steelhead spawning and rearing
Warm Springs MS-4 through MS-7	From Beaver Cr to Schoolie	Spring Chinook, steelhead and redband spawning and rearing and bull trout rearing/foraging
Mill Cr-1 and 2 (WS)	From mouth at Warm Sp R to Old Mill Camp in section 16	Spring Chinook holding, spawning and rearing
Trout Cr-3 through 16	From Mud Springs Cr to 4800 ft level	Summer steelhead and redband trout migration, spawning and rearing
Shitike Cr-1	From mouth at Deschutes R to upper road crossing above 2300 ft contour	Spring Chinook, steelhead and redband spawning and rearing and bull trout rearing/foraging
Willow Cr-2	From edge of Lake Simtustus to headwaters in section 20	Remnant redband trout population
Metolius MS-8 through 11	From Candle Cr to First Cr	Spring Chinook, redband and bull trout spawning and rearing
Crooked MS-3	Opal Springs Dam #50346	Fish passage obstacle
Crooked MS-5 through 14	From Hwy 97 bridge to Bowman Dam	Redband trout, steelhead, spring Chinook spawning and rearing
McKay Cr-1 through 3	From mouth Cr to spring at Harvey Gap	Summer steelhead and redband trout spawning and rearing
Ochoco Cr-1	From mouth at Crooked R to Ochoco Dam #50354	Redband trout, steelhead, spring Chinook spawning and rearing
Mill Cr-1 and 2 (Ochoco)	From mouth at Ochoco Res. to EF/WF confluence	Redband trout spawning and rearing
Ochoco Cr-5 through 7	From top of Ochoco Res. to Ahalt Cr	Redband trout spawning and rearing
Marks Cr-1 and 2	From mouth at Ochoco Cr to Res. Dam #50356 in section 3 at Mt Bachelor Academy	Redband trout spawning and rearing
Marks Cr-3	Res. Dam #50356 in section 3 at Mt Bachelor Academy	Fish passage obstacle

Table 8.6. Deschutes Subbasin - High Priority Restoration Stream Reaches, continued.

Reach Name	**Reach Description**	**Importance**
Marks Cr-4	From Res. Dam #50356 in section 3 at Mt Bachelor Academy to spring NW of Ochoco Pass	Redband trout spawning and rearing
Canyon Cr (Och)	From mouth at Ochoco Cr to 5800 ft level	Redband trout spawning and rearing
Bear Cr-2 and 3	From edge of Prineville Res. in section 19 to Antelope Flat Res. Dam #52019	Redband trout spawning and rearing
Little Bear Cr	From mouth at Bear Cr to trib at 4480 ft level	Redband trout spawning and rearing
Newsome Cr	From mouth at Crooked R to road crossing at 4280 ft level	Redband trout spawning and rearing
Pine Cr-1	From mouth at Crooked R to Pine Cr Rsv Dam	Redband trout spawning and rearing
Pine Cr-2 (Crooked)	Pine Cr Rsv Dam	Fish passage obstacle
Pine Cr-3 (Crooked)	From Pine Cr Rsv Dam to road crossing at 4640 ft level	Redband trout spawning and rearing
Shotgun Cr-1 and 2	From mouth at Crooked R to fork below 5080 ft level	Redband trout spawning and rearing
Drake Cr	From mouth at Shotgun Cr to fork at 5300 ft level	Redband trout spawning and rearing
Crooked NF-6	From Upper Falls in section 21 to Deep Cr	Redband trout core population
Deep Cr-1 and 2 (Crooked)	From mouth at NF Crooked R to Happy/Jackson Cr confluence	Redband trout core population
Little Summit Cr	From mouth at Deep Cr to junction of FS roads 12 and 4270 in section 20	Redband trout core population
Jackson Cr	From mouth at end of Deep Cr to Double Corral Cr	Redband trout core population
Double Corral Cr	From mouth at Jackson Cr to Blevins Springs	Redband trout core population
Crooked NF-8 through 11	From lower end Big Summit Prairie just W of Nelson Road to Lookout Creek	Remnant redband trout population – Core habitat
Howard Cr-1 and 2	From mouth at NF Crooked R to WF Howard Creek	Remnant redband trout population – Core habitat
Allen Cr-1 (NF Crooked)	From mouth at Howard Cr to Allen Cr Res. Dam #50343	Remnant redband trout population – Core habitat
Allen Cr-2 (NF Crooked)	Allen Cr Res. Dam #50343	Fish passage obstacle
Allen Cr-3 and 4 (NF Crooked)	From Allen Cr Res. Dam #50343 Dam to fork in SE corner of section 26	Remnant redband trout population – Core habitat
Lookout Cr	From mouth at NF Crooked R to 6000 ft level	Remnant redband trout population – Core habitat
Wolf Cr	From mouth at Beaver Cr to headwaters at Wolf Spring	Remnant redband trout population – Core habitat
Beaver Cr NF (SF Crooked)	From confluence with SF/mainstem Beaver Cr to headwaters at Hawk Rsv	Remnant redband trout population – Core habitat
Beaver Cr SF-1 through 4 (SF Crooked)	From confluence with NF/mainstem Beaver Cr to Tamarack Creek	Remnant redband trout population – Core habitat
Swamp Cr	From mouth at SF Beaver Cr to fork just above Wade Spring	Remnant redband trout population – Core habitat
Dobson Cr	From mouth at SF Beaver Cr to headwaters at Dobson Spring	Remnant redband trout population – Core habitat

Table 8.6. Deschutes Subbasin - High Priority Restoration Stream Reaches, continued.

Reach Name	Reach Description	Importance
Freeman Cr	From mouth at SF Beaver Cr to headwaters at spring below 6000 ft level	Remnant redband trout population – Core habitat
Crooked SF-1 through 3	From mouth at Crooked R to Logan Res. Dam #53322	Extirpated redband trout
Squaw Cr-1 through 6	From mouth at Deschutes R to upstream irrigation diversion	Spring Chinook, steelhead, bull and redband trout spawning and rearing
M Deschutes MS-12, 14 and 15	From Big Falls to North Unit Main Canal Dam #50317	Remnant redband trout population
U Deschutes MS-1,3,5 and 7	North Unit Main Canal Dam #50317, Steidl Dam (N Unit Div) #52147, Bend Diversion Dam #50319 (Powerhouse) and Shevlin-Hixon Dam #53342 (Colorado St Dam)	Redband trout habitat
U Deschutes MS-2,4,6, and 8 and 9 through 18	From North Unit Main Canal Dam #50317 to upper end of Mill Pond (Southern crossing bridge)	Redband trout
U Deschutes MS-9 through 15	From upper end of Mill Pond (Southern crossing bridge) to Spring River	Core redband trout population
U Deschutes MS-16 through 18	Spring River to Wickiup Dam	Remnant redband trout population
Little Deschutes R-1 and 2	From mouth at U Deschutes R to Gilchrist Mill Pond Dam	Remnant redband trout population
Crescent Cr-1 and 2	From mouth at Little Deschutes to Big Marsh Creek	Remnant redband trout population
Odell Cr-1 and 2	From mouth at Davis Lake to outlet of Odell Lake	Redband trout spawning and rearing, bull trout rearing and foraging
Maklaks Cr	From mouth Odell Cr to headwaters at 5000 ft level	Potential bull trout spawning and rearing
Crystal Cr-2	From edge of Odell Lake to headwaters at 5500 ft level	Potential bull trout spawning and rearing
Trapper Cr-1	From mouth at edge of Odell Lake to falls near footbridge and 4920 ft level	Bull trout spawning and rearing

Inventory

The goals of the *Inventory of Existing Activities* are to demonstrate: current management direction, existing or imminent resource protections, and current strategies implemented through specific projects. Information was collected on projects that have been completed in the last 5 years or those expected to be completed in the near future. In addition, plans, programs and legal requirements were collected describing existing legal requirements such as local ordinances, plans and programs whose purpose is to protect water resources, fish or wildlife species or habitats, including areas protected legally.

1. Methodology

A survey was developed and used in order to reach a broad audience and gather information on completed and ongoing projects.

The survey was emailed to approximately 100 individuals in over 70 organizations. The list of individuals and organizations was initially developed by compiled contact lists created by the Wy'East Resource Conservation and Development (Wy'East RC & D) and the Deschutes Coordinating Group. The list of individual and organizations was refined and expanded by querying (through email, phone calls and personal contact) numerous individuals with knowledge of basin projects to ensure all critical individuals and organizations were on the list. A significant effort was made to identify a point person in each organization to send the survey. The list was continually updated and added to as new information was received. The participant list was also refined as individuals doing the work were identified. Constant updating of the contact list was critical.

Survey participants provided information on several types of projects:

- Agricultural/Rangeland Improvements: riparian fencing, guzzlers, tailwater recovery ponds, filter strips, sediment basin and terraces.
- Fish Passage Improvement projects: fish screens, ladders, infiltration galleries.
- In-stream Flow Restoration: canal piping or lining project, water right acquisition, leasing.
- In-stream Habitat Restoration: large woody debris, fish habitat improvements.
- Monitoring.
- Road Abandonment/Restoration.
- Stream bank restoration: riparian plantings, floodplain improvements.
- Upland Habitat Restoration: forest health, juniper removal, range seeding.
- Wetland Restoration projects.
- Other.

They also provided information on the project's funding source, landowner, budget, status, start and end date, size and the limiting factors they were addressing. In addition, they supplied a brief description of the project and the results.

Survey Results

Thirty-nine individuals from 23 organizations responded to the survey with projects (Appendix --). There was some overlap within agencies with individuals responding regarding a particular project type or for a district or area. Lack of participation occurred primarily when a organization had no projects or programs to report. Some of the larger agencies admitted that the number of projects they provided was far fewer than they actually did, but providing limited information was the best they could do at the time given other responsibilities. By July 31, 2003, over 750 records were included in the Access database and over 1,500 points identified in GIS. Some records have numerous points associated with them. In addition, over 400 projects were entered from the USFS Interagency Restoration Database (IRDA).

2. Existing Plans and Programs

Existing plans and programs affecting fish, wildlife and ecosystem resources in the Deschutes subbasin are shown in Table I.1.

3. Existing Restoration and Conservation Projects

Many existing on-the-ground restoration and conservation projects that have, or are, being implemented in the Deschutes Subbasin are listed on Table I.2 and shown on Map 29. These and other projects have added substantial benefit to fish and wildlife resources in the Deschutes Subbasin, as well as improving overall watershed health.

A number of other projects were not included on Table 1.2. or mapped because they were implemented over five years ago. These projects — including restoration projects implemented on the ground in the Trout Creek system for over 20 years — have significantly benefited habitat conditions. Other beneficial habitat restoration projects were also excluded from the inventory because of time constraints. These projects should be added to the Inventory in the near future.

4. Gap Assessment of Existing Protection, Plans, Programs and Projects

The following discussion describes past and current fish and wildlife habitat and watershed restoration strategies implemented in the subbasin, there success and potential for application in other areas. Maps 30-33 show the relationship between past and on-going restoration efforts, priority areas for restoration, and areas where changes in wildlife habitat have occurred. Unfortunately, because of restricted time and the size of the Deschutes Subbasin, the gap assessment does not adequately assess links the success and limitations of past and present restoration efforts in all the reaches identified as high priorities for restoration. Instead, the gap assessment is limited to evaluating project activity in the ten high priority habitat restoration project areas identified during the subbasin planning process. These areas are scattered across the subbasin. Most of these proposed restoration project areas have had some level of past and/or ongoing restoration work. Information will continue to be collected as new management activities are identified and proposed for implementation to ensure linkage to other habitat restoration efforts.

The *Trout Creek Fish Habitat Restoration Project Area* is a high priority area that has been a primary target of habitat restoration efforts since 1986. The primary focus of this project has been stream and fish habitat restoration, with a top-of-the-watershed down approach. There are 170 miles of perennial and intermittent streams in the Trout Creek watershed. To date approximately 70 miles of stream have been fenced to exclude livestock and restore riparian vegetation. Restoration includes placement of nearly 4,800 log or rock structures in the channel and treatment of 21,000 feet of eroding streambank. In addition, all irrigation diversions have been screened or replaced with infiltration galleries. More than 5,600 acres of cropland in this watershed have been enrolled in the Conservation Reserve Program and converted to permanent grassland. Over 13 miles of roads have been scarified and seeded to reduce stream sedimentation and more than 50 upland water and sediment basin have been installed to slow storm runoff and increase water absorption.

The 2002 Trout Creek Watershed Assessments concluded the highest priority for riparian management would be to protect areas currently in good condition. The assessment also concluded that livestock exclosures that have been constructed within the watershed over the past 15 years appear effective in enhancing riparian conditions and should continue to be maintained (Runyon et al. 2002). Appreciable increases in numbers of summer steelhead spawners in recent years seem to indicate that past habitat restoration has produced some fish benefits (French and Pribyl 2004).

The EDT fish habitat analysis reported that the Trout Creek system has the following habitat deficiencies: summer stream flow, water temperature extremes, and channel instability and habitat diversity. This evaluation emphasizes the need for continued riparian and stream channel restoration, while also investigating the possibility of restoring natural water storage capabilities in headwater valleys and meadows for late season flow and temperature moderation. This report also indicates the importance of upland watershed treatments that are designed to slow runoff and increase water retention. The watershed assessment emphasized the need for baseline resource data to facilitate monitoring of new and ongoing projects.

The *Squaw Creek Instream and Riparian Habitat Restoration Project Area* is identified as a high priority project area because of the potential for re-introduction of anadromous fish into the system. Collaborative habitat restoration projects have been underway for a number of years. The primary emphasis has been on summer flow and instream and channel restoration. To date more than 48,000 feet of open irrigation ditches or canals have been converted to pipe with an cumulative savings of 1,850 to 2,275 acre feet of water annually and an increase in summer stream flow of up to 7.7 cfs. There has been some road obliteration to reduce stream sediment. Nearly 1,000 acres, including stream frontage, have been acquired and converted to natural preserves or added to the Ochoco National Grasslands for habitat restoration. ODEQ is also actively collecting water quality data for the ongoing TMDL process.

The EDT fish habitat analysis reported that the Squaw Creek system has the following habitat deficiencies: summer stream flow, water temperature extremes, sedimentation, and channel stability and habitat diversity. This evaluation emphasized the need for riparian and stream channel restoration, as well as additional water conservation or acquisition of water rights to increase low seasonal flow. Channel stabilization measures would help to reduce sediment loading, while increasing stream shading, natural water table recovery and instream habitat complexity. There is also a need for detailed baseline resource assessment data and monitoring and evaluation of the effectiveness of ongoing and planned projects for habitat recovery and increased fish and wildlife production.

Projects implemented in the ***Middle and Upper Deschutes River Instream and Riparian Habitat Restoration Project Area*** would substantially increase habitat for redband trout and bull trout. Past recovery activities include the lining of more than 22 miles of irrigation ditches and canals to reduce water loss. Nearly 11 miles of the upper river has been treated to increase instream structure and stabilize streambanks. Riparian and wetland restoration is underway on nearly 140 acres adjacent to the upper river. Approximately 8,000 acre feet of water have been leased annually to supplement low stream flow. ODEQ water quality monitoring for the TMDL process is ongoing. Instream structural treatments have been challenging in the upper river because of the extreme fluctuations in flow, but have generally been effective in collecting fine sediment and reducing bank erosion. Planting of willow in riparian areas resulted in 5-25% survival.

The QHA habitat analysis indicated that the Middle and Upper Deschutes had the following habitat deficiencies: low summer or winter flow, flow extremes, stream temperature extremes, fish passage, sedimentation, instream habitat diversity and streambank stability. This evaluation identified the need for seasonal flow modifications, including reductions in extreme flow, which would help resolve instream habitat complexity, seasonal low flow, channel stability and sedimentation issues. Water conservation measures, including the lining or piping of irrigation canals, appears to be a valid technique for restoring some river flow and reducing peak flows. Fish passage at five artificial structures needs to be addressed. There is also a need for detailed baseline resource assessment data and continued monitoring and evaluation of the effectiveness of ongoing and planned projects for habitat recovery and increased fish and wildlife production.

The ***Lower Crooked River Instream and Riparian Habitat Restoration Project Area*** is another high priority project area because of the potential for re-introduction of anadromous fish into the system, as well as benefits to redband and bull trout and a variety of wildlife species.

There are approximately 104 miles of stream in the project area, with approximately fourteen miles of the lower river confined to a narrow basalt canyon. Habitat restoration to date has included riparian restoration along approximately 14 miles of stream; development of off-stream livestock watering sites affecting a mile of stream; 5+ acres of riparian/wetland restoration; restoration/relocation of two miles of stream channel: and some fish passage and screening at water diversion structures. Project monitoring indicates that riparian vegetation has responded favorably to protection and planting projects. It indicates that vegetative response may already be starting to moderate maximum stream temperatures

The EDT fish habitat analysis reported that the Lower Crooked River system has the following habitat deficiencies: seasonally low stream flow, water temperature extremes, sedimentation, and channel stability and habitat diversity. This evaluation emphasizes the need for riparian and stream channel restoration, as well as additional water conservation or water right acquisition to increase low seasonal flow. There is also the need for upland habitat recovery to reduce rapid storm runoff and stream sediment delivery. Restoring fish passage at artificial obstructions will be a key factor affecting potential re-introduction of anadromous fish. There is the need for a detailed baseline stream habitat inventory and long-term monitoring and evaluation for ongoing and proposed habitat projects.

Project implementation in the ***Lake Creek and Link Creek Fish Passage Improvement Project Area*** is crucial to the successful re-establishment of Sockeye salmon in the Metolius/Suttle Lake Habitat complex. Planning has been completed for fish passage and screening at the Link Creek obstruction. The Lake Creek site needs to be evaluated and remedial measures designed. A monitoring and evaluation plan would help to assess the success of the structural modifications, as well as the fish re-introduction.

Restoration in the ***North Fork Crooked River Instream and Riparian Habitat Restoration Project Area*** is a high priority because of the core redband trout population in this stream habitat complex. Stream habitat and fish population inventories have helped to document the need for habitat restoration. Surveys indicated that stream habitat on public forestland remains in fair to good condition, while most stream reaches on privately owned lands have significant habitat deficiencies, including low summer flow, stream temperature extremes, sedimentation, streambank and channel stability, instream habitat diversity and fish passage. A prerequisite for habitat treatment is a detailed baseline habitat inventory to prioritize restoration activities and monitor treatments. Landowner cooperation will be critical before instream, riparian and upland habitat recovery can be initiated. Summer stream flow recovery through riparian and stream channel treatments and restoration of natural water storage by water table recharge are requirements for appreciable increases in fish and wildlife populations. In addition, upland watershed recovery to slow runoff and reduce erosion and stream sedimentation will also be an important ecosystem recovery tool.

Restoration in the ***Beaver Creek Instream and Riparian Habitat Restoration Project Area*** (Warm Springs River system) is a high priority because of the spring Chinook salmon and summer steelhead spawning and rearing in this stream. Past habitat restoration included installation of instream structure in a channelized stream reach. Further restoration is needed to address remaining problems. A portion of the stream was re-located and straightened to facilitate highway construction. Other stream reaches have been impacted by livestock use. A recent detailed stream habitat survey and the EDT habitat analysis identified the following habitat deficiencies in this stream: instream habitat diversity, streambank stability, temperature and sedimentation. A prerequisite to initiation of habitat treatments will be use of the AIP Habitat Survey to prioritize treatments areas and techniques and determine if there is a need for more detailed baseline habitat data for project progress monitoring and evaluation.

The ***Tygh and Badger Creek Habitat Restoration Project Area*** is a high priority area because of the genetically unique redband trout found in the White River system. Past habitat restoration projects include bank stabilization and riparian recovery following the 1974 Flood and subsequent channel alteration and manipulation. In the interim, there has been appreciable recovery of riparian vegetation and streambank stability, except in areas subject to livestock use or channel manipulation. However there was no formal monitoring of these earlier habitat projects. The QHA habitat analysis indicated that these stream reaches had the following habitat deficiencies: summer stream flow, channel stability, instream habitat diversity and fish passage. A detailed habitat survey is needed to establish baseline habitat conditions and aid in project planning and long-term evaluation. It appears that restoration measures should include livestock controls, fish laddering and screening at irrigation diversions and water conservation measures (piping, water acquisition, and relocation of diversion points).

The ***Lower Deschutes River Instream and Riparian Habitat Restoration Project Area*** is a high priority for all focal fish species because of their use of this habitat during some or all of their freshwater life stages. A number of riparian habitat restoration projects have been implemented on the lower 100 miles of the river over the past twenty-five years. Riparian livestock exclosures have proven the most effective treatment for restoration of diverse riparian vegetative communities. These projects have been implemented along approximately 45 miles of river shoreline, which when combined with approximately 90 miles of shoreline protected from livestock by railroad or highway right-of-ways, leaves approximately 65 miles of shoreline that is in need of riparian and instream habitat restoration or protection. There has not been detailed monitoring of past projects, but an ODFW photo-point series has documented the vegetative response in several areas, including the lower twenty miles of river. This limited monitoring has shown substantial recovery in some areas, despite the 1996 Flood-of record. Some areas have shown channel narrowing and increases in overhead and aquatic vegetation. Appreciable increases in fall Chinook salmon spawning in river reaches may be related to recovering riparian and instream habitat.

The EDT habitat assessment analysis concluded that this reach of river has the following habitat deficiencies: instream habitat diversity, streambank stability/cover, flow and temperature. There is no detailed habitat survey for the lower Deschutes River. Such a survey could provide important habitat baseline data and aid in prioritization of restoration components. Based on past projects, it appears effective livestock restrictions are needed for diverse riparian vegetative recovery. Other treatments considered should include upland livestock water developments and limitations on concentrated recreational use in the river’s riparian corridor.

Restoring fish passage in the ***Pelton Round Butte Fish Passage Restoration Project Area*** is a high priority because of the potential for re-introduction of focal fish species into historic habitat and the resulting increase in subbasin fish production. This project is a federal hydropower license requirement for the project operators. Years of engineering and aquatic studies have been conducted, and project completion is anticipated within the next five years. Substantial monitoring and evaluation will also be required to determine the effectiveness of adult fish passage and juvenile collection and transportation facilities.

A number of other stream and watershed restoration projects have been conducted in other portions of the subbasin. These projects include water conservation measures, TMDL data collection and report development, juniper control or thinning, noxious weed control, forest fire rehabilitation, road abandonment, riparian livestock exclosure fencing, instream structure and spawning habitat restoration, vegetative plantings, re-establishment of interior grassland habitat, off-channel livestock water developments and implementation of farm conservation plans. The degree of project monitoring and evaluation detail has varied widely on these projects.

Table I.1. Existing Plans and Programs Affecting Fish, Wildlife and Ecosystem Resources in Deschutes Subbasin.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
1	Crooked River Watershed Council	Local	Crooked River Watershed Assessment	Crook	Plan	>1 million	Fish Species		Entire Crooked R. Watershed	On-going	Completed in 2002, document provides general resource info. And will guide restoration and enhancement efforts throughout the watershed.
2	Crooked River Watershed Council	Local	Ochoco Watershed Channel Conditions	Crook	Plan	50,000-100,000	Fish Species		McKay Creek, Mill, Marks and Ochoco Creeks	On-going	Inventory of channel and habitat conditions on the 4 primary streams in the Crooked River Watershed that originate in the Ochoco Mountains.
3	Wasco Co. SWCD	Local	Buck Hollow Watershed Enhancement Plan	Wasco	Plan	100,000-500,000			Buck Hollow Watershed, 120,000 Acres	On-going	See description under Buck Hollow Watershed Project. Protects upland, riparian and instream resources.
4	Wasco Co. SWCD	Local	Bakeoven Watershed Action Plan	Wasco	Plan	50,000-100,000			Bakeoven Watershed, 88,000 Acres	Reviewed on Regular Basis	See description under Bakeoven Watershed Project. Protects upland, riparian and instream resources. To be reviewed in 2003.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
5	Wasco Co. SWCD	Local	Lower Deschutes Ag H2O Qual. Mgmt. Plan	Wasco	Plan		Water Quality		Deschutes Basin downstream of Trout Creek, plus the E. Hood Basin & Columbia Tribs within Sherman Co	Reviewed on Regular Basis	Describes ag. Practices and prohibited conditions to protect water quality in the Lower Deschutes Area. Oregon Admin. Rules provide ODA with enforcement authority.
6	Deschutes Basin Land Trust	Private	Back to Homewaters	Deschutes	Program	50,000-100,000	Fish Species		Upper Des. Basin, inc. Des. (to Big Falls), Metolius, & Crooked R. (to Bowman & Ochoco dams)& tribs	On-going	landscape scale effort to protect and restore salmon & steelhead habitat for reintroduction. Phase 1: GIS dataset, and prioritizing restoration projects with partners.
7	COIC	Local	COPWRR	Multiple	Plan	>1 million	Upland Habitat		Crook, Deschutes and Jefferson Counties	Will expire and not be renewed	The COPWRR Strategy Framework is a community based strategy to increase hazardous fuel removal by increasing small diameter treatment by-product utilization in Central Oregon.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
8	Oregon Dept. of Agriculture	State	Crooked river Agricultural Water Quality Mgmt. Plan	Multiple	Plan	>1 million	Water Quality		Crooked R. drainage, not the lower 20 Mi. of the Crooked, which are in Middle/Upp Des. And	Reviewed on Regular Basis	Plan is being developed with expect adoption in 2004. Area Plan is not enforceable. It encourages landowners to maintain uplands and properly manage croplands and ranchettes. It emphasizes the effect of healthy uplands on stream system health.
9	Oregon Dept. of Agriculture	State	Crooked River AgWQM Area Rules	Multiple	Legal	>1 million	Water Quality		Crooked R. drainage, not the lower 20 Mi. of the Crooked, which are in Middle/Upp Des. And	Reviewed on Regular Basis	Area Rules for Crooked R. (OAR 603-90 #00-60) are being developed and will be adopted in 2004. They will be enforceable by ODA. The rules will require compliance with ORS468B; additional requirements will be determined.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
10	Oregon Dept. of Agriculture	State	Lower Deschutes AgWQM Plan	Multiple	Plan	>1 million	Water Quality		Lower Deschutes, drainage below trout creek, and drainages to the Columbia outside Des, bet. Hood/JD	Reviewed on Regular Basis	Plan is a tool for landowners to use to control erosion on uplands, minimize streambank erosion, and not pollute. Recommends a conservation plan for landowners.
11	Oregon Dept. of Agriculture	State	Lower Deschutes AgWQM Rules	Multiple	Legal	>1 million	Water Quality		Lower Deschutes, drainage below trout creek, and drainages to the Columbia outside Des, bet. Hood/JD	Reviewed on Regular Basis	Rules adopted 2000 and revised in 2002: landowners must control soil erosion in uplands and streambanks beyond what is naturally occurring.
12	Oregon Dept. of Agriculture	State	Middle Deschutes AgWQM Plan	Multiple	Plan	500,000- 1 million	Water Quality		Middle Deschutes, Trout crk to confluence of Crooked, not inc. Metolius	Reviewed on Regular Basis	Plan focuses on proper use of streambanks and uplands, irrigation and livestock use, storage of crop nutrients and chemicals.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
13	Oregon Dept. of Agriculture	State	Middle Deschutes AgWQM Rules	Multiple	Legal	500,000- 1 million	Water Quality		Middle Deschutes, see above	Reviewed on Regular Basis	Rules adopted in 2001 and reviewed in 2003. Enforceable to have landowners comply with ORS 468B. See other regions WQM area rules.
14	Oregon Dept. of Agriculture	State	Upper Deschutes AgWQM Plan	Multiple	Plan	>1 million	Water Quality		Upper Deschutes, above and including Metolius, not Crooked R.	Reviewed on Regular Basis	Plan will be adopted in 2003. Landowners encouraged to maintain adequate streamside veg, minimize runoff and steambank erosion and pollutants, including manure, out of water systems.
15	Oregon Dept. of Agriculture	State	Upper Deschutes AgWQM Rules	Multiple	Legal	>1 million	Water Quality		Upper Deschutes, see above.	Reviewed on Regular Basis	Rules to be adopted in 2003, and enforceable by ODA. Landowners must comply with ORS 468B, see above regions.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
16	Deschutes Co. Comm. Development Dept.	Local	Title 18- Wildlife Area Combining Zone	Deschutes	Plan		Upland Habitat		Located throughout Deschutes Co.	On-going	The purpose of the wildlife area combining (WA) zone is to conserve important wildlife areas in Deschutes County; to protect an important environmental, social and economic element of area & to permit development compatible w/ protecting wildlife resource
17	Deschutes Co. Comm. Development Dept.	Local	Title 18- Sensitive Bird and Mammal Habitat	Deschutes	Plan		Wildlife or Bird Species		Located at specific sites throughout Des. Co.	On-going	The purpose of SBMH combining zone is to insure sensitive habitat are from the county's Goal 5 sensitive bird & mammal inventory as critical for the survival of select species are protected from excluded FPA activities
18	Deschutes Co. Comm. Development Dept.	Local	Title 18- Flood Plain Zone	Deschutes	Plan		Water Quality		Located throughout Des. Co.	On-going	Purpose of zone are to implement Comp. Plan Flooding Secn, protect public from flood hazards,

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
											conserve riparian areas for maint. Of Fish & Wildlife, preserve sig. Scenic and natural resources & balance pub. Interest.
19	Deschutes Co. Comm. Development Dept.	Local	Title 18- Forest use Zone (F-1 & F-2)	Deschutes	Plan		Upland Habitat		Located Throughout Des. Co.	On-going	Purpose is to conserve forest lands.
20	Deschutes Co. Comm. Development Dept.	Local	Title 18- Open Space and conservation zone	Deschutes	Plan		Upland Habitat		Located throughout Des. Co	On-going	Purpose is to protect designated areas of scenic/natural res., restrict dev. In areas w/fragile, unusual or unique qualities; protect and improve air and water qual. And land resources, and plan dev. That will conserve open space.
21	Deschutes Co. Comm. Development Dept.	Local	Title 18- Landscape Mgt. Combining Zone	Deschutes	Plan		Upland Habitat		Located within 1/8 or 1/4 mile of selected streams and rivers throughout Des. Co.	On-going	Purpose is to maintain scenic and nat. res. Of the designated areas, and to maintain/enhance scenic vistas and natural landscapes as seen from

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
											designated rivers or streams.
22	Deschutes Co. Comm. Development Dept.	Local	Conditional Use-Fill and Removal	Deschutes	Plan		Wetland Resources		Located throughout Des. Co.	On-going	Conditional use permit is required for excavation, grading and fill and removal within the bed and banks of a stream or river or wetland subject to Des. Co. Code (DCC) 18.120.050 and 18.128.270.
23	Deschutes Co. Comm. Development Dept.	Local	100 ft setback from streams and lakes	Deschutes	Plan		Water Quality		100 ft of all streams and lakes in Des. Col	On-going	All sewage disp. Installations, all structures, buildings, and permanent fixtures shall be setcack a min. of 100 ft from the ordinary high water mark along streams and lakes. There are provisions that allow encroachment under special circumstances.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
24	Deschutes Co. Comm. Development Dept.	Local	Conservation Easement DCC 18.116.220	Deschutes	Plan		Water Quantity		10 ft. from select rivers or streams.	On-going	For all land use actions involving property adjacent to the Des., Crooked, Fall, Lil Des, and Spring Rivers, Paulina, Squaw & Tumalo Crks, the property owner shall convey to the county a CE affecting all property on the subject lot w/in 10' of hi water mark
25	Crook Co. Court	Local	Crook Co. Natural Res. Planning Consultation?	Crook	Plan	100,000-500,000	Water Quality		Crook Co.	Reviewed on Regular Basis	Plan to provide guidance to Crook Co. Planning.
26	BLM Prineville Dist.	Federal	Upper Des. Resource Management Plan	Deschutes	Plan	100,000-500,000	Upland Habitat		Crook and Deschutes Co. (refer to BLM planning map)	Reviewed on Regular Basis	BLM resource mgmt. Plan
27	US Fish and Wildlife Service	Federal	ESA Consultation with BOR		Legal				Deschutes Basin	On-going	ESA consultation on BOR's Des. Basin projects. This will complement mitigation efforts the FWS has underway through other consultations,

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
											hydro relicensing, cooperative efforts, etc. Operation and maintenance.
28	US Fish and Wildlife Service	Federal	ESA Consultation with PGE/CTWS		Legal				lower Des. Basin, primarily Jefferson and Des. Co.	On-going	ESA Consultation on the Pelton Round Butte hydro project.
29	US Fish and Wildlife Service	Federal	Relicensing of the Pelton Round Butte project		Legal				lower Des. Basin, primarily Jefferson and Des. Co.	On-going	Hydro relicensing provides an opportunity to address a wide range of environmental issues including fish passage, fish and wildlife habitat and water quality.
30	US Fish and Wildlife Service	Federal	Bull Trout critical habitat designation	Multiple	Legal	>1 million	Fish Species		entire range of bull trout	On-going	designation required under the ESA and is intended to designate all areas essential for the conservation of the species. Protection would include requirements under section 7 of the act, requiring other

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
											federal agencies to consult with FWS to mod. Hab.
31	US Fish and Wildlife Service	Federal	Bull Trout Recovery Plan draft	Multiple	Plan	100,000-500,000	Fish Species		Recovery plan will be range wide, but Des. Basin plan to include waters w/current & potential pops.	Reviewed on Regular Basis	identifies the area occupied, threats and tasks identified to help conserve bull trout to recovery at which they could be delisted. The plan is discretionary and includes specific tasks that could be implemented by land/water proj. mgrs in the basin.
32	Confederated Tribes of Warm Springs	Tribal	Warm Springs Comprehensive Plan	Jefferson/ Wasco	Plan	500,000- 1 million	All	on-going	Warm Springs Reservation	On-going	Resource protection strategies for 650,000 acres of Tribal Lands.
33	Confederated Tribes of Warm Springs	Tribal	Integrated Resource Management Plan	Jefferson/ Wasco	Plan	500,000- 1 million	All	on-going	Warm Springs Reservation	On-going	Protection standards for tribal resources.
34	Confederated Tribes of Warm Springs	Tribal	Water Quality Ordinance	Jefferson/ Wasco	Legal	500,000- 1 million	Water Quality	on-going	Warm Springs Reservation	On-going	Implements comprehensive plan and sets protection

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
											standards.
35	Confederated Tribes of Warm Springs	Tribal	Range & Ag. Ordinance	Jefferson/ Wasco	Legal	500,000- 1 million	Upland Habitat	on-going	Warm Springs Reservation	On-going	Implements comprehensive plan and sets protection standards.
36	Confederated Tribes of Warm Springs	Tribal	Fisheries Ordinance	Jefferson/ Wasco	Legal	500,000- 1 million	Fish Species	on-going	Warm Springs Reservation	On-going	Implements comprehensive plan and sets protection standards.
37	Confederated Tribes of Warm Springs	Tribal	Wildlife Ordinance	Jefferson/ Wasco	Legal	500,000- 1 million	Wildlife or Bird Species	on-going	Warm Springs Reservation	On-going	Implements comprehensive plan and sets protection standards.
38	Confederated Tribes of Warm Springs	Tribal	Timber Ordinance	Jefferson/ Wasco	Legal	500,000- 1 million	Wetland Resources	on-going	Warm Springs Reservation	On-going	Implements comprehensive plan and sets protection standards.
39	Confederated Tribes of Warm Springs	Tribal	Fish, Wildlife and Parks Program	Jefferson/ Wasco	Program	500,000- 1 million	Fish Species	on-going	Warm Springs Reservation	On-going	Implements ordinances.
40	Confederated Tribes of Warm Springs	Tribal	Environmental Program	Jefferson/ Wasco	Program	500,000- 1 million	Water Quality	on-going	Warm Springs Reservation	On-going	Implements ordinances.
41	Confederated Tribes of Warm Springs	Tribal	Range & Ag. Program	Jefferson/ Wasco	Program	500,000- 1 million	Upland Habitat	on-going	Warm Springs Reservation	On-going	Implements ordinances.

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
42	Confederated Tribes of Warm Springs	Tribal	Forestry Program	Jefferson/ Wasco	Program	500,000- 1 million	Upland Habitat	on-going	Warm Springs Reservation	On-going	Implements ordinances.
43	Confederated Tribes of Warm Springs	Tribal	Fire Management Program	Jefferson/ Wasco	Program	500,000- 1 million	Upland Habitat	on-going	Warm Springs Reservation	On-going	Implements ordinances.
44	Confederated Tribes of Warm Springs	Tribal	Monitoring Program	Jefferson/ Wasco	Program	500,000- 1 million	All	on-going	Warm Springs Reservation	On-going	Implements ordinances.
45	Deschutes Basin Land Trust	Private	Community Preserves	Multiple	Program				Des. Basin, on specific sites that met criteria	On-going	The community preserve strategy will seek to identify and acquire properties that are well-suited to serve basin communities as outdoor classrooms to increase awareness
46	Deschutes Co.	Local	Transfer of Development Credits	Deschutes	Program	50,000-100,000	Water Quality		South Des. Co.	On-going	Co. is purchasing dev. Rights from private owners to prevent new septic systems from being installed. Restrictive covenants are placed on property. Dev. Rights are then transferred

ID	Organization	Type	Project Title	County	Type of Protection	Project Size (acres)	Resources Protected	Duration of protection	Location of Protection	Status	Brief Description
47	City of Bend	Local	Waterway Overlay Zone Ordinance	Deschutes	Legal	100- 1000	Water Quality		Des. R. and Tumalo Creek w/in Bend city limits from ord. High water mark inland from 30 ft to >100ft	On-going	THE WOZ has 4 components: Riparian boundary w/setbacks to protect riparian resources; flood plain areas as defined by FEMA; DRDR; and ASI
48	City of Bend	Local	Upland Areas of Special Interest	Deschutes	Legal	100- 1000	Upland Habitat		within city of bend, having spec. features (rock outcroppings and sig. Trees)	On-going	Over 30 unique areas w/in city limits have received special protection under the Upland ASI ordinance. Protection includes a boundary (usually at the toe of slope) and 30 ft. building set back.

Table I.2. Existing Restoration and Conservation Projects.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
1	Crooked River Watershed Council	Local	Little Camp Creek Spring Improvements	Agricultural/Rangeland Improvement	Private	Crook	State	$5,000-10,000	2002	2011+	5000	Acres	On-going	Upland Habitat	n/a		Development of 5 springs for livestock water. Includes installation of spring boxes, pipe, water troughs/tanks, and fencing to protect springs. Will improve livestock distribution and range conditions in several pastures totalling 5000 acres.		All 5 structures are functioning properly.
2	Crooked River Watershed Council	Local	Mill Creek Habitat Enhancement	In-stream Flow Restoration	Private	Crook	State	$5,000-10,000	2002	2011+	1	Miles	On-going	Fish Habitat	Mill Creek		Placement of large woody debris and rock "j-hook" structures to enhance instream habitat. Included placement of juniper "riprap" to stabilize streambanks.		Structures have performed well in first flow event since installation.
3	Crooked River Watershed Council	Local	Lawson Creek Road Mitigation	Road Abandonment/Restoration	Private	Crook	State	$1,000-$5,000	2002	2011+	.10	Miles	On-going	Water Quality	Lawson Creek		Relocation of road away from riparian area. Old roadbed was seeded, covered with organic material, and blocked. New roadbed was contructed upslope, out of riparian zone.		Old roadbed has grass growing through placed organic material (branches, logs).
4	Crooked River Watershed Council	Local	Mill Creek Irrigation Ditch Removal	In-stream Flow Restoration	Private	Crook	State	$1,000-$5,000	2002	2011+	.75	Miles	On-going	Fish Habitat	Mill Creek		Installation of diversion pipe that will direct water from diversion ditch back to Mill Creek. Will eliminate .75 mile of diversion ditch, returning water to creek further upstream and preventing flow losses due to leakage and infiltration.		Pipe is functioning properly.
5	Crooked River Watershed Council	Local	Lower Crooked River Restoration (2002)	Stream Bank Restoration	Private	Crook	Federal	$25,000-$50,000	2002	2011+	.25	Miles	On-going	Riparian/Wetland Habitat	Crooked River		Streambank restoration utilizing low-intensity methods. Vertical streambanks were excavated to create a floodplain terrace and a sloped bank. Erosion cloth and extensive riparian plantings were utilized to stabilize the bank. Rock "j-hook" structures w		Structures have performed well and bank remains stable following first flow event since installation.
6	Crooked River Watershed Council	Local	Duncan Creek Restoration	Instream Habitat Restoration	Private	Crook	State	$25,000-$50,000	2002	2011+	1	Miles	On-going	Riparian/Wetland Habitat	Duncan Creek		Repair to 2 irrigation diversion structures to alleviate existing headcuts. Included installation of rock weirs to direct flows, and a rock step pool structure to facilitate fish passage. In addition, riparian fencing to exclude livestock was installed &		Structures have performed well in first flow event since installation.
7	Crooked River Watershed Council	Local	McKay Creek Bank Stabilization	Stream Bank Restoration	Private	Crook	State	$5,000-10,000	2002	2011+	.25	Miles	On-going	Riparian/Wetland Habitat	McKay Creek		Stream restoration to address bank stabilization, riparian veg., and fish hab. Activities included the use of juniper "riprap" to stabilize banks & improve fish hab., the installation of rock "j-hooks," riparian planting, & riparian fencing to exclude li		Structures have performed well in first flow event since installation.
8	Crooked River Watershed Council	Local	McKay Creek Channel Relocation	Stream Bank Restoration	Private	Crook	State	$25,000-$50,000	2002	2011+	2	Miles	On-going	Riparian/Wetland Habitat	McKay Creek		Creation of new channel in areas where channelization was having negative impact on riparian conditions. Included channel relocation, installation of rock "j-hooks," juniper root wads, extensive riparian planting, & installation of riparian fence to exclu		Structures have performed well in first flow event since installation.
9	Crooked River Watershed Council	Local	Mill Creek Restoration (2001)	Instream Habitat Restoration	Private	Crook	State	$25,000-$50,000	2002	2011+	1	Miles	On-going	Fish Habitat	Mill Creek		Stream restoration to address bank stabilization, riparian veg., & fish hab. Activities included use of juniper "riprap" to stabilize banks & improve fish hab., installation of rock "j-hooks," & large wood, to improve fish hab. & riparian fence to exclude		Riparian veg. Is emerging (willow,alder), banks have begun stabilization process, & additional pool are forming.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
10	Crooked River Watershed Council	Local	Upper Crooked/Shotgun Restoration	Stream Bank Restoration	Private	Crook	State	$25,000-$50,000	2001	2011+	2.5	Miles	On-going	Riparian/Wetland Habitat	Upper Crooked R., Shotgun Ck, Pine Ck		Stream restoration to address bank stabilization & riparian veg. Activities included installation of rock "j-hooks," to direct flows & improve fish hab., & riparian fencing to exclude livestock.		Riparian veg. Is emerging (willow, alder) and banks have begun stabilization process.
11	Crooked River Watershed Council	Local	Mill Creek Restoration (2000)	Stream Bank Restoration	Private	Crook	State	$10,000-$25,000	2000	2006-201	1	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Steam restoration to address bank stabilization, riparian veg., & fish hab. Activities included use of juniper "riprap" to stabilize banks & improve fish hab., installation of rock "j-hooks," to direct flows & improve fish hab., & riparian fencing to excl		Riparian veg. Is thriving (willow, alder), banks have begun stabilization process, & habitat has been improved through increased cover & more pools.
12	Crooked River Watershed Council	Local	Allen Creek Restoration	Stream Bank Restoration	Private		State		2000	2006-201	.5	Miles	On-going	Riparian/Wetland Habitat	Allen Creek		Stream restoration to address bank stabilization, riparian veg., & fish hab. Activities included use of juniper "riprap" to stabilize banks & improve fish habitat, installation of rock "j-hooks," to direct flows & improve fish hab., & riparian hab., & rip		Riparian veg. Is thriving (willow, alder), banks have begun stabilization process, & habitat has been improved through increased cover & more pools.
13	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	City	Crook	Private	<$1,000	2001	2005	.25	Miles	On-going	Riparian/Wetland Habitat	Crooked River		Riparian planting along .25 mile of Crooked River.		Plantings have encouraged the revegetatin process, which is stabilizing streambanks, narrowing the channel, helping reduce stream temperatures, & restoring native vegetation to a city park.
14	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	County	Crook	Private	<$1,000	2002	2006-201	.25	Miles	On-going	Riparian/Wetland Habitat	Ochoco Creek		Riparian planting along .25 mile of Crooked River.		Plantings have encouraged the revegetation process, which is stabilizing streambanks, narrowing the channel, helping reduce stream temperatures, & restoring native vegetation to a county park.
15	Crooked River Watershed council	Local	Riparian Fencing and Planting	Stream Bank Restoration	Private	Crook	State	$10,000-$25,000	2001	2011+	2	Miles	On-going	Riparian/Wetland Habitat	McKay Creek		Riparian fencing of 2 miles of McKay Creek w/riparian plantings totalling 1 acre.		Livestock exclusion from riparian area has begun revegetation process. Streambanks are stabilizing, channel is narrowing, & fish habitat is improving.
16	Crooked River Watershed council	Local	Riparian Fencing and Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	.3	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Riparian fencing of .3 mile of Mill Creek w/riparian plantings totalling .1 acre.		Livestock exclusion from riparian area has begun revegetation process. Streambanks are stabilizing, channel is narrowing, and fish habitat is improving.
17	Crooked River Watershed Council	Local	Riparian Fencing and Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Riparian fencing of .5 miles of Mill Creek with riparian plantings totalling 1 acre.		Livestock exclusion from riparian area has begun revegetation process. Streambanks are stabilizing, channel is narrowing, & fish habitat is improving.

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
18	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	1	Miles	On-going	Riparian/Wetland Habitat	Ochoco Creek		Riparian plantings along 1 mile of Ochoco Creek		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
19	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	McKay Creek		Riparian plantings along .5 mile of McKay Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
20	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	McKay Creek		Riparian plantings along .5 mile of McKay Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
21	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.1	Miles	On-going	Riparian/Wetland Habitat	Crooked River		Riparian plantings along .1 mile of Crooked River.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping reduce stream temperatures.
22	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Duncan Creek		Riparian plantings along .5 mile of Duncan Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping reduce stream temperatures.
23	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.6	Miles	On-going	Riparian/Wetland Habitat	Little Bear Creek		Riparian plantings along .6 mile of Little Bear Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
24	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Bear Creek		Riparian plantings along .5 mile of Bear Creek		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
25	Crooked River Watershed council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.25	Miles	On-going	Riparian/Wetland Habitat	Ochoco Creek		Riparian plantings along .25 mile of Ochoco Creek		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowin the channel, and helping to reduce stream temperatures.
26	Crooked River Watershed council	Local	Riparian Planting	Stream Bank Restoration	City	Crook	State	<$1,000	2001	2011+	.2	Miles	On-going	Riparian/Wetland Habitat	Ochoco Creek		Riparian plantings along .2 mile of Ochoco Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
27	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	<$1,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Ochoco Creek		Riparian plantings along .5 mile of Ochoco Creek.		Plantings have encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
28	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$5,000-10,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	n/a		Riparian fencing in upland headwaters of Sugar Creek. 12 acres of upland habitat, which excludes . Mile of Sugar Creek from grazing.		Fencing has encouraged revegetation process,which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
29	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	1.5	Miles	On-going	Riparian/Wetland Habitat	Wolf Creek		Riparian fencing of 1.5 miles of Wolf Creek.		Livestock exclusion has encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
30	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$10,000-$25,000	2001	2011+	6	Miles	On-going	Riparian/Wetland Habitat	Little Bear Creek		Riparian fencing of 6 miles of Little Bear Creek and tributaries.		Fencing has encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
31	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Riparian fencing of .5 miles of Mill Creek.		Livestock exclusion has encouraged revegetation process, which is stabilizing sreambanks, narrowing the channel, and helping to reduce stream temperatures.
32	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Riparian fencing of .5 miles of Mill Creek.		Fencing has encouraged revegetation process,which is stabilizing streambanks, narrowing the channel, and helping to reduce stream temperatures.
33	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$10,000-$25,000	2001	2011+	4	Miles	On-going	Riparian/Wetland Habitat	South Fork Crooked River		Riparian fencing of 4 miles of South Fork Crooked River.		Livestock exclusion has encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, and helping to reduce stream termperatures.
34	Crooked River Watershed Council	Local	Riparian Planting	Stream Bank Restoration	Private	Crook	State	$1,000-$5,000	2001	2011+	.5	Miles	On-going	Riparian/Wetland Habitat	Mill Creek		Riparian fencing of .5 miles of Mill Creek		Fencing has encouraged revegetation process, which is stabilizing streambanks, narrowing the channel, an helping to reduce stream tempertures
35	Crooked River Watershed council	Local	Wolf Creek Off-Stream Watering	Agricultural/Rangeland Improvement	Private	Crook	State	$10,000-$25,000	2003	2011+	1	Miles	On-going	Water Quality	Wolf Creek		Development of 2 off-stream watering structures (solar & electric) that will improve livestock destribution, & coupled w/riparian fencing, will improve water quality & channel conditions.		Just recently implemented.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
36	Crooked River Watershed Council	Local	McKay Creek Off-Stream Watering	Agricultural/Rangeland Improvement	Private	Crook	State	$10,000-$25,000	2003	2011+	1	Miles	On-going	Water Quality	McKay Creek		Development of 3 off-stream watering structures that will improve livestock distribution, and coupled with riparian fencing, will improve water quality and channel conditions.		Just recently implemented.
37	Crooked River Watershed council	Local	Beaver Creek Off-Stream Watering	Agricultural/Rangeland Improvement	Private	Crook	State	$1,000-$5,000	2003	2011+	2	Miles	On-going	Water Quality	South Fork Beaver Creek		Development of 3 off-stream watering structures (spring developments) that will improve livestock distribution and will improve water quality and channel conditions.		To be implemented Spring 2003.
38	Crooked River Watershed Council	Local	Little Bear Creek Off-Stream Watering	Agricultural/Rangeland Improvement	Private	Crook	State	$10,000-$25,000	2003	2011+	2	Miles	On-going	Water Quality	Little Bear Creek		Development of 10 off-stream watering features (solar/troughs and spring developments) that will improve livestock distribution, and coupled with riparian fencing, will improve water quality and channel conditions.		To be implemented Spring 2003.
39	DRC	Private	Annual Water Leasing Program	In-stream Flow Restoration	Private	Deschutes	Federal	$50,000-$100,000	2001	2011+	8000	acre feet	On-going	water quantity	Mid. Deschutes, L. Crooked, Tumalo, Squaw		The AWLP is a cooperative effort w/irrigation districts to pay landowner to lease water rights instream to improve streamflow on an annual basis. The program pays landowners a set price to lease water for one year only. It complements efforts to increas		Lease of around 8000 acre feet of water instream in each of 2001 & 2002. The program will likely expand in the future.
40	Wasco County SWCD	Local	Double Barrel Water Works (B bar B)	Upland Habitat Restoration	Private	Wasco	State	$10,000-$25,000	2002	2003	100	Acres	On-going	Riparian/Wetland Habitat	White River		Collects runoff water in series of ponds for wildlife habitat. Also stores irrigation water. Includes tree and shrub planting.		Provides for atrificial wetland habitat in previously dry area.
41	Wasco County SWCD	Local	Fire Damage Recovery Grants	Other	Private	Wasco	State	$25,000-$50,000	2002	2003	400	Acres	On-going	Upland Habitat	Buck Hollow, Bakeoven, Deschutes River		Reseeds & rehabilitates firebreaks & severely burned areas of White River Wildfire. Project actually represents three separate grants. Includes fencing, where necessary to protect new seeding.		Will restore grazing land condition & rotational grazing system to parts of the White River Wildfire.
42	Wasco County SWCD	Local	Buck Hollow Watershed Project	Agricultural/Rangeland Improvement	Private	Wasco	Other	>$500,000	1999	2003	120,000	Acres	On-going	Multiple	Buck Hollow	BLUE	Buck Hollow Wtershd Prjt start: '90 & sched. for completion in 2005. Treats all aspects of watshd function from upland hydrology/habitat-riparian conditions, -instream habitat. Funded by USDA, State (OWEB) and local lndowners. Inc. extensive monitoring		Buck Hollow runs clean. Formerly seasonal tribs are now perennial. 95% of riparian area is in riparian pasture mgmt or exclusion. Upland range conditions are vastly improved. Spawning has risen steadily since '94.
43	Wasco County SWCD	Local	Dancing Wolf Reservoir	Agricultural/Rangeland Improvement	Private	Wasco	State	$10,000-$25,000	2002	2003	20	Acres	On-going	Upland Habitat	White River	Green	Improves irrigation conveyance and storage efficiency, reducing the nbeed for water withdrawals during the critical late season.		
44	Wasco County SWCD	Local	McElheran No-till	Agricultural/Rangeland Improvement	Private	Wasco	Federal	$100,000-$500,000	1999	2004	600	Acres	On-going	Upland Habitat	White River	Blue	Provides cost share funding for conversion to direct-see (no-till) farming on a farm on Juniper Flat		Reduces runoff and erosion from cropfields. Reduces high flows from storm events. Increases infiltration of precipitation into soil and may have a positive effect on summer baseflows and stream temperatures. Improves overall soil quality.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
45	Wasco County SWCD	Local	White River No-Till	Agricultural/Rangeland Improvement	Private	Wasco	State	$100,000-$500,000	2000	2004	600	Acres	On-going	Riparian/Wetland Habitat	White River and tribs	Pink	Provides cost share funding for conservation to direct-see (no-till) farming on several farms in White River Watershed		Reduces runoff and erosion from cropfields. Reduces high flows from storm events. Increases infiltration of precipitation into soil and may have a positive effect on summer baseflows and stream temperatures. Improves overall soil quality.
46	Wasco County SWCD	Local	Bakeoven Best Management Practices	Agricultural/Rangeland Improvement	Private	Wasco	Federal	$100,000-$500,000	2001	2003	600	Acres	On-going	Riparian/Wetland Habitat	Bakeoven Creek and tribs	Green	Provides cost share for a variety of upland range and crop management practices that protect water quality by reducing runoff and erosion rates from uplands to streams. Funding provided by fed, state and landowners.		Reduces runoff and erosion from cropfields. Reduces high flows from storm events. Increases infiltration of precipitation into soil and may have a positive effect on summer baseflows and stream temperatures. Improves overall soil quality.
47	Wasco County SWCD	Local	Bakeoven Instream Habitat	Agricultural/Rangeland Improvement	Private	Wasco	Federal	$100,000-$500,000	1999	2004	20	Miles	On-going	Riparian/Wetland Habitat	Bakeoven Creek and tribs	Green	Makes various improvements to riparian conditions and instream habitat in Bakeoven Creek and major tribs.		Directly improves fish habitat. Complements Bakeoven Best Management Practices project by providing another piece of the puzzle.
48	Wasco County SWCD	Local	Butler Canyon Quarry Restoration	Agricultural/Rangeland Improvement	Private	Wasco	State	$5,000-10,000	2001	2003	12	Acres	On-going	Riparian/Wetland Habitat	Butler Canyon (trib to White R)	Purple	Resoration of a former quarry. Project includes removal of a road and culvert, reshaping of the streambanks, grass seeding, and tree planting.		Reduces streambank erosion and consequent sedimentation. Reduces potential for flood damages at downstream sights
49	Wasco County SWCD	Local	Jordan Creek Restoration Project	Agricultural/Rangeland Improvement	Private	Wasco	Other	$50,000-$100,000	2002	2004	4	Miles	On-going	Riparian/Wetland Habitat	Jordan Creek (trib of White R)	Blue	Makes various improvements to riparian conditions on Jordan Creek. Practices include installation of a bridge, repair of an existing bridge, riparian fencing, and tree planting		Protects fish habitat and water quality by eliminating at grade crossings, and improving and protaecting riparian corridor.
50	Wasco County SWCD	Local	Columbia Plateau Riparian Buffers	Stream Bank Restoration	Private	Wasco	Other	$100,000-$500,000	2001	2003	200	Miles	On-going	Riparian/Wetland Habitat	Deschutes, John Day and tribs		Provides funds to pay SWCD conservation planners to develop riparian buffer plans for the CREP and Continuous Conservation Reserve Programs		100 stream miles in riparian buffers to date, 30 + miles in planning stages, and a constant influx of new signups (countywide data)
51	Wasco County SWCD	Local	Anderson Ditch Piping	Other	Private	Wasco	State	$10,000-$25,000	2002	2003	1	Miles	On-going	Riparian/Wetland Habitat	Threemile Creek (Trib of White R)	Purple	Pipes a private irrigation ditch		Creates an on-demand system, reduces withdrawals and eliminates most tailwater.
52	Wasco County SWCD	Local	Forman Feedlot Relocation	Riparian	Private	Wasco	Other	$10,000-$25,000	2002	2003	1	Miles	On-going	Riparian/Wetland Habitat	Indian Creek (Trib of Trout Creek)	Blue	Relocates a feed lot out of riparian corridor onto uplands. Develops water sources, installs fences. Mulitple funding sourcesincludes state, fed and landowner		Allows riparian recovery, reduces or eliminates organic waste into stream
53	Wasco County SWCD	Local	White River Wire Fencing	Upland Habitat Restoration	Private	Wasco	State	$100,000-$500,000	2002	2003	2000	Acres	On-going	Upland Habitat	Buck Hollow, Bakeoven, Deschutes R	Purple	Provides funding to replace fences destroyed by wildfire and reseed. Practices are necessary to ensure good upland pasture mgmt.		Allows Reestablishment of grass stands and rotational grazing system.
54	Portland General Electric	Private	Water Quality Studies	Monitoring		Jefferson e	Private		1996				On-going	Water Quality	Deschutes Basin	Blue	Several studies including monitoring program with continuous temp and grab sample pH, turbidity, chlorophyll a, zooplankton, etc.		
55	Portland General Electric	Private	Geomorphology Studies	Monitoring		Jefferson e	Private			1998				Fish Habitat	Deschutes River	Brown	Several studies on geomorphology of Deschutes Basin concentrating on Pelton Round Butte Project waters and downstream		

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
56	Portland General Electric	Private	Fish population research and monitoring	Monitoring		Jefferson e	Private		1995				On-going	Fish Habitat	Deschutes Basin	Green	Several studies to determine life history patterns, diseases, and needs of bull trout, kokanee, rainbow, steelhead, spring chinook, signal crayfish. Includes monitoring program.		
57	Portland General Electric	Private	Engineering Studies	Monitoring		Jefferson	Private		1995				On-going	Fish Habitat	Deschutes River	Pink	Various studies to determine and engineering solution to water quality problems, redirection of reservior currents and other barriers to fish passage.		
58	Deschutes Basin Land Trust	Private	Metolius Preserve	Combination	Private Nor	Jefferson	Private	>$500,000	2002	2001+	1240	Acres	On-going	Multiple	Lake Creek (South, Middle, and North Forks)		Acquistion of developmt-threatened fish/wildlife habitat in Metolius sub-basin. Lake Crk provides current bull trout & redband habitat, & potential sockeye & spring chinook habitat. & includes primary winter range for Metolius Elk herd, exc. Bird habitat		as of 3/03, raised $1.7 of $3million project cost. Mgmt planning and restoration begins 7/03. Focus: protectin and enhacement of fish and wildlife habitat.
59	Deschutes Basin Land Trust	Private	Indian Ford Creek Instream Flow Enhancement	In-stream Flow Restoration	Private	Deschutes	Other	<$1,000	2002	2003	100	Acres	On-going	Fish Habitat, Water Quality and Quantity	Indian Ford Creek		Transfer of approx. 2cfs insteram as result of surface to ground water conversion. Decommissioning of 4 mile long, leaky irrigation ditch. Paterning with DRC and OWT.		Awaiting permit approvals from Water Resources Dept.
60	Deschutes Basin Land Trust	Private	Trout Creek Conservation Area	Combination	County	Deschutes	Private	<$1,000	1997	2011+	160	Acres	On-going	Multiple	Trout Creek		Easement protects a rare wildflower (Peck's Penstemon) which threatened to derail a land exchange between the Des. Natl. Forest, Des. County and the Sisters School Dist.		Working with Sisters School Dist., UDWC, Native Plant Society, Des. Natl. Forest and local landowners to created a management plan and cirricula to engage local students in conserving this property's natural resources.
61	Deschutes Basin Land Trust	Private	Thomas Preserve	Combination	USFS	Deschutes	Other	<$1,000	2002	2011+	7	Acres	On-going	Multiple	Squaw Creek		Acquisition of a seven acre oxbow island on the upper Deschutes River.		Currently developing a management plan for the preserve. The plan will focus on managing the Preserve for migratory waterfowl use, as well as providing habitat for the elk, deer and other animals that frequent the island.
62	Deschutes Basin Land Trust	Private	Indian Ford Meadow Preserve	Combination	Private Nor	Deschutes	Federal/S	>$500,000	2000	2011+	63	Acres	On-going	Multiple	Indian Ford (Squaw Creek)		Acquisition and protection of the 63 acre Indian Ford Meadow on a primary tributary to Squaw Creek. The meadow provides redband trout habitat, spectacular views and important avian habitat.		No restoration necessary. Weed control (reed canary grass) and management plans in place; weed control efforts ongoing.
63	Deschutes Basin Land Trust	Private	Alder Springs	Combination	USFS	Deschutes	Federal/S	>$500,000	1998	2011+	840	Acres	On-going	Mulitple	Squaw Creek		With the Trust for Public Lands, we acquired and transferred 840 acre Alder Srpings Ranch to the Crooked River National Grasslands. This project protected Mule Deer winter range, bull trout habitat, chinook/steelhead future spawning habitat		
64	Deschutes Basin Land Trust	Private	Hopkins-Young Conservation Easement	Upland Habitat Restoration	Private	Klamath	Local	$100,000-$500,000	2000	2011+	3045	Acres	On-going	Upland Habitat			development of old-growth Ponderosa pine forest east of Crescent. The Land Trust holds, monitors, and enforces this easement, which will also pomote development of additional old growth/late old structure forest.		All harves proposals approved by Land Trust; entire property monitored annually for compliance and effectiveness

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
65	Deschutes Basin Land Trust	Private	Camp Polk Meadow Preserve	Combination	Private No	Deschutes	Private	>$500,000	2000	2011+	148	Acres	On-going	Multiple	Squaw Creek		Historic Camp Polk meadow acquisition. Restoration of stream channel, wetland, uplands. Property contains what was historically among the most productive steelhead habitat on the creek. Provide educational and interp. Opportunities.		Completed first phases of wetlands/uplands restoration in 2002. Over 900 central Oregon kids have used site for outdoor ed. Through Wolftree and local programs. Assessing channel work with USACOE.
66	Bureau of Reclamation- LCAO	Federal	Crooked River Fish Screens	Fish Passage Improvements	Other Fede	Crook	Federal	$100,000-$500,000	2000	2003	1	Acres	Complete	Fish Habitat	Crooked River		Installation of a vertical fish screen at the diversion of the Crooked River Feed Canal.		No fish diverted from the river in to the canal system of Ochoco Irrigation District.
67	Bureau of Reclamation- LCAO	Federal	Dillman Meadows	Wetland Restoration	USFS	Deschutes	Federal	$25,000-$50,000	2000	2003	10	Acres	Complete	Riparian/Wetland Habitat	Deschutes River		Creation of ponds and the relocation of the spotted frog population from the toe drain at wickiup dam.		Frog population is monitored - after 1 full year, frogs seem to be doing fine.
68	Sunriver Owners Association	Other	Conservation Planning/CRP	Other	Private No	Deschutes	Federal	$100,000-$500,000	2003	2011+	128	Acres	On-going	Riparian/Wetland Habitat	Deschutes River		Implementing a conservation plan as part of the Conservation Reserve Program. This will include pasture guidelines (rotation, weed control, manure mgmt.), riparian plantings, erosion control and other activities.		
69	Sunriver Owners Association	Other	Sunriver Noxious Weed Control	Other		Deschutes	Private	$100,000-$500,000	1998	2011+	3000+	Acres	On-going	Upland Habitat			Integrated Noxious Weed mgmt. In Sunriver, including control and education as part of an ongoing commitment.		
70	OR DEQ and Deschutes Co.	State/Lo	La Pine National Demonstration Project	Other	Other	Deschutes	Federal	>$500,000	1995	2005			On-going	Water Quality	Deschutes and Little Deschutes watersheds		Install and field test innovative septic systems that provide advanced treatment of residential wastewater. The goal is to identify systems that will reduce the amount of nitrogen entering sole source aquifer of S. Des. Co. area.		Field testing portion of the project is approximately 50% complete with sampling to end in Dec. 2004. Results too extensive to report here.
71	OR DEQ and Deschutes Co.	State/Lo	La Pine National Demonstration Project	Other	Other Fede	Deschutes	Federal	>$500,000	1999	2003			On-going	Water Quality	Deschutes and Little Deschutes watersheds		A comprehensive groundwater study and 3-D groundwater and nutrient fate and transport model of the La Pine subbasin. Model scenarios indicate the extent of potential nitrate contamination in the groundwater.		Preliminary results have just been made available and too extensive to report here. A public meeting is scheduled for the April May 2003 time frame.
72	OR DEQ	State	TMDL Temperature Monitoring Program	Monitoring	Other Fede	Deschutes	State (OWEB)		2000	2000			Complete	Water Quality	Squaw Creek and Indian Ford Creek		continuous temp. data and Forward Looking Infrared Radiometry (FLIR) data were collected in the Squaw Creek Watershed during 2000. The FLIR survey was conducted July 28, 2000. The data will be used to develop a temp. TMDL for Squaw and Indian Ford Creek		In-stream temp. results are available from DEQ. The FLIR report/data is available from DEQ or the UDWC.
73	OR DEQ	State	TMDL Temperature Monitoring Program	Monitoring	Other	Deschutes	State (OWEB)		2001	2001			Complete	Water Quality	Des., Lil Des., Cresecent, Odell, Fall River, Tumalo, Paulina, Metolius, Lake		Continuous temp. data and FLIR data were collected in the Upper and Little Deschutes Subbasins during 2001. The FLIR survey was conducted from July 23-27, 2001. The data will be used to develop a temp. TMDL for streams in the 2 subbasins.		In-stream temperature results and FLIR report/data are available from DEQ

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
74	OR DEQ	State	Ambient Monitoring Program	Monitoring	Multiple	Deschutes	State		1998	2011+			On-going	Water Quality	Des., Lil Des., Metolius, Crooked		DEQ monitors 151 sites statewide, every other month, to assess water qual. Conditions/ trends. There are 10 ambient sites in the Deschutes Basin. Parameters include BOD Alkalinity, Chlorophyll, Specidic Conductance, DO, Bacteria, nutrients, solids, tur		Results available from DEQ's Datatbase. Data is also evaluated through Oregon Water Quality Index, used to assess water quality trends. The index evaluates temp., DO, BOD, pH, fecal coliforms, total solids, nitrogen and phosphorus.
75	OR DEQ	State	Regional Environ. Monitoring & Assess (REMAP)	Monitoring	Multiple	Deschutes, Jefferson, Klamath,			1998 prio	1998			Complete	Water Quality	Multiple streams in Des. Basin above lake Billy Chinook		Primary objective of Des. REMAP project was to assess status and trends of the aquatic natural resources of the Des. River Basin above Lake Billy Chinook. Riparian Habitat, water chemistry and biological information were collected at 55 sites over 2 yrs.		Warer Chemistry, temp., and vertebrate summary reports are available from the DEQ website. They are too numerous to describe here.
76	OR DEQ	State	TMDL Intensive Monitoring Program	Monitoring	Multiple	Deschutes	State		2001	2002			Complete	Water Quality	Multiple		July 16 and Nov. 5 weeks,'01, and Apr. 29 week, '02, DEQ did intensive water chem. Monitoring. Parameters: ph, alkalinity, conductivity, DO, turbidity, solids, nutrients. Data used in models to develop TMDLs for Upper & Lil Des. Subbasins.		Available from DEQ's database
77	OR DEQ	State	TMDL Sediment/Turbidity Monitoring	Monitoring	Multiple	Deschutes	State		2001	2001			Complete	Water Quality	Deschutes and Little Deschutes Rivers		Sediment/turbidity monitoring of the Des. River betwn Wickiup & Benham Falls. Continuous samplers collected daily composite samples from Mar. 30-Jun. 7, '01, & for the 1st week of each following month through Oct. '01. Data for TMDL dev.; 6 sites		Samples also collected from mouth of Lil. Des., Results available from DEQ's database.
78	OR DEQ, USFS	State/ F	TMDL Monitoring in Odell Lake	Monitoring	USFS	Klamath	State		2001				Complete	Water Quality	Odell lake and tributaries		Water chem. Data was collected for use in water quality modeling to develop a TMDL for Odell Lake. Odell Lake is included on the 303(d) List for not meeting the pH standard. The parameters collected included: temp., pH, DO and nutrients.		Results available from DEQ's database. They indicate that a more intensive study is needed to more adequately determine the nutrient/pH dynamics of the systems and the causes. Grant fundign is currently being sought to expand the project.
79	OR DEQ, USFS, BLM, ODFW, UDWC, OWRD, Grasslands	State	Continuous Temperature Monitoring	Monitoring	Multiple	Deschutes	State		1998 prior				On-going	Water Quality	Upper and Middle Deschutes		Agencies have been collecting in-stream continuous temp. data in the Upper/Middle Des. For a number of years. Effort now coordinated by UDWC according to "Framework for Regional, Coordinated Monitoring in the Middle and Upper Deschutes River Basin" report		The ARcView File referenced with this project includes a list of all sites that have been monitored up through 2001. An updated list including 2002 data will be available from the UDWC at some point in the future.
80	US Forest Service	Federal	Road Closures and Seeding	Road Abandonment/Restoration	USFS	Crook	Federal	$5,000-10,000	2002	2003	13	Miles	Complete	Water Quality	Trout Creek Watershed		Road closures, scarified, seeded and culverts pulled that are contributing to sediment to streams in the Trout creek watershed. Mid-Columbia River steelhead trout are present in this watershed.		Improvement (increase) in filtering riparian vegetation, educed sedimentation in streams; improvement in water quality (1 map enclosed for project 1)`
81	US Forest Service	Federal	Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$10,000-$25,000	2002	2003	11	Miles	Complete	Riparian/Wetland Habitat	Maury's West Side/Lookout Mountain Range		Planting ripipairan rooted stock in the Maury Mountains to increase riparian habitat along streams to improve and increase riparian vag. Removed by the Hash Rock Fire of 2000.		Improve shade along streams, increase and improve filtering veg. In the watershed to improve water quality and spawning habitat for redband trout. (2 maps enclosed for project 2)

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
82	USFS Ochoco NF	Federal	Derr Creek Riparian Planting	Stream Bank Restoration	USFS	Wheeler	Federal	$1,000-$5,000	2002		.4	Miles	Complete	Water Quality	Derr Creek		Performed riparian planting activities on Derr Creek. Species included: willow and alder.		Increase bank stability and shade.
83	USFS Ochoco NF	Federal	Wolf Creek Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$1,000-$5,000	2002		2.2	Miles	Complete	Water Quality	Wolf Creek		Performed riparian planting activities in Wolf Crek. Species included: Willow and cottonwood.		Increase bank stability and shade.
84	USFS Ochoco NF	Federal	Trib to N. Wolf Creek Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$1,000-$5,000	2002		1	Miles	Complete	Water Quality	N. Wolf Creek		Performed riparian planting activities in N. Wolf creek. Species include: willow		Increase bank stability and shade.
85	USFS Ochoco NF	Federal	Rager Creek Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$1,000-$5,000	2002		.2	Miles	Complete	Water Quality	Rager Creek		Performed riparian planting activities in Rager Creek. Species included: Willow and cottonwood.		Increase bank stability and shade.
86	USFS Ochoco NF	Federal	Powell Creek Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$1,000-$5,000	2002		.4	Miles	Complete	Water Quality	Powell Creek		Performed riparian planting activities in Powell Creek. Species included: willow.		Increase bank stability and shade.
87	USFS Ochoco NF	Federal	Little Summit Creek Riparian Planting	Stream Bank Restoration	USFS	Crook	Federal	$1,000-$5,000	2002		.6	Miles	Complete	Water Quality	Little Summit Creek		Performed riparian planting activities in Little Summit Creek. Species included: Willow and alder.		Increase bank stability and shade.
88	USFS Ochoco NF	Federal	North Wolf Creek Riparian Planting																
89	USFS Ochoco NF	Federal	Beaver Dam Creek Riparian Planting																
90	USFS Ochoco NF	Federal	Survey Creek LW Placement																
91	USFS Ochoco NF	Federal	Derr Meadow Restoration																
92	Jefferson SWCD	Other	Fish Habitat	Fish Passage Improvements	Private	Crook	State	$50,000-$100,000	2002	2003	2	Miles	Not Startec	Fish Habitat	Higgins Creek		Provide for native fish passage into the Higgins Creek Watershed. Improve water qulaity by decreasing sediment inflows and increasing cooling shad.		Pending
93	Jefferson SWCD	Other	Water Quality	Other	Private	Jefferson	State	$10,000-$25,000	2002	2003	4.5	Acres	On-going	Water Quality	Willow Creek		Pipe overflow water to a newly created sedimentation pond to filter sidement, nutrients, pesticides, and topsoil and prevent them from flowing into Willow Creek.		Pending
94	Jefferson SWCD	Other	Water Quality	Other	Private	Jefferson	State	$5,000-10,000	2003	2003	<1	Acres	Not Startec	Water Quality	Frog Springs		Repair pond which collects runoff from fields and irrigation tailwater which contains fertilizer, chemicals and sediment.		Pending
95	Jefferson SWCD	Other	Water Quality	Other	Private	Wasco	State	$10,000-$25,000	2003	2003	1+	Miles	On-going	Water Quality	Indian Creek		Relocate feed lots away from stream and created livestock watering facilities.		Pending
96	Jefferson SWCD	Other	Sediment Elimination	Other	Private	Jefferson	State	$5,000-10,000	2003	2003	1400	Feet	Not Startec	Water Quality	Trout Creek		Pipe open irrigation delivery ditch that overflows		Pending
97	Jefferson SWCD	Other	Water Quality	Other	Private	Jefferson	State	$10,000-$25,000	2003	2003	143	Acres	Not Startec	Water Quality	Lake Billy Chinook		Reseeding native veg. For long term controls of erosion and wildlife habitat support on sloping ground		Pending
98	Jefferson SWCD	Other	Sediment Elimination	Other	Private	Jefferson	State	$5,000-10,000	2002	2003	1375	Feet	On-going	Water Quality	Mud Springs		Pipe open irrigation delivery ditch that overflows		Pending
99	Jefferson SWCD	Other	Stream Monitoring	Monitoring	Private	Jefferson	State		2002	2011+			On-going	Fish Habitat	Willow Creek		Monitoring Willow Creek for changes in stream due to projects and/or events occurring along the stream		Pending
100	Jefferson SWCD	Other	Off Creek Watering	Stream Bank Restoration	Private	Wasco	State	$5,000-10,000	2001	2003	1	Miles	Complete	Riparian/Wetland Habitat	Antelope Creek		Off creek water facility to keep livestock away from creek and banks.		Pending
101	Jefferson SWCD	Other	Stream Monitoring	Monitoring	Private	Jefferson	State		2002	2006-201	2	Miles	On-going	Fish Habitat	Higgins Creek		Monitoring Higgins Creek for changes instream due to projects and/or events occurring along the stream.		Pending

Table I.2. Existing Restoration, Conservation Projects

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
102	Jefferson SWCD	Other	Watershed Analysis Printing Project	Other	Private	Jefferson	State	$1,000-$5,000	1999				Complete		Willow Creek		Publish 100 Willow Creek Watershed Analysis documents		Complete
103	Jefferson SWCD	Other	Feral Swine Control	Other	Private	Jefferson	State	$5,000-10,000	2001				Complete				Eradicate Feral pigs to help reduce soil erosion and habitat destroyed by pigs in Jeff. And Wasco Co.		58 Feral Pigs eradicated.
104	Jefferson SWCD	Other	Willow Creek Monitoring supplies	Other	Private	Jefferson	State	$10,000-$25,000	1999				On-going		Willow Creek		Purchase supplies to assist with continued montoring of Willow Creek.		Successfully completed.
105	Jefferson SWCD	Other	Plantings	Other	Private	Jefferson	State	$1,000-$5,000	1999		2	Miles	Complete	Fish Habitat	Willow Creek		Purchase native plantings for riparian restoration after 2 miles fencing placed to keep livestock from having grazing access.		Successfully completed.
106	Jefferson SWCD	Other	Monitoring Equipment	Other	Private	Jefferson	State	$5,000-10,000	1998	2011+			On-going	Fish Habitat	Willow Creek		Purchase 5 temp. data loggers and software that will be used by the local high school class to monitor temperatures throughout Willow Creek.		Monitoring is ongoing.
107	Jefferson SWCD	Other	Infiltration Galleries	Other	Private	Jefferson	Federal	$50,000 each	1998	2003			Complete	Fish Habitat	Trout Creek		Eliminate 11 push up dams and replace with infiltration galleries		Successfully completed.
108	Jefferson SWCD	Other	Sprinkler System	Other	Private	Jefferson	Federal	$100,000-$500,000	2000	2006-201	217	Acres	Complete	Water Quality	Trout Creek		Converting from flood irrigation to sprikler irrigation		Project completed, monitoring is ongoing.
109	Jefferson SWCD	Other	Streamside Restoration	Other	Private	Jefferson	State	$50,000-$100,000	1999	2005	.25	Miles	Complete	Riparian/Wetland Habitat	Trout Creek		Stream Bank stabilization to improve fish habitat and water quality.		Project successfully completed, monitoring ongoing.
110	Jefferson SWCD	Other	Riparian Fencing	Stream Bank Restoration	Private	Jefferson	State	$10,000-$25,000	1998	2004	2	Miles	Complete	Riparian/Wetland Habitat	Willow Creek		Riparian fencing installed on both sides of stream to exclude livestock		Project completed, monitoring ongoing.
111	Jefferson SWCD	Other	Solar Powered Off-Site Watering Facility	Stream Bank Restoration	Private	Jefferson	State	$5,000-10,000	2000	2005			Complete	Riparian/Wetland Habitat	Willow Creek		Solar powered off-site watering facility for livestock excluded from riparian area.		Project completed, monitoring ongoing.
112	Jefferson SWCD	Other	CREP	Stream Bank Restoration	Private	Jefferson	State	$100,000-$500,000	2002	2011+	3860	Feet	On-going	Riparian/Wetland Habitat	Trout Creek		Riparian fencing installed on both sides of stream to exclude livestock, off-site watering facility, spring development, plantings.		Fencing completed, remaining practices pending
113	Jefferson SWCD	Other	CREP	Stream Bank Restoration	Private	Jefferson	State	$100,000-$500,000	2003	2011+	5	Miles	Not Startec	Riparian/Wetland Habitat	Amity/Board Hollow Creeks		Riparian fencing installed on both sides of stream to exclude livestock, off-site watering facility, spring development, plantings.		To begin spring of 2003
114	Jefferson SWCD	Other	Wetland Enhancement	Wetland Restoration	Private	Jefferson	State	$25,000-$50,000	1999	2003	23	Acre/ft	Complete	Riparian/Wetland Habitat	Newbill Creek				
115	Jefferson SWCD	Other	Riparian fencing/well	Stream Bank Restoration	Private	Jefferson	State	$25,000-$50,000	1999	2003	4.5	Miles	Complete	Riparian/Wetland Habitat	Tenmile Creek/Tourt Creek/Deschutes R.		Livestock Exclusion and water gap removal from creeks and river. Well for livestock watering.		Project Completed.
116	Jefferson SWCD	Other	Sediment Retention Dams	Other	Private	Jefferson	Other	$10,000-$25,000	2003	2005			Not Startec	Water Quality	Trout Creek		Sediment retention from runoff.		To begin spring of 2003
117	Jefferson SWCD	Other	Irrigation System Buried Mainline	Other	Private	Jefferson	Federal	$10,000-$25,000	1999	2003	4340	Feet	Complete		Trout Creek		Buried Mainline		Project Completed. Project Completed
118	Jefferson SWCD	Other	Berm Removal/Channel Reconstruction	In-stream Flow Restoration	Private	Jefferson	Federal	>$500,000	2003	2011+	8	Miles	Not Startec	Riparian/Wetland Habitat	Trout Creek		Remove channel straightening and "flood control" berms installed in 1965. Construct new channel, create new floodplain, and plant riparian forest buffer.		Proposed to be started in 2003
119	Jefferson SWCD	Other	Pond - EQIP	Other	Private	Jefferson	Federal	$5,000-10,000	2000	2003			Complete		Trout Creek		Pond - EQIP		Project Completed.

Table I.2. Existing Restoration, Conservation Projects

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description	Results
120	North Unit Irrigation District	Special	Main Canal Lining	In-stream Flow Restoration	Private	Deschutes	Local	>$500,000	Prior to 1	1998	11.5	Miles	Complete	Water Quantity		Blue	Lined 11.5 Miles of main canal.	Reduced water loss by approx. 20300 acre/ft. per year. Water went back to N. Unit ID.
121	North Unit Irrigation District	Special	Silt Pond Removal/ Canal Lining	In-stream Flow Restoration	BLM	Deschutes	Other , Mu	$100,000-$500,000	2003	2003	1300	Feet	Complete	Water Quantity		Blue and	Lined 1300 feet of main canal and removed old silt pond. Silt pond was no longer needed. It was built to catch logging debris from mills. It was being used as a party place.	Project just completed; no results.
122	North Unit Irrigation District	Special	51-4 Piping Project`	In-stream Flow Restoration	Private	Jefferson	Other, Mu	$100,000-$500,000	1998	2001	27000	Feet	Complete	Water Quantity		Blue and	Piped 27000 ft. of canal 51-4. 598 acft of water were conserved.	Conserved water by lining canal. Half of conserved water went to N. Unit ID and half went instream.
123	North Unit Irrigation District	Special	58-1 Piping Project	In-stream Flow Restoration	Private	Jefferson	Federal	$100,000-$500,000	2003	2004	17000	Feet	On-going	Water Quantity		Blue, Yell	Piping total of 17000 feet of canal.	Project underway, no results.
124	North Unit Irrigation District	Special	L-52 Piping Project	In-stream Flow Restoration	Private	Jefferson	Other	$100,000-$500,000	Prior to 1	1997	12600	Feet	Complete	Water Quantity		Blue	Piped 12600 feet of lateral canal (L-52). Conserved 433 acft of water.	Conserved water. Half of conserved water went to N. Unit ID and half went instream.
125	Upper Deschutes Watershed Council	Private	Trapper Creek	Instream Habitat Restoration	Federal	Klamath	State	$50,000-$100,000	2002	2003	2000	Feet	On-going	Fish Habitat	Trapper Creek		Bull Trout spawning habitat restoration on Odell Lake	
126	Upper Deschutes Watershed Council	Private	Log Deck Park Riparian/Wetland Rest.	Wetland Restoration	Other Fede	Deschutes	State	$50,000-$100,000	2003	2005	2600	Feet	Not Startec	Riparian/Wetland Habitat	Deschutes River		Wetland and riparian area enhancement/restoration at Log Deck park, Bend.	
127	Upper Deschutes Watershed Council	Private	Alder Springs Road Obliteration	Instream Habitat Restoration	Other Fede	Jefferson	State	$50,000-$100,000	2001	2003	2000	Feet	Complete	Upland Habitat	Squaw Creek		Road restoration to manage sediment input into lower Squaw Creek.	
128	Upper Deschutes Watershed Council	Private	Sunriver Fish habitat enhancement	Instream Habitat Restoration	Private	Deschutes	State	$50,000-$100,000	2000	2003	3.5	Miles	Complete	Fish Habitat	Deschutes River		Large woody material placement in-stream to enhance fish habitat.	
129	Swalley Irrigation District	Special	New Fish Screen	Fish Passage Improvements	Private	Deschutes	Private	$50,000-$100,000	2003	2005			Not Startec	Fish Habitat	Deschutes River		Swalley curently has a fish screen that needs to be replaced to meet state or federal guidelines. The district is aware of this and is planning on doing this work in the near future.	Improved screening to prevent/reduce the number of fish entering the irrigation canal system.
130	Swalley Irrigation District	Special	Piping Study	Agricultural/Rangeland Improvement	Private	Deschutes	Other	>$500,000	2001	2003			On-going	Fish Habitat	Deschutes River		City of Bend is paying Swalley to complete an engineering study to pipe approx. 6 mi. of main canal for use by city for mitigation credits that can be used by them to drill a well. The water saved will remain in the middle Des. & benefit stream/habitat.	Study nearly complete. Once finished, Swalley will meet with the city to determine the next step and related funding issues.
131	Tumalo Irrigation District	Special	Tumalo Creek Irrigation	In-stream Flow Restoration	Usfs and P	Deschutes	Federal ar	>$500,000	Prior to 1	1994	12	Miles	Complete	Water Quantity	Tumalo Creek		Abandoned 9 miles of Upper Columbia Southern canal and restored water to 12 miles of Tumalo Creek by relocating the diversion	12 miles of restored stream, 20cfs saved in transmission loss went back to district.
132	Tumalo Irrigation District	Special	Red Rock Siphon	In-stream Flow Restoration	Private	Deschutes	Federal ar	>$500,000	Prior to 1	1995	890	Feet	Complete	Water Quantity			Replaced leaky wood pipe and replaced with new pipe.	saved 5-6 cfs back to district.
133	Tumalo Irrigation District	Special	Flume #4	In-stream Flow Restoration	Private	Deschutes	Local	>$500,000	2001	2001	470	Feet	Complete	Water Quantity			Removed leaky wooden flume replaced with underground steel pipe.	Saved 5-6 cfs back to district.
134	Tumalo Irrigation District	Special	Webber	In-stream Flow Restoration	Private	Deschutes	Federal ar	>$500,000	1999	2000	690	Feet	Complete	Water Quantity			Removed leaky wooden flume, replace with 84" steel pipe	1-2 cfs back to district.
135	Tumalo Irrigation District	Special	Kipple	In-stream Flow Restoration	Private	Deschutes	Federal ar	$100,000-$500,000	1999	2000	690	Feet	Complete	Water Quantity			Removed leaky wooden flume, replace with 84" steel pipe	
136	Tumalo Irrigation District	Special	Telemetry	Monitoring	Multiple	Deschutes	Federal	$100,000-$500,000	1999				On-going	Water Quantity			Installing telemetry equipment at the head and tail of diversions across the district.	More accurate measurements will result in more precision diversions.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
137	Tumalo Irrigation District	Special	Pipeline 3B	In-stream Flow Restoration	Private	Deschutes	Federal an	>$500,000	2002	2002	1	Miles	Complete	Water Quantity			Piped one mile of canal using 84" plastic pipe.		10 cfs saved back to district.
138	Tumalo Irrigation District	Special	Pipeline 2B	In-stream Flow Restoration	Private	Deschutes	Other	>$500,000	2000	2000	1100	Feet	Complete	Water Quantity			Piped 1100 feet of leaky canal		saved 3 cfs back to district.
139	Tumalo Irrigation District	Special	River's Edge piping	In-stream Flow Restoration	Private	Deschutes	Federal an	>$500,000	2003	2003	1200	Feet	Complete	Water Quantity			Piped 1200 feet of leaky canal		Saved 5cfs back to district.
140	Tumalo Irrigation District	Special	Bend Feed Canal	In-stream Flow Restoration	Private	Deschutes	Local	$100,000-$500,000	1999	1999	1200	Feet	Complete	Water Quantity			Piped 1200 feet of leaky canal.		Saved 5 cfs back to district.
141	Tumalo Irrigation District	Special	Davis Linder pipeline	In-stream Flow Restoration	Private	Deschutes	Federal an	$100,000-$500,000	Prior to 1	1998	2.75	Miles	Complete	water Quantity			Piped 2.75 miles of leaky canal. Linder pipeline was 2 miles, Davis Fill Lateral was 3/4 mile.		3 cfs saved back to district.
142	Tumalo Irrigation District	Special	Highland Project	In-stream Flow Restoration	Private	Deschutes	Private an	$1,000-$5,000	2002	2002	.25	Miles	Complete	Water Quantity			Piped a quarter mile of leaky canal and metered it.		1cfs saved back to district.
143	Oregon Dept. of Transportation	State	Crooked River Mitigation	Wetland Restoration	County	Crook	Federal	$100,000-$500,000	2003	2005	5	Acres	Not Started	Riparian/Wetland Habitat	Crooked River	crooked	Expansion of existing wetlands adjacent to the Crooked, removal of grazing from wetland areas.		pending; plan is to have approx. 5-10 acres of emergent wetlands and restored riparian habitat.
144	Oregon Dept. of Transportation	State	Culver Railroad Crossing	Wetland Restoration	County	Jefferson	Federal	$100,000-$500,000	2003	2004	.13	Acres	Not Started	Riparian/Wetland Habitat		lower	Removal of roadbed to restore underlying wetlands and reconnect two wetlands.		restoration of small wetland area and creation of one continuous wetland.
145	Oregon Dept. of Transportation	State	Riley bridge	In-stream Flow Restoration	State	Deschutes	Federal	$100,000-$500,000	2003	2005	300	Feet	Not Started	Water Quality	North Unit Main Canal	Upper	Pipe canal where it passes under US 97		portion of canal is piped.
146	Oregon Dept. of Transportation	State	Biggs-Wasco	Stream Bank Restoration	State	Sherman	Federal	$100,000-$500,000	2003	2005	500	Feet	Not Started	Riparian/Wetland Habitat	Spanish Hollow	Lower	installation of biostabilization consisting of seed filled sandbags, willow cuttings, and vegetated cribwalls.		currently unstable streamside slopes will be stabilized with combination of primitive structures, plantings and seeding.
147	Oregon Dept. of Transportation	State	Butler Canyon Quarry restoration	Road Abandonment/Restoration	Private	Wasco	State	$5,000-10,000	2002	2003	1	Acres	Complete	Fish Habitat	Butler Canyon Creek	Lower	Project involved decommissioning a stream crossing within the quarry and rehabilitating the streamband and channel in the area.		Rehab has taken and channel is flowing well. Habitat has been restored to reflect surrounding area.
148	Oregon Dept. of Transportation	State	OR 216 Shoulder Repair	Stream Bank Restoration	Tribal	Wasco	State	$1,000-$5,000	2003	2003	.1	Acres	Not Started	Riparian/Wetland Habitat	Winter Water Creek	Lower	Shoulder of road eroding and pavement is undercut, crumbling. To rebuild slop and stabilize road bed. No work will be done below the high water mark and no impacts to existing riparian veg expected. Rehab will involve willow planting for addtl stabliza		No construction yet.
149	US Fish and Wildlife Service	Federal	Lower Crooked R. Channel Restoration	Stream Bank Restoration	Private	Crook	Federal	$50,000-$100,000	2003	2003	6	Miles	On-going	Water Quality	Lower Crooked River`	Upper	Lower Crooked river channel restoration coordinated by Crooked R Watershed council: DRC, OWEB and ODFW major contributors.		improved water quality.
150	US Fish and Wildlife Service	Federal	Juniper Removal	Upland Habitat Restoration	Private	Crook	Federal	$5,000-10,000	2003	2003	250	Acres	On-going		Upper Crooked River Basin	Crooked	removal of juniper		upland habitat restoration.
151	US Fish and Wildlife Service	Federal	Opal Springs Dam Fish Ladder	Fish Passage Improvements	Private	Jefferson	Other	$100,000-$500,000	2002	2005	70	Miles	Not Started	Fish Habitat	Crooked River	upper	Fish ladder for upstream passage, which is needed to complement upsteam/downstream passage and anadromous reintroduction a the Pelton Round Butte hydro project downstream.		upsteam passage to 70 miles of the Crooked River for bull trout, steelhead, chinook salmon and other species.
152	Oregon Dept. of Fish and Wildlife	State	Wickiup Bioengineering Project	Stream Bank Restoration	USFS	Deschutes	Multiple	$50,000-$100,000	2001	2002	1000	Feet	Complete	Water Quality/Fish Habitat	Deschutes R.		Placed lg. Woody material, org. matting, willow, sedges and spirea along 1000 ft. of eroding sterambank on the Des. R.(1/2 mile from Wickiup dam) to increase streambank stability. Adjacent uplands were planted with 500 ponderosa pine seedlings.		Unknown at present.

Table I.2. Existing Restoration, Conservation Projects

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
153	Oregon Dept. of Fish and Wildlife	State	Beith Fish Habitat Restoration Project	In-stream Habitat Restoration	Private	Deschutes	Multiple	$1,000-$5,000	2001	2001	1000	Feet	Complete	Water Quality/Fish Habitat	Deschutes R.		Installed 25 trees instream to provide fish habitat and reduce erosion adjacent to a steep 30 foot high bank.		Project is successfully reducing erosion. Monitoring over next 5 yrs. Will determine if this is a permanent solution.
154	Oregon Dept. of Fish and Wildlife	State	Austin Fish Habitat Restoration Project	In-stream Habitat Restoration	Private	Deschutes	Other	$5,000-10,000	2001	2001	300	Feet	Complete	Water Quality/Fish Habitat			Installed 7 large trees instream to reduce erosion and provide habitat.		Several tons of sediment have been trapped and creek channel has moved away from bank by 8-10 ft.
155	Oregon Dept. of Fish and Wildlife	State	Sunriver I	In-stream Habitat Restoration	Multiple	Deschutes	Multiple	$1,000-$5,000	Prior to 1	2002	7	Miles	Complete	Water Quality/Fish Habitat	Deschutes R.		Objective was to restore bank stability and fish habitat from Harper Bridge to Sunriver Marina by planting nearly 5000 willows and placing 300 whole trees along the banks of both sides of a 3.5 mile stretch of the Deschtues.		Hundreds of tons of sediment have been deposited at the project site. Success of planting was varied.
156	Oregon Dept. of Fish and Wildlife	State	La Pine State park Willow Planting	In-stream Habitat Restoration	State	Deschutes	Multiple	<$1,000	Prior to 1	2001	8	Miles	Complete	Water Quality/Fish Habitat	Deschutes, Little Des?		Experiment with willow plating on a medium slope area with a gravel toe. 900 willow stakes were planted in 2001 along 4 miles of river on both sides. Trees were placed on streambank in 1997.		Success varied from 5% to 25% depending on location. Trees that were placed in 1997 need to be repositioned because they are not diverting water.
157	Oregon Dept. of Fish and Wildlife	State	Odell Creek Phase I & II	In-stream Habitat Restoration	USFS	Deschutes	Multiple	$1,000-$5,000	2001	2001	3500	Feet	Complete	Water Quality/Fish Habitat	Odell Creek		Replace cable that rusted out and pull wood back to the cahnnel that floated away from projects that occurred in '92 and '94. Each phase treated 1500 ft of creek.		Cable was successfully replaced. Wood was noit moved due to equipment problems. Time ran out and fish were spawning by the time equipment was available.
158	Oregon Dept. of Fish and Wildlife	State	Oldham Sedge Planting	In-stream Habitat Restoration	Private	Deschutes	Other	$1,000-$5,000	2001	2001	700	Feet	Complete	Water Quality/Fish Habitat	Deschutes R.		Planted 416 sedge clumps along 700 ft. of one side of Des. R.		Vegetation restoration of the site is complete. Final step will be to add more woody debris.
159	The Nature Conservancy	Private	Juniper Burn	Upland Habitat Restoration	Private No	Crook	Federal	$1,000-$5,000	1999	2003	30	Acres	Complete	Upland Habitat	Lost Creek		A cooperative fall prescribed burn was completed with BLM. Objective to reduce juniper population.		Monitoring results show that small junipers were reduced. However in areas where the fire burned, cheatgrass increased on site.
160	The Nature Conservancy	Private	USFS north boundary fire	Upland Habitat Restoration	Private No	Crook	Federal	$1,000-$5,000	2000	2003	300	Acres	Complete	Upland Habitat	Lost Creek		USFS and TNC conducted a spring prescribed burn. Objective to reduce fuel hazards.		No monitoring conducted. Unsure of results.
161	The Nature Conservancy	Private	Lost Creek Crossings	In-stream Flow Restoration	Private No	Crook	State	$5,000-10,000	2001	2003	5	Acres	Complete	Upland Habitat	Lost Creek		Creek crossings were graveled and culverts were placed.		Project seems to be reducing sediment.
162	The Nature Conservancy	Private	Noxious Weed control	Upland Habitat Restoration	Private No	Crook	Private	$1,000-$5,000	1999	2003	300	Acres	On-going	Upland Habitat	Lost Creek		TNC is controlling white top, russian knapweed and medusahead rye.		weed poplulations are drastically reduced.
163	The Nature Conservancy	Private	Ungulate exclosures	Instream Habitat Restoration	Private No	Crook	Federal	$25,000-$50,000	2001	2003	9	Acres	Complete	Riparian/Wetland Habitat	Lost Creek		Junipers were cut along steam to help protect deciduous woody vegetation. Five elk exclosures were built to protect riparian habiatat and allow for recovery. Some planting was included.		Vegetation is beginning to recover.
164	The Nature Conservancy	Private	head cut repair	Stream Bank Restoration	Private No	Crook	State	<$1,000	2001	2003	200	Feet	Complete	Riparian/Wetland Habitat	Lost Creek		A small headcut on Lost creek with a less than 3 ft drop was repaired using fiber mat and veg. The project was conplete with volunteers in a day. TNC hired a consultant.		The project has held for 2 seasons now. Looks successful.
165	The Nature Conservancy	Private	Junipers removed from springs	Upland Habitat Restoration	Private No	Crook	State	$1,000-$5,000	2002	2003	10	Acres	Complete	Upland Habitat	Lost Creek	4 sites	Junipers were cut and removed from 10 springs.		vegetation is beginning to recover.
166	The Nature Conservancy	Private	Juniper removal from aspen groves	Upland Habitat Restoration	Private No	Crook	State	<$1,000	2002	2003	8	Acres	Complete	Riparian/Wetland Habitat	Lost Creek	3 sites	There are 3 aspen patches found on the Juniper Hills preserve. Junipers were removed from within and around the stands.		Vegetation is recovering.

Table I.2. Existing Restoration, Conservation Projects

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
167	The Nature Conservancy	Private	Junipers removed from creek	Stream Bank Restoration	Private No	Crook	State	$1,000-$5,000	2002	2003	30	Acres	Complete	Upland Habitat	Lost Creek		Junipers were cut and removed on 30 ft each side of a trib of Lost Creek.		Vegetation is beginning to recover.
168	The Nature Conservancy	Private	Mechanical Juniper removal studay	Upland Habitat Restoration	Private No	Crook	State	$10,000-$25,000	2002	2003	20	Acres	Complete	Riparian/Wetland Habitat	Lost Creek		We are comparing 2 removal treatments. One with handcut chainsaw, lopped and scattered branches, and large wood removed with 4 wheeler. The other was removed with a hydroax and skidder. Wood will be piled and burned.		TNC is monitoring results.
169	Oregon Dept. Of Fish and Wildlife	State	Trout Creek habitat restoration project	In-stream Flow Restoration	Private	Jefferson	Federal	$100,000-$500,000	Prior to 1	2011+	20 Strea	Miles	On-going	Fish Habitat	Low Trout Creek (below Ashwood) & Antelope Creek	Red	20 stream miles riparian fence (mostly on tribs). One mile instream work, numerous low head check dams (Sagebrush Creek).		Moderate mainstem instream recovery. Mainstem Trout Crk insteam function limited by USACE berms. Tributary recover is good with increase riparian veg. And improved width to depth ratio. Modest increase in steelhead spawning/rearing. Flow limiting fctr
170	Oregon Dept. Of Fish and Wildlife	State	Trout Creek habitat restoration project	In-stream Flow Restoration	Private	Jefferson	Federal	$100,000-$500,000	Prior to 1	2011+	30 strea	Miles	On-going	Fish Habitat	Upper Trout Creek (above Ashwood).	Yellow	30 stream miles riparian fence. Numerous log weirs, habitat boulders, and rock check dams.		Moderate mainstem recovery where berms are present. Trib recovery is good with increased riparian veg and improved width to depth ratios. Substantial increase in steelhead spawning and rearing. Instream flow still a limiting factor.
171	Bureau of Land Management	Federal	Ammons Chaining Burn	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			694	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
172	Bureau of Land Management	Federal	Sheep Mountain Burn	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			4000	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.
173	Bureau of Land Management	Federal	Flat Pasture Burn	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			595	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.
174	Bureau of Land Management	Federal	South Boundary Rx Burn (F)	Upland Habitat Restoration	BLM	Crook	Federal	$5,000-10,000			388	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.
175	Bureau of Land Management	Federal	South Boundary Rx Understory burn (G)	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			1647	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.
176	Bureau of Land Management	Federal	South Boundary Rx burn (D)	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			1194	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
177	Bureau of Land Management	Federal	South Boundary Understory burn (E)	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			105	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
178	Bureau of Land Management	Federal	South Boundary Rx Burn (B)	Upland Habitat Restoration	BLM	Crook	Federal	$1,000-$5,000			93	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
179	Bureau of Land Management	Federal	South Boundary understory burn ©	Upland Habitat Restoration	BLM	Crook	Federal	$1,000-$5,000			182	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
180	Bureau of Land Management	Federal	Studhorse II Burn	Upland Habitat Restoration	BLM	Crook	Federal	$100,000-$500,000			5381	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.

Table I.2. Existing Restoration, Conservation Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
181	Bureau of Land Management	Federal	South Boundary Understory burn (A)	Upland Habitat Restoration	BLM	Crook	Federal	<$1,000			41	Acres	Complete	Upland Habitat		BLM Map	prescribed burn		Not reported.
182	Bureau of Land Management	Federal	Gerry Mountain Burn	Upland Habitat Restoration	BLM	Crook	Federal	$100,000-$500,000			9400	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
183	Bureau of Land Management	Federal	South Dagis Burn	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			1022	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
184	Bureau of Land Management	Federal	Maupin Butte Burn	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			2977	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
185	Bureau of Land Management	Federal	Owens Juniper Cut	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			1022	Acres	Complete	Upland Habitat		BLM map	Mechanical juniper thinning		Not reported.
186	Bureau of Land Management	Federal	Liggett Table Burn	Upland Habitat Restoration	BLM	Crook	Federal	$5,000-10,000			623	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
187	Bureau of Land Management	Federal	Cave Allotment Burn	Upland Habitat Restoration	BLM	Crook	Federal	$5,000-10,000			273	Acres	Complete	Upland Habitat		BLM map	prescribed burn		Not reported.
188	Bureau of Land Management	Federal	Paulus North Fence	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$5,000-10,000			1	Miles	Complete	Upland Habitat		line Blue	fenced 1 mile.		Not reported.
189	Bureau of Land Management	Federal	pine Ridge Fence Repair	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$1,000-$5,000			5	Miles	Complete	Upland Habitat		line Blue	fenced 5 miles.		Not reported.
190	Bureau of Land Management	Federal	Millican Cattle Guards	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$10,000-$25,000			15	each	Complete	Upland Habitat		point red	installed 15 cattle guards in Millican area at $3000 each.		excluded cattle.
191	Bureau of Land Management	Federal	Sontag Fence	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$10,000-$25,000			1.5	Miles	Complete	Upland Habitat		line blue			Not reported.
192	Bureau of Land Management	Federal	South Dry Creek Fence	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$10,000-$25,000			1.5	Miles	Complete	Upland Habitat		line Blue	fenced 1.5 miles		Not reported.
193	Bureau of Land Management	Federal	Paulina Aspen Cut	Upland Habitat Restoration	BLM	Crook	Federal	$5,000-10,000			96	Acres	Complete	Upland Habitat		poly, blue	reduce juniper and pine so aspen can regenerate and provide forage and cover for wildlife.		Not reported.
194	Bureau of Land Management	Federal	Dykstra Pasture Fence	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$5,000-10,000			1.3	Miles	Complete	Upland Habitat		line blue	fenced 1.3 miles.		Not reported.
195	Bureau of Land Management	Federal	East Frederick Fence Reconstruction	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$1,000-$5,000			2	Miles	Complete	Upland Habitat		line Blue	fence construction on an allotment.		Not reported.
196	Bureau of Land Management	Federal	Fehrenbacher Fence Reconstruiciton	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$1,000-$5,000			1.5	Miles	Complete	Upland Habitat		line blue	2 fences. One is .5 miles and the other is 1 mile.		Not reported.
197	Bureau of Land Management	Federal	Burke Fence	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$5,000-10,000			1	Miles	Complete	Upland Habitat		line blue	1 mile of fence.		Not reported.
198	Bureau of Land Management	Federal	Yreka Butte Rx Burn	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			580	Acres	Complete	Upland Habitat		poly pink	prescribed burn to reduce juniper occupation and restoration of upland habitat.		Not reported.
199	Bureau of Land Management	Federal	ZX Allotment Fence Reconstruction	Agricultural/Rangeland Improvement	BLM	Crook	Federal	$25,000-$50,000			30	Miles	Complete	Upland Habitat		line blue	30 Miles of fence.		Not reported.
200	Bureau of Land Management	Federal	West Butte Juniper thinning project area	Upland Habitat Restoration	BLM	Crook	Federal	$100,000-$500,000			3306	Acres	Complete	Upland Habitat		BLM map	mechanical juniper cut		Not reported.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
201	Bureau of Land Management	Federal	Frederick Butte Burn	Upland Habitat Restoration	BLM	Crook	Federal	$10,000-$25,000			1000	Acres	Complete	Upland Habitat		poly pink			Not reported.
202	Bureau of Land Management	Federal	Upper Bear Juniper thinning project area	Upland Habitat Restoration	BLM	Crook	Federal	$100,000-$500,000			1924	Acres	Complete	Upland Habitat		BLM map	mechanical juniper cut		Not reported.
203	Bureau of Land Management	Federal	Taylor Butte Juniper thinning project area	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			1194	Acres	Complete	Upland Habitat		BLM map	mechanical juniper thinning area		Not reported.
204	Bureau of Land Management	Federal	Upper Prineville Res.Activity Plan area	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			1145	Acres	Complete	Upland Habitat		BLM map	mechanical juniper cut around prineville res.		Not reported.
205	Bureau of Land Management	Federal	Taylor Butte Thinning project area	Upland Habitat Restoration	BLM	Crook	Federal	$50,000-$100,000			1194	Acres	Complete	Upland Habitat		BLM map	#3		Not reported.
206	Bureau of Land Management	Federal	Mecca Tree Planting	Upland Habitat Restoration	BLM	Crook	Federal	<$1,000			1	Acres	Complete	Upland Habitat		point blue			Not reported.
207	Bureau of Land Management	Federal	Windy Flats Fire rehab	Upland Habitat Restoration	BLM	Jefferson	Federal	$100,000-$500,000			180	Acres	Complete	Upland Habitat		poly blue			Not reported.
208	Bureau of Land Management	Federal	Grass Valley Fire Rehab	Upland Habitat Restoration	BLM	Wasco	Federal	$50,000-$100,000			1000	Acres	Complete	Upland Habitat		poly pink and scattered			Not reported.
209	Bureau of Land Management	Federal	Harpham Flat Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$10,000-$25,000			1.5	Miles	Complete	Upland Habitat		point blue			Not reported.
210	Bureau of Land Management	Federal	Bully Point Fence	Agricultural/Rangeland Improvement	BLM	Wasco	Federal	$10,000-$25,000			5	Miles	Complete	Upland Habitat		line blue			Not reported.
211	Bureau of Land Management	Federal	King Canyon Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	<$1,000			.1	Miles	Complete	Upland Habitat		line blue			Not reported.
212	Bureau of Land Management	Federal	Criterion Boundary Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$10,000-$25,000			5	Miles	Complete	Upland Habitat		point blue			Not reported.
213	Bureau of Land Management	Federal	Trout Creek OHV Rehab project	Upland Habitat Restoration	BLM	Jefferson	Federal	<$1,000			.4	Miles	Complete	Upland Habitat		line blue			Not reported.
214	Bureau of Land Management	Federal	Wood Side Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$5,000-10,000			1	Miles	Complete	Upland Habitat		point blue			Not reported.
215	Bureau of Land Management	Federal	North Juniper camp fence	Upland Habitat Restoration	BLM	Jefferson	Federal	$1,000-$5,000			.3	Miles	Complete	Upland Habitat		point blue			Not reported.
216	Bureau of Land Management	Federal	Jones Canyon Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$5,000-10,000			1	Miles	Complete	Upland Habitat		point blue			Not reported.
217	Bureau of Land Management	Federal	Salt Springs Creek Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.5	Miles	Complete	Upland Habitat		line blue			Not reported.
218	Bureau of Land Management	Federal	Buck Hollow Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$10,000-$25,000			5	Miles	Complete	Upland Habitat		point blue			Not reported.
219	Bureau of Land Management	Federal	Trout Creek Campground Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.2	Miles	Complete	Upland Habitat		point blue			Not reported.
220	Bureau of Land Management	Federal	Criterion Spring protection fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.5	Miles	Complete	Upland Habitat		line blue			Not reported.

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
221	Bureau of Land Management	Federal	Macks Canyon campground fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.5	Miles	Complete	Upland Habitat		point blue			Not reported.
222	Bureau of Land Management	Federal	Ten Mile Fence	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.5	Miles	Complete	Upland Habitat					Not reported.
223	Bureau of Land Management	Federal	Rock Corral Spring	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.25	Acres	Complete	Upland Habitat		point red			Not reported.
224	Bureau of Land Management	Federal	Blue Gate Parking Area	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	<$1,000			.25	Acres	Complete	Upland Habitat		point red			Not reported.
225	Bureau of Land Management	Federal	Sheep Spring	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$5,000-10,000			.75	Miles	Complete	Upland Habitat		point red			Not reported.
226	Bureau of Land Management	Federal	Delude Spring	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.25	Miles	Complete	Upland Habitat		point red			Not reported.
227	Bureau of Land Management	Federal	N. Fk. Crooked R. Berm Removal	Instream Habitat Restoration	BLM	Crook	Federal	$5,000-10,000	2002		30	Feet	Complete	Fish Habitat		point red	Removal of stock pond berm and spillway channel. Floodplain reconstructed.		Not reported.
228	Bureau of Land Management	Federal	Reckman Springs	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$1,000-$5,000			.5	Miles	Complete	Upland Habitat		point red			Not reported.
229	Bureau of Land Management	Federal	BLM Cattle Guards (not millican)	Agricultural/Rangeland Improvement	BLM	Jefferson	Federal	$50,000-$100,000			30	each	Complete	Upland Habitat		point red	install 30 cattle guards in various locations @ $3000 each. BLM proj #: 737085 (3), 104, 106, 144-145, 147-152, 177,228,234, and 735104-05,107,114-117,120,122,125.		Not reported.
230	Bureau of Land Management	Federal	North Stearns Water Development	In-stream Flow Restoration	BLM	Crook	Federal	$1,000-$5,000			.5	Acres	Complete	water Quantity		line blue	storage tanks, troughs and pipelines for livestock and wildlife.		Not reported.
231	Bureau of Land Management	Federal	Brickie Pipeline	In-stream Flow Restoration	BLM	Crook	Federal	$5,000-10,000			1	Miles	Complete	water Quantity		line blue			Not reported.
232	Bureau of Land Management	Federal	Sanford Creek Road Closures	Road Abandonment/Restoration	BLM	Crook	Federal	$5,000-10,000			6	Miles	Complete	Water Quality		line red	Road closures in the Sanford creek watershed to reduce erosion and improve water quality.		Not reported.
234	Oregon Dept. of Fish and Wildlife					Deschutes		$10,000-$25,000			3000	Feet	Complete	Water Quantity					
266	Bureau of Land Management	Federal	South Stearns Pipeline	In-stream Flow Restoration	BLM	Deschutes	Federal	$5,000-10,000			1	Miles	Complete	water Quantity					
267	Squaw Creek Irrigation District	Special	Vermilyea	In-stream Flow Restoration		Deschutes		$10,000-$25,000			3000	Feet	Complete	Water Quantity	Squaw Creek		Piped 3000 feet of the 7000 foot ditch.		Conserves 50-75 acre feet per irrigation season.
268	Squaw Creek Irrigation District	Special	Brown	In-stream Flow Restoration				$50,000-$100,000			8000	Feet	Complete	Water Quantity	Squaw Creek		Eliminated 8000 feet of ditch. The 5 farms the ditch served were converted from flood to pressurized sprinklers.		Conserves 500 acre feet per irrigation season.
269	Squaw Creek Irrigation District	Special	Bartlemay Pipeline	In-stream Flow Restoration				$50,000-$100,000			7200	Feet	Complete	Water Quantity	Squaw Creek		Piped 7200 feet of ditch w/a 50% loss factor and lined 3 ponds.		Conserves 300-500 acre feet per irrigation season.
270	Squaw Creek Irrigation District	Special	Thompson	In-stream Flow Restoration				$50,000-$100,000			7000	Feet	Complete	Water Quantity	Squaw Creek		Eliminated entire Thompson ditch - 7000 feet. Changed from flood to sprinkler system.		Returned 1 cfs of 1885 senior water right & 1 cfs junior 1900 water right to Squaw Creek between SCID diversion & Deggendorfer property. Eliminated ditch losses and conserves additional water due to irrigation method change.
271	Squaw Creek Irrigation District	Special	Cloverdale	In-stream Flow Restoration				>$500,000			14880	Feet	Complete	Water Quantity	Squaw Creek		Piped 14880 feet of canal.		Conserved 6 cfs. 3 cfs dedicated to instream; 3 cfs to district farmers.

Deschutes Subbasin Inventory Projects

ID	Organization	Organization Type	Project Title	Project Type	Land Owner	County	Funding Source	Budget for Project	Project Start Date	Project End Date	Project Size	Project Units	Project Status	Limiting Factor or Eco Process Addressed	Stream Name	Mapped Color	Project Description		Results
272	Squaw Creek Irrigation District	Special	Schead	In-stream Flow Restoration				$25,000-$50,000			8000	Feet	Complete	Water Quantity	Squaw Creek		Piped 8000 feet of open ditch using HDPE ADS pipe.		Conserved 200-300 acre feet per irrigation season.
273	Squaw Creek Irrigation District	Special	B-Ditch	In-stream Flow Restoration			Private	$10,000-$25,000			6000	Feet	Complete	Water Quantity	Squaw Creek		Piped 6000 feet of a 7000 foot ditch using culverts and PVC pipe.		Conserved 200-300 acre feet per irrigation season.
274	Squaw Creek Irrigation District	Special	Fryrear	In-stream Flow Restoration	Multiple			>$500,000			19000	Feet		Water Quantity	Squaw Creek		Piped 19,000 feet of Fryrear Ditch which serves 475 acres.		Conserved estimated 600 acre feet per season and return a flow rate of 1.5 cubic foot per second to Squaw Creek.
275	Squaw Creek Irrigation District	Special	McKenzie Canyon/Black Butte Canal	In-stream Flow Restoration				>$500,000						Water Quantity	Squaw Creek				Permanent transfer of 1.2 cfs of water to Squaw Creek.

Table I.2. Existing Restoration, Conservation Projects

Management Plan

"Management and restoration programs for native salmonids have a fundamental requirement: They must work in concert with the natural strengths of the fishes that compose the native community and the natural processes that form and maintain the habitats required by those communities"

J. Lichatowich et al. 1998. A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River.

The Management Plan consists of five elements described in the Council's program: 1) a vision for the subbasin; 2) biological objectives; 3) strategies; 4) research, monitoring and evaluation; and 5) consistency with the Endangered Species Act and Clean Water Act. In addition, the management plan provides a conceptual foundation for the Deschutes Subbasin. While the vision is a policy choice about how the subbasin will be managed in the future, the conceptual foundation reflects the information provided in the assessment and frames this information to provide an understanding of the ecological conditions in the subbasin that must be considered in the management plan.

The management plan is part of the Deschutes Subbasin Plan, which is a living document. It reflects the current understanding of conditions in the Deschutes watershed. This understanding — as well as the biological objectives, management strategies and actions based on this understanding — will be updated through an adaptive management approach that includes research and evaluation. The management plan will be reviewed and approved by the Northwest Power and Conservation Council, and will act as a draft amendment to the Council's Columbia Basin Fish and Wildlife Program.

1. Vision for Deschutes Subbasin

The Vision describes the desired future condition for the subbasin. Crafted by the Deschutes Coordinating Group, it incorporates the conditions, values and priorities of a wide spectrum of stakeholders in the Deschutes Subbasin. The vision for the Deschutes Subbasin also is consistent with and builds from the vision described in the Northwest Power and Conservation Council's Columbia River Basin 2000 Fish and Wildlife Program.

The Vision for the Deschutes Subbasin is:

> *To promote a healthy, productive watershed that sustains fish, wildlife and plant communities as well as provides economic stability for future generations of people. An inclusive consensus-based process will be used to create a plan for the achievement of sustainable management of*

> *water quality standards, instream flows, private water rights, fish and wildlife consistent with the customs and quality of life in this basin.*

This vision of the Deschutes Subbasin framed the development of the biological objectives and thereby the strategies that are incorporated to change conditions within the subbasin.

2. Conceptual Foundation

Purpose

This Conceptual Foundation summarizes the underlying ecological conditions that define how salmonid and lamprey producing ecosystems in the Deschutes watershed function. A scientific foundation, it sets the stage for identifying key factors that influence fish and wildlife populations in the basin, and for determining appropriate solutions. It recognizes that fish and wildlife are part of the physical and cultural landscape, and that by understanding how ecosystem functions affect the vitality of fish and wildlife populations, we can better define steps needed to sustain a productive ecosystem that will support these populations.

The term conceptual foundation may have best been described by Jim Lichatowich (1998) in his report *A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River*. He compares a conceptual foundation to the picture that comes with a jigsaw puzzle. This picture, usually on the box lid, illustrates what all the pieces will look like when placed in their proper order. Each piece of the puzzle is a small data set containing information, which is interpreted by continually comparing or referencing back to the picture. Assembling the puzzle without the guidance of the picture, or with the wrong picture, would be extremely difficult if not impossible (Lichatowich et al. 1998).

Our foundation builds on the work by Lichatowich (1998). It is also consistent with the foundation and scientific principles for the larger Columbia River Basin as defined in the Northwest Power Planning Council's 2000 Fish and Wildlife Program. Actions taken in the subbasin to fulfill the vision for the Deschutes Subbasin will be consistent with, and based upon, these principles. While the vision is a policy choice about how the subbasin will be managed, the scientific foundation describes our best understanding of the biological realities that will ultimately determine the success of various resource management solutions.

A Conceptual Foundation for the Deschutes Subbasin

The following principles reflect the more detailed description of population and environmental characteristics in the Deschutes Subbasin, as discussed in the subbasin assessment. The descriptions of these characteristics, and the relationships between them, provide the raw material for a conceptual foundation. The guiding principles identified in this section highlight the key elements of a conceptual foundation for the Deschutes ecosystem.

Guiding Scientific Principles

The following principles, and discussion shown in italics under each of the principles, describe our understanding of the Deschutes subbasin ecosystem. These principles build on the work conducted by Lichatowich et al. (1998). Together, they provide a foundation for identifying effective management strategies needed to reach our objectives for rebuilding fish and wildlife populations in the Deschutes River Subbasin.

1. **Fish and wildlife populations in the Deschutes Subbasin have complex life histories that respond to the subbasin's considerable variation in habitat conditions. Such diversity promotes production and long-term persistence at the species level and must be protected.**

   Aquatic habitats in the Deschutes subbasin vary from small and large runoff streams with extremely dynamic habitat parameters to small and large perennial spring-driven streams. The presence of both natural lakes and man-made reservoirs adds to the diversity. The terrestrial landscape varies from the high cascades above timberline with high precipitation to lower elevation, semi-arid landscapes with high solar input. With different elevations, exposures, slopes, soil types and associated ecotypes, tremendous potential exists. With this diversity, the challenge of resource plans is to allow natural expression of ecosystem potential and allow access for individuals and populations between productive habitat areas.

2. **The Deschutes Subbasin is part of a coevolving natural—cultural system. Suitable ecosystem attributes can be achieved by managing human interference in the natural habitat forming processes.**

   Humans often view themselves as separate and distinct from the natural world. Still, we play an integral role in the shaping of our ecosystem. Our actions have a pervasive impact on the structure and function of ecosystems, while at the same time, our health and well-being are tied to these conditions.

   Human practices in the Deschutes watershed since the mid-1850s have weakened the natural biophysical processes that create and maintain healthy habitats. Today, however, more people are aware of how different land and water management actions influence stream habitats and overall watershed health, and are changing their practices. Increased efforts to restore watershed health and conserve water will allow recovery of natural habitats. Thus, the recovery of fish and wildlife populations in the subbasin depends on the extent to which we chose to control our impacts on natural habitat forming processes.

3. **Productivity of focal fish species requires a network of complex interconnected habitats.**

   Many fish and wildlife populations in the Deschutes subbasin rely on a network of connected habitats during different life stages and times of year. Summer steelhead using eastside habitats — such as in Trout, Bakeoven and Buck Hollow creeks — adjusted to flow and temperature constraints by migrating and spawning earlier than steelhead returning to the lower Deschutes River westside tributaries. Juvenile salmonids in eastside tributaries particularly relied on deep natural pools, pools associated with beaver dams, and other coldwater refuge areas to escape higher summer water temperatures. Good connectivity between different habitat areas also made it possible for fish populations to weather *natural changes in habitat quality, and to escape to more suitable habitat when problems occurred.*

In systems such as the Deschutes subbasin, much of the biological diversity within species is expressed at the margins of the habitats for each species. Thus, to maintain this diversity it is extremely important to maintain marginal habitats. The individuals able to persist in these habitats provide a source of strength for the species should these marginal habitats become more widespread with climate change or normal variation.

4. **There is a physical connection between the upper and lower Deschutes Subbasin. Changes in land and water uses in the upper watershed could affect the stability of the lower river environment, and thus the distribution and performance of native salmonids. Potential impacts must be understood and considered.**

   Much is known about the unique hydrological regime that characterizes the Deschutes Subbasin, but there are many questions remaining regarding the relationship between water lost through leakage in upper subbasin irrigation canals and the effects on the lower Deschutes River when new allocations are proposed in conjunction with conservation methods. The reduction in canal leakage will have a complimentary reduction in flow of the springs in the Crooked River and Deschutes Rivers above Lake Billy Chinook. However, the flow below the Pelton Round Butte Complex will only be reduced if new water appropriations are allocated based on those conservation practices. Understanding the effects of present and past impacts of human actions is key to planning and future habitat restoration efforts.

5. **Activities outside the Deschutes Subbasin can have tremendous influence on salmonid production and genetics. Potential impacts of out-of-subbasin programs must be considered and addressed.**

   Development and operation of the Columbia River hydropower system negatively affects salmon and steelhead production and opportunities for recovery in the Deschutes subbasin. The effects of these operations must be recognized, reflected in established subbasin biological objectives, and addressed simultaneously with restoration actions in the subbasin.

   Out-of-basin stray hatchery origin summer steelhead from upper Columbia River hatcheries have out-numbered Deschutes steelhead for more than ten years. The large influx of out-of-subbasin stray summer steelhead may be contributing significant amounts of maladapted genetic material to the wild summer steelhead population in the lower Deschutes River subbasin. The cumulative effect of this genetic introgression may contribute to lowered productive capacity of the wild population as evidenced by low run strength of wild summer steelhead through time.

3. Key Findings, Biological Objectives and Management Strategies

3.1. Overall Planning Direction

During the assessment, it became apparent that it will take several decades to achieve the needed level of habitat recovery in many parts of the Deschutes Subbasin. Because the ecosystem's semi-arid nature, geology and vegetation restrict the pace of habitat restoration, remedial measures implemented to restore vegetative diversity and recovery of stream channel stability and diversity will require many years or decades to achieve the desired objective. Consequently, planners selected a planning horizon of 25 years for meeting subbasin objectives, instead of the horizon of 10 to 15 years suggested by the Council. This extended recovery period is particularly important for potential restoration of riparian and floodplain function, as well as channel aggradations. In some cases, earlier progress toward recovery of focal fish species will be made. Restoration of fish passage at manmade obstructions or unusual debris jams will frequently produce rapid response when fish begin to access historical fish habitat. The time required to implement these remedial fish passage projects could be substantially less than the time required for stream or upland habitat recovery to produce measurable increases in fish production.

3.1.1. Priority Reaches and Project Areas

During the subbasin assessment process, planners and resource managers concluded that for depressed, fragmented or isolated resident focal fish populations the most effective habitat and population restoration strategy would be to begin with recovery of core populations and core habitat. They identified key stream reaches that provide core habitat for focal fish species, including important spawning and rearing habitat, and important habitat for ESA-listed species. These stream reaches, or conservation reaches, were earmarked as high priority reaches during the EDT and QHA analyses (Map 28). The team determined that these stream reaches deserve high priority protection because of their importance in meeting desired biological objectives during the planning horizon. Further, 21 of the high priority protection reaches were identified as high candidates for future monitoring and evaluation (Map 26). These 21 reaches display desired stream habitat conditions for the Deschutes Subbasin and will serve as reference reaches for monitoring and evaluation. These high priority protection reaches and reference reaches are identified and discussed in the Syntheses and Interpretation Section of the Assessment.

The fish technical team also identified stream reaches with high restoration value to focus future habitat restoration. Restoration of these reaches is needed to meet biological objectives within the planning horizon. These determinations reflected historical focal fish species use and potential for increasing focal fish production, distribution and re-establishing population connectivity. Further, the team identified ten high priority fish habitat restoration projects or scenarios that deserve immediate attention. These reaches, which are also identified and discussed in the Syntheses and Interpretation Section of the Assessment, are:

1. Trout Creek Fish Habitat Restoration Project
2. Squaw Creek Instream and Riparian Habitat Restoration Project

3. Middle and Upper Deschutes River Instream and Riparian Habitat Restoration Project
4. Lower Crooked River Instream and Riparian Habitat Restoration Project
5. Lake Creek and Link Creek Fish Passage Improvement Project
6. North Fork Crooked River Instream and Riparian Habitat Restoration Project
7. Beaver Creek Instream and Riparian Habitat Restoration Project
8. Tygh and Badger Creek Habitat Restoration Project
9. Lower Deschutes River Instream and Riparian Habitat Restoration Project
10. Pelton Round Butte Fish Passage Restoration Project

Overall Strategy for Habitat Restoration

Conclusions reached during the assessment formed the bases for an overall strategy to direct habitat restoration work in the subbasin. Under this strategy, habitat restoration will center on improving and expanding conditions for focal species in core habitats. The following direction will focus habitat restorations in the subbasin:

- Core habitats will be expanded downstream to build on the benefits of preceeding restoration work.
- In areas where headwaters are degraded — or where the system is influenced by flashy or uncontrolled stream flows — habitat restoration for focal fish populations will take place progressively from the upper-most degraded reaches downstream, and restoration projects will include upland restoration work to maintain a ridge top-to-ridge top approach.
- Where headwater areas are in good condition, habitat restoration will begin in at the upper end of a degraded priority reach and work progressively downward.
- In areas where the system is hydrologically stable and habitat restoration is not at risk of loss from an uncontrolled flow situation, the most cost effective habitat restoration opportunities for restoring core fish populations may exist in lower watersheds. In such cases, these projects should be pursued, especially when opportunities become available to work with cooperating landowners.

3.1.2. Management Plan Development

During the subbasin planning process, work sessions were held in different parts of the Deschutes Subbasin to develop key sections of the management plan. State and tribal fish managers, natural resource specialists, landowners, irrigation district representatives, city personnel and others — people who were often very familiar with the populations and/or habitat conditions in a particular drainage — participated in these sessions. The purpose of these meetings was to receive feedback on findings generated from the EDT and QHA analyses, and to refine biological and habitat objectives and management strategies for protection and restoration of focal fish and wildlife species.

Before each meeting, members of the subbasin planning team developed a list of potential biological objectives and strategies that would lead to restoration of focal species in particular assessment units. These lists reflected the findings from the EDT and QHA analyses, and were distributed to potential meeting participants before each meeting. The work sessions began with a review of the results from the EDT and QHA analyses, including ratings showing reaches in highest need of restoration or protection. Following this review, the participants refined the draft lists of key findings, biological objectives and management strategies to best reflect the on-the-ground conditions and needs in particular subbasin drainages. Information received during the work sessions formed the cornerstones for development of biological and habitat objectives and needed management strategies in the different assessment units.

The following lists of key findings, biological objectives and management strategies were generated based on results from the EDT, QHA and IBIS analyses, and information received during the work sessions. They are supported by information presented in the Assessment. Unfortunately, the tight timeline for this subbasin planning process restricted the review and refinement of these lists. It also restricted the participation of some people who wanted to join the work session but had schedule conflicts. Consequently, the direction — while the best available at this time — could be improved with additional review.

Approach for Establishing Plan Objectives

Specific biological objectives for Chinook salmon and steelhead were derived after considering the EDT projections for adult fish production with moderate habitat restoration, review of extensive inventory data and consultation with fishery managers. The objective was a numerical range that typically bracketed the population abundance point value reflecting habitat restoration, provided in the EDT Report 3 – Future Scenario Spawner Population Performance. The fish biological production objective was modified to reflect reality in several areas. For example resource managers agreed that the spring Chinook salmon production potential projected for Shitike Creek was excessively high, based on past population monitoring, high quality habitat conditions and limited opportunities for restoration. The Shitike Creek spring Chinook population objective was revised to more accurately reflect the potential response to habitat modifications.

Summer steelhead run-size objectives were developed by conducting EDT analyses for each demographically independent population and associated habitat identified by the Interior Columbia Basin Technical Recovery Team (TRT). The actual numerical fish population objective is expressed as a range that brackets the EDT estimated adult fish production following habitat restoration.

Salmon and steelhead biological objectives for increased life history diversity, increased population productivity and increased habitat capacity were derived directly from the EDT Report 3 data generated for assessment units, population habitats or major stream systems.

Specific resident redband trout population objectives were generally impossible to develop based on habitat variability within assessment units and lack of sufficient life history data. The one exception was the lower Deschutes River, where ODFW had developed specific biological objectives based on a detailed life history study and years of population monitoring. These objectives were originally included as part of the ODFW - Lower Deschutes River Fish Management Plan (ODFW 1997) and were determined to still be valid.

Restoration of subbasin stream habitat is largely dependent on meaningful recovery of riparian habitat. There are approximately 1,894 miles of stream within the subbasin. Within the 25-year planning horizon, or by 2030, it is assumed that the riparian habitat along one-half of the subbasin streams will be substantially protected or restored. It was also assumed that the average width of the riparian corridor, including both stream banks, without the stream channel, averages approximately seventy-five feet. A seventy-five foot wide swath of riparian vegetation totals approximately nine acres of riparian habitat per stream mile. Potentially the subbasin stream corridors could have up to 17,046 acres of riparian habitat. The goal of this plan is to protect or restore 8,523 acres of riparian habitat during the 25-year planning horizon. It is unlikely that degraded habitat will be fully restored within this period, but the percentages of recovery are included as assessment unit or habitat complex strategies.

Restoration of a variety of stream habitat attributes would be difficult to quantify without developing specific objectives for each stream reach. This was not a realistic expectation based on the time allotted for this planning process, and the number of stream reaches and attributes involved. Habitat restoration objectives generally reflect a percentage change expressed as the difference between the template and current conditions. The same objective percentage applies to all stream reaches in a habitat complex, but the expected degree of recovery is directly dependent on the current habitat condition. Compliance with the habitat attribute objectives would require considerably more change for a severely degraded stream than a stream in relatively good condition. In most areas, definitive baseline habitat attribute values need to be determined before initiation of any restoration programs if habitat recovery is to be accurately monitored and evaluated.

Potential stream habitat restoration scenarios with low, moderate and high levels of habitat restoration were analyzed by the EDT model to determine potential fish production capabilities. It was determined that for this planning horizon the moderate level of habitat restoration was the most realistic and offered the greatest likelihood for success. The projected percentage of improvement for various habitat attributes included in the moderate habitat restoration scenario has generally been included as specific plan habitat attribute objectives.

This document recognizes that the subbasin planning process is adaptive in nature. As indicated in the findings from the EDT and QHA analyses, in some cases there is not enough information currently available to accurately quantify our biological and habitat objectives, or targets for habitat restoration. For example, it is unclear at this point whether or not the numeric targets for sediment, channel width and pools identified in the management strategies will be consistent with the water quality goals that are now being produced at the State level. These and other numeric targets will be modified as better information becomes available.

3.2. Lower Westside Deschutes Assessment Unit

Lower Westside Deschutes Assessment unit includes the lower 100 miles of the Deschutes River, the Warm Springs River system, Shitike Creek and the smaller tributaries that enter the lower Deschutes — except Bakeoven, Buck Hollow and Trout creeks.

Key Findings

- The Warm Springs River system, Shitike Creek and the lower 100 miles of the Deschutes River historically supported populations of most subbasin focal species (summer steelhead, Chinook salmon, redband trout, bull trout and Pacific lamprey).
- Miscellaneous, small Deschutes River tributaries generally supported summer steelhead and redband trout populations.
- Today the assessment unit supports spring and fall Chinook salmon, summer steelhead, pacific lamprey, bull trout and resident redband trout. The anadromous salmonid populations have been monitored for up to 25 years.
- Fall Chinook salmon are only found in the Deschutes River.
- Fall chinook production has been on an increasing trend. Spring chinook and steelhead runs have fluctuated and are currently stable.
- Reestablished sockeye and spring Chinook salmon and steelhead runs to the middle subbasin will use the lower Deschutes as a migration corridor and for rearing.
- Indigenous Deschutes stocks have been used for Round Butte Fish Hatchery summer steelhead and spring Chinook salmon production. These fish are released annually into the river as mitigation for lost production upstream of the hydroelectric complex.
- Indigenous Deschutes stock is used to produce hatchery spring Chinook for annual release into Warm Springs River from the Warm Springs National Fish Hatchery.
- Out-of-basin stray hatchery origin summer steelhead from upper Columbia River hatcheries have out-numbered Deschutes steelhead for more than 10 years.
- Out-of-basin hatchery origin fall and spring Chinook stray into the Deschutes River.
- It is unclear how many wild and unmarked out-of-subbasin hatchery strays also stray into the Deschutes River.
- Hatchery rainbow trout have not been released into the lower Deschutes River since 1978.
- Before the early 1990s, hatchery rainbow trout were released by the Confederated Tribes of Warm Springs into Shitike Creek and the Warm Springs River.
- The lower Deschutes has supported an important Tribal subsistence fishery for thousands of years and today supports a world class redband trout and steelhead fishery. The Sherars Falls site remains an important traditional tribal fishing site.
- The Pelton Round Butte Complex, completed in 1964 at river mile 100, is the upstream limit of anadromous fish distribution in the assessment unit.
- The Pelton Round Butte Complex has blocked the natural recruitment of river substrate and large wood since 1957 (completion of Pelton Dam).
- The lower 100 miles of the Deschutes River is an exemplary example of a river fed by significant springs and groundwater with very uniform annual flow.
- Lower Deschutes River tributaries have a more flashy flow regime resulting from intense rain-on-snow or summer convection storms.

- Many of the miscellaneous small lower Deschutes River tributaries are characterized by intermittent or seasonally low flows.
- White River annually contributes glacial silt, sediment and turbidity to the Deschutes River below RM 46.
- Upland watersheds have been degraded by livestock, forestry and agricultural practices, and invasion by western juniper and noxious exotic vegetation.
- Riparian habitat along the Deschutes River is in best condition where protected from livestock use by fencing or in areas with grazing systems designed to protect vegetative diversity.
- Watershed and stream corridor degradation has resulted in low or intermittent flow and higher peak flows in most small miscellaneous streams.
- Channel alterations, flood scouring and loss of riparian vegetation have contributed to the general lack of instream habitat complexity and pool habitat in most small tributary stream reaches.
- Some reaches in the lower Deschutes River is deficient in instream structural habitat diversity.
- Road and railroad construction and maintenance along stream corridors has created some migration barriers and resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices, and recreational use have degraded riparian vegetation along some stream reaches.
- Sediment from uplands, including cropland, rangeland and road system run-off, degrades stream substrate.
- Headwater stream channel scouring has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes in small miscellaneous Deschutes tributary streams.
- Low summer stream flow and high water temperature limit redband trout and summer steelhead distribution and production in most miscellaneous small Deschutes tributary streams.
- Stream habitat restoration projects are underway on a number of stream reaches within the assessment unit.
- Agricultural irrigation return flows entering the Deschutes River and tributaries may pose water quality concerns.
- Over 99,000 acres of grassland wildlife habitat, all the grassland habitat in the AU, have been completely lost in this assessment unit since mid-1800s. Agriculture uses, shrub-steppe, and juniper woodlands have replaced these grasslands.
- 37% of historic ponderosa pine forests have been lost since mid-1800s, amounting to over 85,000 acres of loss. These forests have been replaced by other mixed conifer forests.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes required in 25 years in the Lower Westside Deschutes Assessment Unit to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Achieve and maintain a run of 4,500 to 5,500 naturally produced adult summer steelhead into assessment unit streams.
- Increase summer steelhead population life history diversity from 53% to 70% (EDT projection).
- Increase summer steelhead population productivity from 4.2 to 6.0 (EDT projection).
- Increase summer steelhead habitat capacity to produce 5,348 adult fish (EDT projection) with habitat restoration.
- Achieve and maintain an annual run of 2,600 to 2,800 adult spring chinook to the Deschutes River destined for the Lower Westside Deschutes Assessment Unit streams (EDT Projection).
- Achieve a spawning escapement of 2,200 to 2,300 adult wild spring Chinook salmon above the barrier dam at Warm Springs National Fish Hatchery.
- Achieve a spawning escapement of 400 to 500 adult wild spring Chinook salmon into Shitike Creek.
- Increase spring Chinook salmon population life history diversity from 95% to 98% (EDT projection).
- Increase spring Chinook salmon population productivity from 5.4 to 7.0 (EDT projection).
- Increase spring Chinook salmon habitat capacity by the equivalent of 702 adult fish (EDT projection).
- Achieve and maintain an annual run of 13,000 to 16,000 naturally produced adult fall Chinook salmon into the lower Deschutes River.
- Increase fall Chinook salmon population life history diversity from 53% to 60% (EDT projection).
- Increase fall Chinook salmon population productivity from 6.0 to 7.1 (EDT projection).
- Increase fall Chinook salmon habitat capacity to produce 1,549 adult fish (EDT projection).
- Maintain a population of redband trout of 1,500 to 2,500 fish per mile larger than 8 inches in length in the lower Deschutes River from Pelton Reregulating Dam to Sherars Falls.
- Maintain a population of redband trout of 750 to 1,000 fish per mile larger than 8 inches in length in the lower Deschutes River below Sherars Falls.
- Restore and maintain numbers of indigenous bull trout and Pacific Lamprey throughout their historic ranges within the assessment unit.
- Maintain the genetic diversity, adaptiveness, and abundance of the wild indigenous redband trout, steelhead, spring and fall Chinook salmon, bull trout, and Pacific lamprey in the Lower Westside Deschutes Assessment Unit.
- Restore beaver colonies to at least 20% of historic habitat areas within 25 years.

Habitat Objectives

- Protect or restore 1,471 acres of riparian habitat along 163 miles of stream in the Lower Westside Deschutes Assessment Unit.
- Protect and restore important wildlife habitats, including backwaters, oxbow sloughs, seeps and springs, and cottonwood groves, willows, and aspen groves.
- Provide efficient fish passage to all historic fish habitat in the assessment unit.

- Increase minimum stream flows in lower Deschutes River tributaries and mainstem Deschutes.
- Restore and maintain upland vegetative conditions to improve overall watershed health.
- Restore and maintain grasslands and ponderosa pine forests (including white oak component) to benefit wildlife populations.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations in the Lower Westside Deschutes Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Westside Deschutes Assessment Unit.

Overall Management Strategies for Assessment Unit

- Protect or restore 1,471 acres of riparian habitat along 163 miles of stream to meet interim habitat attribute criteria described for each assessment unit habitat complex.
- Restore focal fish species distribution and abundance to meet biological and habitat objectives.
- Increase minimum stream flows and channel habitat complexity.
- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore water tables under tributary stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage an increase in beaver numbers and distribution through restoration of woody vegetation.

Key Findings and Management Strategies for Individual Habitat Complexes

The following four habitat complexes for the Lower Westside Deschutes Assessment Unit contain connected or similar habitats for focal fish populations.

Lower Deschutes River – mainstem, Pelton Reregulation Dam to mouth
Warm Springs River Habitat Complex
Shitike Creek Habitat
Miscellaneous small Deschutes River Tributary Streams

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.2.1. Lower Deschutes River Mainstem

Key Findings

- Fall Chinook spawn and rear in the lower Deschutes River. Their historical range may have been similar to that seen today.
- Steelhead and resident redband trout spawn and rear throughout the lower Deschutes River. Most steelhead and resident redband trout spawn above the White River confluence.

- Resident redband are less abundant in the Deschutes below Sherars Falls than above, and most abundant from the Pelton Reregulating Dam to Maupin.
- Some spring chinook produced in westside tributaries rear in the lower Deschutes River.
- Some juvenile summer steelhead produced in eastside tributaries rear in the lower Deschutes River.
- The river margin provides important juvenile rearing habitat for salmonids in the lower Deschutes River.
- There is no evidence that wild spring Chinook spawn in either the mainstem lower Deschutes River or tributaries other than the Warm Springs River or Shitike Creek.
- The river from the Pelton Reregulating Dam (RM 100) to Sherars Falls (RM 43) provides foraging habitat for bull trout.
- The river provides rearing habitat for Pacific lamprey.
- Reestablished sockeye and spring Chinook salmon and steelhead runs to the middle subbasin will use the lower Deschutes as a migration corridor.
- The Deschutes River (RM 0 to 100) is designated as a National Wild and Scenic River and State Scenic Waterway.
- Natural recruitment of river substrate and large wood into the lower Deschutes is believed to have been low. All recruitment, however, has been blocked for over fifty years by upriver storage reservoirs.
- River temperatures and dissolved oxygen levels immediately downstream from the Pelton Round Butte Complex do not meet State water quality standards. Mitigation actions associated with hydroelectric complex relicensing will be taken to meet these water quality standards.
- Wild fire and human activities, including livestock grazing and agricultural practices, road and railroad construction and maintenance, and recreational use have contributed to the loss of riparian vegetation along the river.
- Stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Conservation practices implemented in recent years on some cropland and upland range have increased water retention and reduced upland erosion.
- Riparian restoration projects in several stream reaches have produced improved habitat conditions, including bank stabilization and channel narrowing.
- Out-of-subbasin summer steelhead have been found with IHN type 2 virus and the causative agent (spores) for whirling disease.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain or increase minimum stream flow in the Deschutes River to correspond to instream water rights.
- Maintain maximum stream temperature at or below the state water quality standard.
- Maintain dissolved oxygen levels at or above water quality standards.
- Increase instream structural habitat complexity by 25%.
- Reduce channel width by 50% in degraded stream reaches.
- Increase tributary primary pool habitat by 20%

- Reduce stream substrate embeddedness between the Pelton Reregulating Dam and the White River confluence by 30%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Restore diverse riparian vegetative function by 50%.
- Implement upland and riparian grazing systems or exclosures to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources to reduce livestock use of the river's riparian corridor.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Encourage road and railroad maintenance that protects the riparian corridor.
- Manage recreational use to protect riparian values.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and maintain minimum instream flows.
- Improve and protect water quality consistent with State water quality standards.
- Initiate collaborative conservation, restoration and enhancement projects that improve focal fish species habitat.
- Work with the Pelton Round Butte Complex operator to improve river water quality below the hydro complex.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin strays.

Research and Evaluation Strategies

- Continue monitoring of focal fish species population trends. Determine specific life-history requirements and habitat use for focal species such as lamprey and bull trout.
- Determine lamprey over-wintering areas.
- Continue monitoring incidence of stray anadromous fish in the lower Deschutes River.
- Evaluate possible causes and impacts of out-of-subbasin strays in the drainage and determine most effective instream evaluation methods for assessing numbers of stray fish.
- Evaluate the effectiveness of riparian restoration projects.
- Monitor water quality and quantity to document changes from restoration projects.
- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor harvest of focal species to determine population trends and escapement levels.
- Monitor water quality of irrigation return flow to the assessment unit streams.
- Evaluate the incursion of exotic fish species into assessment unit streams.

3.2.2. Warm Springs River Habitat Complex

Key Findings

- The Warm Springs River system historically supported populations of all focal species, except sockeye and fall Chinook salmon.
- Most spring Chinook spawn in Beaver and Mill creeks and the upper Warm Springs River.
- Spring Chinook rearing occurs throughout the Warm Springs system. Some spring Chinook drop into the Deschutes River to over-winter and rear.
- Most summer steelhead spawn in the middle and upper Warm Springs River, lower Mill Creek and lower Beaver Creek. Rearing occurs throughout the system.
- Bull trout spawn in the upper Warm Springs River above Schoolie.
- Research is underway to determine Pacific lamprey and bull trout abundance, distribution and habitat requirements in the system.
- Severe flooding in the last 40 years eliminated some instream habitat complexity and impacted riparian vegetation.
- The lower reach of the Warm Springs River has been manipulated and confined in some areas.
- Upland watershed conditions, combined with rain on snow and summer convection storms, contribute to the flashy stream flow regime.
- The Quartz and Coyote creek channels are generally incised into highly erodible soils, which results in turbidity and sedimentation in lower Beaver Creek and the Warm Springs River during runoff periods.
- Road systems and upland management practices, including forestry and livestock grazing, contribute silt to a number of streams.
- Some stream reaches, such as Beaver Creek along Highway 26, have been confined or relocated by highway construction.
- Riparian habitat along a number of stream reaches has been degraded by livestock grazing and wild fires.
- Low stream flow and high water temperatures have resulted from the cumulative effects of loss of natural floodplain and riparian function and areas of channel scour and incision.
- Stream habitat restoration projects have been completed on several stream reaches.
- Brook trout introgression may affect long term viability of bull trout populations.
- Brook trout have displaced bull trout in Mill Cr.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flow.
- Reduce stream temperature to meet water quality criteria for salmonid rearing.
- Reduce channel width by 50%.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Increase primary pool habitat by 20%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Restore diverse riparian vegetative function by 50%.
- Proper construction and maintenance of range and forest roads can reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources to help alleviate livestock concentrations in streams and riparian corridors.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation and reduce stream sedimentation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout and summer steelhead, bull trout, Pacific lamprey and spring Chinook salmon populations.
- Initiate conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Initiate brook trout eradication efforts to increase bull trout rearing habitat.
- Re-establish bull trout in formerly occupied habitat in Mill Cr.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout, summer steelhead, bull trout and Pacific lamprey in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue annual steelhead, bull trout and spring Chinook spawning surveys.
- Monitor population trends in bull trout and Pacific lamprey populations.
- Determine lamprey spawning distribution in the assessment unit.
- Determine affects of brook trout introgression into bull trout rearing habitat.

3.2.3. Shitike Creek Habitat Complex

Key Findings

- Shitike Creek historically supported populations of all focal species, except sockeye and fall Chinook salmon.

- Spring chinook spawn in Shitike Creek from the mouth upstream to the upper road crossing.
- Bull trout spawn primarily in upper Shitike Creek above Peter's Pasture.
- Shitike Cr. provides spawning and rearing habitat for the majority of bull trout in the lower Deschutes.
- Brook trout are present and hybridizing with bull trout.
- Summer steelhead and redband trout spawn and rear primarily in lower Shitike Creek below the upper road crossing.
- Research is underway to determine Pacific lamprey and bull trout abundance and distribution in the system.
- This watershed contains some high quality fish habitat in the mid and upper reaches. Habitat is pristine above Peter's Pasture.
- The stream has been manipulated and confined in some areas downstream from the old Warm Springs headworks.
- The old Warm Springs headworks has been modified to provide good fish passage.
- Riparian habitat has been degraded in the lower stream reach as a result of urban and industrial development, channel alterations and livestock use.
- Riparian habitat between the old Warm Springs headworks and the upper road crossing has been impacted by livestock grazing.
- Some habitat restoration work has been completed on lower Shitike Creek downstream of the community of Warm Springs in recent years.
- Occasional sewage spills from treatment lagoons at Warm Springs negatively impact stream water quality.
- The Warms Springs Tribes are supplementing Shitike Creek with adult Warm Springs Hatchery spring chinook.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain pristine condition of the stream above Peter's Pasture.
- Maintain or increase stream flow.
- Reduce stream temperature to comply with current water quality standards.
- Increase primary pool habitat by 20% in appropriate stream channel types.
- Restore diverse riparian vegetative corridors to provide 80% stream shading and increase stream bank stability to 80%.
- Reduce channel width-to-depth ratio to less than 10.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood per 100 meters of stream channel or other comparable structure.
- Reduce substrate fine sediment percentage to less than 10%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Proper construction and maintenance of roads can reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.

- Develop upland livestock water sources to help alleviate livestock concentrations in the stream and riparian corridor.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution and population abundance of redband trout, summer steelhead, bull trout, spring Chinook salmon and Pacific lamprey populations.
- Initiate conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with the forest and range managers to protect and maintain a healthy riparian stream corridor.
- Initiate brook trout eradication efforts to eliminate interbreeding and increase bull trout rearing habitat.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of focal fish species in the habitat complex.
- Determine the affects of brook trout introgression into bull trout rearing habitat.
- Evaluate the success of adult spring chinook supplementation on increasing natural production.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue annual bull trout, steelhead and spring Chinook spawning surveys.
- Monitor population trends in bull trout and Pacific lamprey populations.
- Determine lamprey spawning distribution in this stream.

3.2.4. Miscellaneous Small Deschutes Tributaries (including lower White River below White River Falls)

Key Findings

- Summer steelhead populations from the small tributaries contribute to life history diversity in the Deschutes system.
- Resident redband are distributed throughout the systems where suitable habitat conditions exist.

- Historically juveniles in these streams may have been able to drop down to rearing habitat in the Deschutes River when tributary habitat conditions became unsuitable.
- Lower White River is designated as a National Wild and Scenic River.
- These systems are generally gravel-rich and provide good spawning habitat for steelhead in areas where flow is adequate for migration and spawning.
- Stream flows generally decrease rapidly and become intermittent in early summer causing fish to become isolated in remaining exposed pools where they are susceptible to predation.
- Changes in land management activities and their affect on overall watershed health have contributed to the flashy stream flow regime.
- Riparian habitat in some reaches is degraded because of channel alteration and livestock grazing.
- Road and railroad crossings hinder upstream fish passage in some streams.
- Low stream flow and high water temperatures result from the cumulative effects of poor watershed health, loss of properly functioning floodplains and riparian function and severe channel scour or incision.
- Loss of riparian stream corridors and severe flooding in the last 40 years has eliminated most instream habitat complexity.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio.
- Stream sediment loading has originated from cropland and rangeland runoff, and channel erosion.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Areas of historic interior grassland wildlife habitat have been lost in some of the stream watersheds.
- Riparian habitat restoration, changes in livestock management and other efforts have improved riparian condition along some stream reaches.
- Conservation practices implemented on some cropland and upland rangeland in recent years have increased water retention and reduced upland erosion by establishing permanent grasslands and minimizing soil tillage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and/or maintain a continuous stream flow at stream confluences with the Deschutes River.
- Reduce stream temperature to meet State and/or Tribal water quality criteria for salmonid rearing.
- Restore diverse riparian vegetative corridors to provide 80% stream shading and increase stream bank stability to 80%.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood, or comparable structure, per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Manage riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat in historic grassland areas in upper watersheds.

Operational and Policy Strategies

- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, springs and seeps, and upland habitats to benefit fish and wildlife through restored natural hydrology.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor stream water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in these streams.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue or expand annual steelhead spawning surveys.
- Monitor straying of out-of-subbasin steelhead into lower tributary streams.
- Monitor beaver population abundance and distribution.
- Determine if lamprey are present in these tributaries.

3.3. Lower Eastside Deschutes Assessment Unit

Lower Eastside Deschutes Assessment Unit includes four primary stream systems in the lower eastside Deschutes River watershed: Buck Hollow, Bakeoven, Trout and Willow creeks.

Key Findings

- Historically spawning summer steelhead and redband trout were distributed throughout the Buck Hollow, Bakeoven, Trout and Willow creeks systems.
- The Pelton Round Butte Complex and water withdrawals led to the extirpation of Willow Creek steelhead.
- The stream systems may have historically supported bull trout foraging and Pacific lamprey production.
- Current spawning distribution has been reduced by artificial barriers, habitat degradation and reduced stream flow.
- Steelhead spawners in these streams developed the genetic characteristics to survive in the sometimes hostile conditions that occur in this semi-arid environment. Currently, the population has a unique spawning timing and may leave the tributaries to rear in the mainstem when habitat conditions decline.
- The number of out-of-basin stray hatchery origin steelhead spawning with indigenous steelhead in assessment unit streams has increased significantly in the last twenty years.
- Genetic integression could alter the genetic characteristics that now allow the native steelhead to survive. If it alters spawning timing or juvenile migration timing, this could result in substantial mortality.
- The causative agent (spores) for whirling disease have been found in stray fish in the subbasin.
- Hatchery steelhead and rainbow trout have not been released into assessment unit waters.
- Uplands in the watershed are degraded with reduced ability to collect and store runoff and maintain soil stability.
- Historically periodic fires were an important component in maintaining vegetative species diversity, watershed health and native grasslands.
- Several major floods in the last forty years have negatively affected stream channels, riparian vegetation and stream floodplains.
- Watershed and stream corridor degradation has resulted in an altered flow regime with higher peak flows and lower low or intermittent flows in many stream reaches.
- Channel alterations, flood scouring and loss of riparian vegetation have contributed to the general lack of instream habitat complexity and pool habitat in most stream reaches.
- Road construction and location in and along stream corridors has resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices have removed riparian vegetation along some stream reaches.
- Sediment from uplands, including cropland and road system run-off, degrades tributary stream substrate.

- Headwater stream channel incision has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes.
- Low summer stream flow and high water temperature limit redband trout and summer steelhead distribution, connectivity and production in assessment unit streams.
- Stream irrigation diversions and pumping have contributed to extremely low or intermittent flow for much of the year in Trout Creek and Willow Creek systems.
- There is one active water right on Buck Hollow Creek and no consumptive water rights on Bakeoven Creek.
- Stream channel alterations, head cutting and road crossings have blocked fish passage.
- Beaver habitat has been degraded by loss of riparian vegetation, reduced stream flow, loss of riparian vegetation, and loss of oxbow sloughs and backwaters in lower gradient stream reaches.
- A large contiguous area of approximately 370,000 acres of interior grassland wildlife habitat that existed in the Upper Bakeoven, Buck Hollow, and Antelope creeks watersheds historically has been lost to encroachment by other habitats and land uses.
- Stream habitat restoration projects are underway on all four stream systems.
- Screening has been installed to protect fish at most water diversions and pump intakes in the Trout Creek system.
- Fish passage facilities or infiltration galleries have been installed at most water intake sites to facilitate fish passage in the Trout Creek system.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the Eastside Assessment Unit needed to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Achieve and maintain a long-term average annual run of 2,400 to 2,900 Deschutes natural origin adult summer steelhead (EDT projection) destined for assessment unit streams in 25 years, including the following distribution of fish: Buck Hollow Creek – 800 to 900 adult steelhead, Bakeoven Creek – 600 to 800 adult steelhead and Trout Creek – 1,000 to 1,200 adult steelhead (EDT projections).
- Maintain the life history diversity of the wild redband trout in the Willow Creek system.
- Increase summer steelhead population life history diversity from 18% to +50% (EDT projection).
- Increase summer steelhead population productivity from 1.2 to 2.3 or more (EDT projection).
- Increase the summer steelhead habitat capacity by 425 or more adult fish.
- Provide efficient fish passage to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Habitat Objectives

- Provide suitable habitat conditions for adult focal fish species spawning, holding and movement, and juvenile summer steelhead life history stages and migratory patterns.
- Provide suitable foraging habitat for sub adult and adult bull trout in the assessment unit.
- Provide suitable habitat conditions for adult and juvenile life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness of redband trout and Pacific lamprey in Buck Hollow, Bakeoven, and Trout creek systems.
- Increase minimum stream flows by 25%.
- Restore water tables under former wet meadows and stream floodplains.
- Restore and maintain upland vegetative conditions to improve overall watershed health to increase water infiltration, retention and permeability rates, and soil stability.
- Increase riparian function by 50%.
- Maintain existing riparian habitat vegetation and structure and restore degraded riparian habitat to produce suitable beaver habitat in 20% of the stream habitat that was historically inhabited by beaver. Restore 20% of oxbow sloughs and backwaters within lower gradient stream reaches.
- Convert and/or restore 10% of invasive and nonnative upland vegetation to native perennial grasslands to provide wildlife habitat in the upper Bakeoven, Buck Hollow and Antelope creek watershed.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Eastside Assessment Unit by 2030.

Overall Management Strategies

- Protect and restore fish and wildlife habitat, beginning in the headwater areas and progressing downstream to restore fish distribution and abundance to meet biological and habitat objectives.
- Prioritize and plan future habitat restoration to protect or restore habitat for core populations of summer steelhead and/or redband trout populations and expand their range.
- Increase minimum stream flows and channel habitat complexity, and provide fish passage at all artificial barriers to support production of summer steelhead and/or redband trout populations during all life stages and provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Improve upland management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.

- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation, oxbow sloughs, and backwaters.
- Restore natural permanent grasslands, beginning with areas adjacent to streams in the upper watersheds as the highest priority.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin steelhead hatchery strays.
- Conduct a genetic study on Deschutes river summer steelhead to examine effects of out-of-subbasin strays.
- Conduct an aggressive monitoring program to determine whether and/or where out-of-subbasin steelhead are spawning with native steelhead. Develop control measures, such as installation of weirs and distinctive marking of hatchery fish, to protect the native stock.
- Work with landowners and land managers to explore the use fire as a tool to restore upland watershed health and native grasslands.

Management Strategies for Habitat Complexes

The following four habitat complexes identified for the Lower Eastside Deschutes Assessment Unit coincide with the primary stream systems.

Buck Hollow Creek Habitat Complex (including Finnegan and Thorn Hollow creeks)
Bakeoven Creek Habitat Complex (including Deep and Cottonwood creeks)
Trout Creek Habitat Complex (including Antelope and Ward creeks)
Willow Creek Habitat Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.3.1. Buck Hollow Creek Habitat Complex

Key Findings

- Redband trout exist throughout the system. During periods of low stream flow, they occupy areas with suitable summer habitat.
- Adult steelhead spawn throughout the system in areas where access and flows are suitable.
- Juvenile steelhead rear throughout the system where suitable summer habitat exist.
- Some juvenile salmonids migrate to rearing habitat in the Deschutes River before stream flow diminishes and water temperatures rise.
- Loss of riparian stream corridors and severe flooding in the last 40 years eliminated most instream habitat complexity.
- Upland watershed conditions contribute to the flashy stream flow regime, which accentuated by the invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- Some riparian areas are degraded because of channel alteration and livestock grazing.

- Low stream flow and high water temperatures result from the cumulative effects of generally rapid runoff from upland dry land fields and rangeland, loss of natural floodplain and riparian function and severe channel scour and incision.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio, which typically approaches 30.
- Stream sediment loading has originated from soil disturbance by livestock, cropland runoff, and from road drainage on uplands in assessment unit.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain-on-snow events with frozen ground, or summer convection storms.
- Approximately 120,000 acres of interior grassland wildlife habitat have been lost in the upper stream watershed since historic times.
- Conservation practices implemented on some cropland and upland rangelands in recent years have increased water retention and reduce upland erosion by establishing permanent grasslands and minimizing soil tillage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Establish perennial flow and increase stream flow to a minimum 5 cfs at the stream's confluence with the Deschutes River as an interim step toward achieving the instream water right flow.
- Meet state temperature standards for salmonid spawning and rearing.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood, or comparable structure, per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Restore sinuosity to create additional oxbow sloughs, backwaters and floodplain connectivity.
- Provide protective fish screen at the only irrigation water intake.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Construct upland water and sediment control basins to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.

- Restore diverse riparian vegetative corridors to increase riparian function by 50%.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Work with the one water right holder to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the stream.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.
- Work with Columbia Basin co-managers to address genetic and disease concerns associated with out-of-subbasin hatchery strays.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Buck Hollow Creek flow and water quality.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys.
- Evaluate possible causes and impacts of out-of-subbasin steelhead strays in drainage and determine instream evaluation methods for assessing stray rates.
- Monitor beaver population abundance and distribution.

3.3.2. Bakeoven Creek Habitat Complex

Key Findings

- Redband trout are distributed throughout the system. During periods of low streamflow, they are found in areas with suitable habitat.
- Adult steelhead spawn throughout the system in areas where flows are suitable.
- Juvenile steelhead rear throughout the system in areas with suitable summer habitat.
- Some juveniles likely migrate to rearing habitat in the Deschutes River before flows diminish and water temperatures rise.

- Loss of riparian stream corridors, channel alterations and severe flooding in the last 40 years eliminated most instream habitat complexity.
- Upland watershed conditions contribute to the flashy stream flow regime, which has been accentuated by invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- Stream sediment loading has originated from range and cropland in the upland portions of the assessment unit.
- No surface water is removed from the Bakeoven Creek system for irrigation or other purposes.
- Stream turbidity and sedimentation is usually associated with high intensity rain-on-snow events with frozen ground, or summer convection storms.
- Riparian habitat in some reaches is impacted by livestock grazing.
- Low stream flow and high water temperatures have resulted from the cumulative effects of rapid runoff from upland dry land fields, rangelands, loss of natural floodplain and riparian function, and severe channel scour and/or incision.
- Fish passage is frequently blocked by intermittent stream flow and high channel width to depth ratios.
- Approximately 100,000 acres of former interior grassland wildlife habitat in the upper stream watershed have been lost.
- Conservation practices implemented on some cropland and upland rangelands in recent years have increased water retention and reduced upland erosion.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Establish perennial flow and increase stream flow to a minimum 5 cfs at the stream’s confluence with the Deschutes River as an interim flow until the instream water right flow is achieved.
- Meet State water temperature criteria for salmonid spawning and rearing.
- Restore natural upland vegetation, such as permanent grasslands.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood or comparable natural structure per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable habitat types.
- Restore sinuosity to create additional oxbow sloughs, scour pools, backwaters and floodplain connectivity.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.

- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Construct upland water and sediment control basins to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore diverse riparian vegetative corridors and near-stream aspen and cottonwood groves to increase riparian function by 50%.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout and summer steelhead populations.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin steelhead hatchery strays.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Bakeoven Creek flow and water quality.
- Evaluate the effectiveness of upland watershed treatments, including establishment of permanent grasslands, to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys.
- Monitor beaver population abundance and distribution.
- Evaluate causes and impacts of out-of-subbasin steelhead strays in drainage, and determine instream evaluation methods for assessing instream stray rates.

3.3.3. Trout Creek Habitat Complex

Key Findings

- The Trout Creek watershed historically supported summer steelhead, Pacific lamprey and resident redband trout.
- Today the system supports remnant redband trout and summer steelhead populations. Most remnant production occurs in upper areas of the watershed where flows and habitat conditions are suitable.
- Steelhead and resident redband trout in the system are particularly adapted to eastside warm water conditions.
- Key fish production areas impacted by reduced flows are the lower portions of Trout Creek, Trout Creek within the Ashwood Valley and Antelope Creek.
- Of the studied stream reaches, upper Trout stream reaches above Ashwood Valley (above Amity Creek confluence) have the best habitat quality and the highest numbers of steelhead and redband trout production and rearing.
- Out-of-subbasin hatchery steelhead have been observed spawning with native fish.
- The watershed retains some high quality fish habitat, but historical and current management impacts have adversely altered watershed processes and habitats.
- Reduced summertime stream flows, “flashy peak flows”, and areas where riparian vegetation and/or upland vegetation are degraded, have reduced the quality and quantity of fish habitat in the Trout Creek Watershed.
- Key factors contributing to seasonally elevated water temperatures include modifications in riparian conditions from land management, low flow conditions, and widening of channels.
- Low summer stream flow conditions, especially in Trout and Antelope Creeks, affect habitat quality by increasing temperatures, reducing pool habitats, reducing or eliminating floodplain connectivity, and limiting fish movement.
- The Trout Creek system is over-appropriated for irrigation water withdrawal.
- The system has lost the ability to “absorb” high flows because of changes in upland plant communities, loss of floodplain connectivity (through channel straightening, and berms) and wetlands, and reduction in channel complexity.
- The natural flow regime has been modified through loss of in channel structure, increased stream gradient, loss of sinuosity, reductions in wetland habitats, increased distribution of western juniper and exotic plants, and altered runoff timing from roads and other upland management practices. This has resulted in higher peak flows and lower summer flows than existed historically.
- The entire length of Trout Creek and a number of tributaries (Auger, Big Log, Bull, Cartwright, Dick, Dutchman and Potlid creeks) are listed as water quality limited because they exceed State criteria for temperature and sedimentation.
- High water temperatures limit fish production throughout the basin.
- Flood control berms along Trout Creek and channelization of other stream reaches have affected areas that once had very productive fish habitat.
- Channel relocation and storage reservoirs have eliminated steelhead access to the Hay Creek system.
- Fish passage barriers affect significant portions of the Mud Springs Creek, Antelope, and Hay Creek systems. Seasonal fish passage barriers associated with intermittent stream flow and irrigation diversions (push up berms for juveniles) affect the quality and quantity of fish habitat.

- The road network, especially dirt or gravel roads, can generate and deliver excess sediment to the streams. The highest density of gravel roads with the potential to deliver sediment is on forested land in the Upper Trout Creek Subbasin.
- Stream restoration projects have increased instream structure and stream bank stability in a number of stream reaches.
- Riparian fencing projects and management have significantly improved riparian conditions in key areas (for example, the upper watershed).
- An estimated 100,000 acres of interior grassland wildlife habitat once existed in the Antelope Creek and Ward Creek watersheds.
- Forest habitat conditions in the watershed have been altered through intensive timber harvest and associated management activities.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large woody debris or comparable natural structure per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Restore sinuosity to create additional oxbow sloughs, backwaters and floodplain connectivity.
- Establish perennial flow and increase stream flow to a minimum 5 cfs above the stream’s confluence with Mud Springs Creek as interim flow until instream water right is met.
- Meet State water temperature criteria for salmonid spawning and rearing.
- Reduce channel width-to-depth ratio to less than 12.
- Increase primary pool habitat by 20% in reaches with suitable channel types.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Restore diverse riparian vegetative corridors to increase riparian function by 50%.
- Restore natural upland vegetation, such as permanent grasslands.
- Construct upland water and sediment control basins in ephemeral drainages to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.

- Protect riparian and floodplain areas to encourage development of habitat complexity and native plant species diversity, and restoration of beaver populations.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout, summer steelhead and pacific lamprey populations.
- Work with Columbia Basin co-managers to address genetic and disease concerns from put-of-subbasin steelhead hatchery strays.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish and wildlife habitat and water quality.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and summer water quantity and quality.
- Work with the Ochoco National Forest and private landowners to protect and maintain healthy riparian stream corridors.
- Restore interior grasslands, to improve natural hydrologic regime and wildlife habitat, with the highest priority areas adjacent to streams.

Research and Evaluation Strategies

- Identify key rearing areas for steelhead and redband populations.
- Determine juvenile migration patterns.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Identify areas where water conservation could have a significant impact on flows.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Trout Creek flow and water quality.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Evaluate possible causes and impacts of out-of-subbasin steelhead strays in drainage and determine instream evaluation methods for assessing stray rates.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys and downstream migrant monitoring.
- Monitor beaver population abundance and distribution.

3.3.4. Willow Creek Habitat Complex

Key Findings

- Upland watershed conditions contribute to the flashy stream flow regime, which has been accentuated by invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- All stream flow in the upper reaches is diverted at several locations for irrigation.
- Stream corridor shading averages less than 20%.
- The State water quality criterion for water temperature is exceeded during summer months.
- The stream has been channelized through the City of Madras.
- Sixty percent of the cropland (15,000 acres) is classified as Highly Erodible Land.
- Public lands on the Crooked River National Grasslands are used for livestock grazing and recreation.
- Sections of the channel above Morrow Reservoir have been altered or incised.
- A series of springs in the lower section of the reach from Madras to the mouth at Lake Simtustus provide a substantial base stream flow.
- Stream sediment loading has originated from highly erodible soils, unstable stream banks, agricultural and forest management practices and drainage from the watershed road system. Irrigation tailwater occasionally discharges over the canyon rim and erodes sediment into lower Willow Creek.
- Fish passage is blocked by intermittent stream flows, as well as the Morrow Reservoir Dam and road culverts on Higgins Creek and Willow Creek near the Higgins Creek confluence.
- Riparian habitat has been degraded by flooding, channel scour, channel alteration and livestock grazing.
- A number of riparian and stream channel restoration projects have been implemented from the downstream boundary of the Crooked River National Grasslands to the headwaters.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a perennial flow with an interim minimum flow of 1 cfs above RM 4.5 until the instream water right is met.
- Meet state temperature standards for salmonid spawning and rearing.
- Reduce channel width to depth ratio to less than 10.
- Reduce channel incision by 50%
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Reduce substrate fine sediment by 25%.
- Reduce stream substrate embeddedness by 25%.
- Screen all water intakes.
- Provide fish passage at all artificial barriers.

Sub-Watershed Strategies

- Increase riparian function by 50%, including restoration of diverse riparian vegetative corridors.

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain forest, range and farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Increase the quality and quantity of redband trout spawning and rearing habitat and wildlife habitat by restoring stream meander, oxbow sloughs, and backwaters, and restoring beaver populations.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies
- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.

Research and Evaluation Strategies
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor beaver population abundance and distribution.
- Determine instream flow needs to meet biological objectives.

3.4. White River Assessment Unit

The White River Assessment unit includes the White River watershed above White River Falls.

Key Findings

- White River Falls (RM 2) isolates the White River system fish population.
- White River contains genetically unique redband trout stocks that have been isolated above White River Falls for thousands of years. These stocks are more similar to isolated populations of redband trout in the Fort Rock Basin than they are to lower Deschutes River redband trout.
- Pure indigenous redband populations are found in several headwater areas.
- Core redband populations are found in Tygh, Jordan and Little Badger creeks above waterfalls and in upper Threemile and Boulder creeks.
- Retention of natural fish passage barriers will help protect genetically unique populations of native redband trout from genetic intergression.
- Hatchery rainbow trout and brook trout have been stocked into waters in the White River drainage. Stocking of rainbow trout is now restricted to lakes and reservoirs. Self-perpetuating brook trout populations are found in several headwater streams.
- There is evidence that genetic intergression between indigenous redband trout and hatchery rainbow trout populations may have occurred in the lower White River, lower Tygh, Jordan and Rock creeks.
- Key fish production areas are found in tributary streams with no glacial influence.
- Loss of riparian vegetation for feeding, loss of oxbow sloughs for habitat, and loss of permanent water for habitat have resulted in low beaver populations.
- Degradation and loss of ungulate winter ranges has resulted in lower mule deer populations.
- Low summer stream flows and high water temperatures limit redband trout production in approximately 40 miles of lower Tygh, Badger, Jordan, Threemile, Rock, Gate, Boulder and Forest creeks.
- Irrigation storage impoundments and/or diversions for irrigation or reservoir storage result in extremely low or intermittent flow for much of the year in lower Gate, Rock and Threemile creeks.
- Irrigation diversions and storage reservoir dams have blocked fish passage and screening to protect fish is generally lacking.
- Channel alterations have reduced instream habitat complexity in lower river tributaries.
- Road culverts have impeded the movement of large wood in streams.
- Livestock grazing, agricultural practices, forest fire and channel manipulation have removed riparian vegetation along some stream reaches.
- The Rocky Forest Fire appreciably impacted the watersheds of upper Gate, Rock and Threemile creeks.
- Seasonally high water turbidity and high silt concentrations in the White River substrate from natural glacial action on Mount Hood limit fish production.
- Sediment from uplands, including cropland and road system run-off degrades tributary stream substrate.
- Sediment from cropland has been significantly reduced by programs such as the Conservation Reserve Program.

- Over 56,000 acres (57%) of the historic ponderosa pine forests have been lost, as well as 26,000 acres (36%) of historic shrub steppe habitat.
- White oak groves and cottonwood groves have been lost since historic times.
- Ungulate winter ranges are being impacted by other uses, reducing the capacity of these ranges to winter deer and elk and other wild ungulates.
- Increased water storage could be gained through promoting good forest management and controlling runoff.
- A thinner forest canopy and less dense understory existed historically. The current forest condition has a much higher danger of catastrophic fire.
- Water may be available in White River tributaries to meet out-of-stream and instream water rights. Currently water use and diversions are monitored infrequently.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the White River Assessment Unit needed to achieve the vision for the Deschutes River Subbasin in the next 25 years. These assessment unit objectives are consistent with the vision, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout and mountain whitefish in White River and tributaries above White River Falls.
- Maintain the genetic diversity of the wild indigenous redband trout in the White River watershed.
- Conserve redband trout genetic diversity and provide opportunity for genetic exchange within the watershed above White River Falls.
- Maintain beaver populations in suitable habitat in the mainstem and lower-to-middle tributaries.
- Maintain wild ungulate populations by protecting the quality and acreage of existing winter range.

Habitat Objectives

- Protect, restore and maintain the quality and quantity of aquatic and riparian habitat along ninety-nine miles of stream to meet or exceed habitat attribute objectives discussed in the following habitat complex discussions by 2030.
- Increase minimum stream flows 25% by 2030.
- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and migratory patterns.
- Restore and maintain upland vegetative conditions to improve overall watershed health, especially Oregon white oak groves, ponderosa pine forests, and shrub steppe that have been lost since historic times.
- Restore and maintain permanent water to provide beaver habitat in those historic areas where this habitat existed.
- Protect ungulate winter ranges from development and other uses and restore the quality of winter ranges.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the White River Assessment Unit by 2030.

Overall Management Strategies

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Screening and fish passage is a high priority for fish restoration in the drainage.
- Reconnect redband trout populations across the assessment unit.
- Conserve genetic diversity and restore historic opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for redband trout populations and expand their range.
- Increase minimum stream flows, channel habitat complexity, and provide fish passage at all artificial barriers to support production of residual redband trout populations during all life stages.
- Provide connectivity for fish to areas where good riparian habitat currently or historically existed.
- Improve upland watershed health through proper management, including protection of ponderosa pine forest, white oak groves, and shrub steppe habitat.
- Restore ponderosa pine forests, white oak woodlands and native understory in historic areas, to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity, including large wood, gravel and sand bars, oxbow sloughs, and vegetative species diversity.
- Riparian stream corridors should include species that will eventually contribute large wood to the stream channel (i.e. conifer and/or cottonwood trees), to help meet biological objectives.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage an increase in beaver abundance and distribution through restoration of woody vegetation and maintenance of perennial stream flow.
- Analyze water availability in the White River tributaries to determine water use and potential for meeting out-of-stream and instream water rights.

Management Strategies for Habitat Complexes

The following five habitat complexes for the White River Assessment Unit contain connected or similar habitats for focal fish populations.

Tygh Creek Habitat Complex – including Badger and Jordan creeks
Boulder Creek Habitat Complex – including Forest Creek
Clear Creek Habitat Complex – including Frog Creek
Threemile, Gate and Rock Creek Habitat Complex
White River Habitat Complex – including small, upper basin tributaries

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.4.1. Tygh Creek Habitat Complex

Key Findings

- Past channel alterations eliminated most instream habitat complexity in the lower stream reaches.
- Hatchery rainbow trout in Badger Lake need to be separated from native redband trout populations downstream.
- High fuel loads in the wilderness area are causing increased risk of catastrophic fire.
- Ditch failures, including vandalism, have caused substantial sediment input to the stream system.
- Road culverts impede large wood movement in streams.
- Riparian habitat in some reaches is degraded due to channel alteration, agricultural practices and livestock grazing.
- Low stream flow and high water temperatures result from the cumulative effect of multiple irrigation diversions and degraded riparian vegetative stream corridors.
- Fish passage is blocked permanently at several diversion structures or seasonally during the irrigation season at other sites.
- Most diversions or water intakes are unscreened.
- Stream sediment loading originates from uplands and, in particular, cropland in the northern fringe of this watershed.
- Water in excess of instream water rights may be available in the winter for off-channel storage and later use.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030.
- Increase large woody debris or comparable natural instream structure by 25% by 2030.
- Reduce maximum stream water temperatures by 25% by 2030.
- Reduce fine sediment in the stream substrate by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.
- Reduce stream channel width.
- Restore stream meander and oxbow sloughs.
- Provide fish passage at artificial barriers on natural fish bearing streams, excluding Badger Lake by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams and at Badger Lake Dam by 2030.

Sub-Watershed Strategies

- Increase riparian function by 50% by restoring and maintaining streambank stability and integrity by restoring vegetation such as willow and cottonwood.

- Improve upland watershed health to increase water infiltration, retention and permeability rates and soil stability.
- Restore ponderosa pine forests, shrub steppe prairies, and white oak and cottonwood groves.
- Reduce the risk of catastrophic fire.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity, such as cottonwood, willow and dead and downed wood.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage an increase in abundance and distribution of beaver.
- Promote off-stream water storage for wildlife habitat and water conservation purposes where water is available beyond existing water rights.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality and quantity.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Monitor water quality to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Investigate the need and/or feasibility of screening the outlet at Badger Lake Dam.

3.4.2. Boulder Creek Habitat Complex

Key Findings

- Irrigation water withdrawal results in very low stream flow in lower Boulder and Forest creeks during irrigation season.
- Fish passage conditions at a natural cascade near the mouth of Boulder Creek would improve with increased stream flow.
- Fish passage issues on Forest Creek associated with debris jams would be improved with increased flow.
- Fish passage is blocked at diversion structures and fish screening is lacking on most diversions. A fish screen is being installed in Lost and Boulder Ditch in 2004.
- Stream channels receive fine sediment from upland management activities and road run-off.
- There are multiple miles of low gradient ditch with major water loss in Lost and Boulder irrigation system.
- High fuel loads on forestlands are causing increased risk of catastrophic fire.
- Increased water storage could be gained by promoting good forest management to restore watershed storage and control runoff.

- Boulder Creek joins White River in the Wild and Scenic River section.
- Water may be available over and above existing water rights for off-channel storage and later use.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030, with an ultimate objective of meeting the instream water right flow.
- Reduce fine sediments by 25% by 2030.
- Provide fish passage at artificial barriers on natural fish bearing streams by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams by 2030.
- Protect and maintain instream habitat structure and complexity.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce stream sediment delivery from upland sources.
- Promote off-channel water storage, particularly in winter if there is unallocated water, to increase wildlife habitat and summer stream flows.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with Mount Hood National Forest to protect and maintain upland watershed health.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex.
- Monitor stream flow and water quality to assess affects of restoration projects.

3.4.3. Clear Creek Habitat Complex

Key Findings

- Clear and Frog creeks have seasonally low stream flow below irrigation diversion structures. There is some flow recovery in the lowest stream reaches.
- Water is diverted from Frog and Clear Creeks year around.
- Clear Creek immediately downstream from Wasco Dam has low winter flow associated with upstream reservoir water storage.

- Warm surface water withdrawn from Clear Lake in mid to late summer elevates stream temperatures between the dam and the Juniper Flat Irrigation District diversion.
- There is significant water loss in Juniper Flat Ditch.
- Elevated stream sediment levels are associated with the altered stream flow regime.
- Road culverts impede large wood movement in streams.
- Irrigation diversions are fish passage barriers and have no protective screening.
- There is no fish passage at Wasco Dam.
- A portion of the tail water from Juniper Flat ditch is diverted to Wapinitia Creek, which flows into the Deschutes River.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030, with an ultimate objective of meeting the instream water right flow.
- Reduce fine sediment by 25% by 2030.
- Reduce maximum stream temperatures by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.
- Increase large wood by 25% by 2030.
- Provide fish passage at artificial barriers on natural fish bearing streams, except Wasco Dam by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams, including Wasco Dam by 2030.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce stream sediment delivery from road systems, unstable stream banks, and recreational use and forest practices.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with the Mount Hood National Forest and others to protect and maintain healthy riparian stream corridors.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex.

- Evaluate the effects of the self-perpetuating brook trout populations on the indigenous redband trout populations.
- Investigate the need and/or feasibility of screening the outlet at Clear Lake Dam.

3.4.4. Threemile, Rock and Gate Creek Habitat Complex

Key Findings

- Water withdrawn from Threemile, Rock and Gate creeks for irrigation and water storage in Rock Creek and Pine Hollow reservoirs results in low or intermittent stream flow for much of the year downstream from the diversion sites and reservoirs.
- Water diversions are generally unscreened and there is no upstream fish passage.
- Summer water temperatures in the diversion reaches exceed water quality standards.
- The watersheds and stream corridors associated with the upper reaches of these streams were devastated by the Rocky Forest Fire in the mid-1970s.
- Fine sediments from stream bank erosion, road density and other upland sources impacts stream substrate quality.
- A natural cascade in lower Threemile Creek is a fish passage barrier at most flows.
- Riparian and instream habitat is in generally poor condition in the mid and lower stream reaches.
- Recent implementation of a new community sewer system at Wamic addressed a water quality problem associated with failing septic systems along Threemile Creek.
- Septic systems at Pine Hollow Reservoir may reduce water quality in the lower reaches of Threemile Creek.
- The Pine Hollow drainage was not historically a fish bearing stream, but connects to Threemile Creek which historically was a natural fish bearing stream
- There is a potential impact of pollution in Rock Creek Reservoir and lower Rock Creek from a community septic system at Sportsman Park.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030, with a long-term objective to meet the instream water right.
- Improve stream water quality.
- Provide fish passage at artificial barriers on natural fish bearing streams by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams by 2030.
- Reduce stream sediment loads by 25% by 2030.
- Reduce maximum stream temperatures by 25% by 2030.
- Increase large woody debris or other comparable natural structure by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.

Sub-Watershed Strategies

- Increase riparian function by 50% by protecting and maintaining healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Improve upland watershed health, particularly on forest lands, through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire associated with lateral fuel buildup.
- Reduce stream sediment delivery from road sources and other upland sources.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and natural connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on stream flow recovery.
- Determine life history characteristics of redband trout in the habitat complex.
- Monitor stream flow and water quality.

3.4.5. White River Habitat Complex

Key Findings

- A series of three natural waterfalls at RM 2 blocks all upstream fish migration.
- The lower reaches of the upper river tributaries are occasionally captured by White River as it migrates across the floodplain.
- Concentrated recreational use at four campgrounds and a road has degraded riparian habitat along sections of Barlow Creek.
- Road culverts impede large wood movement in tributary streams.
- Road run-off and slope failures contribute sediment to tributary streams (Red, Bonney and Barlow creeks).
- The glacial source of the river contributes to naturally high fine sediment loading and seasonally high water turbidity.
- The upper river channel is generally transitory, except where confined by a deep, narrow basalt canyon.
- A seasonal irrigation diversion in White River below Tygh Valley is unscreened.
- The White River from the mouth to the Mt. Hood National forest boundary is a designated Wild and Scenic River. The river is designated as recreational, except for a stretch designated as scenic between the mouths of Deep Creek and Threemile Creek. Increased flow from the tributaries would contribute to flows in this designated reach.
- White River contributes an average flow of 433 cfs to the Deschutes River.
- The stream flow gauge on White River below White River Falls has been out of operation for the past ten years.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain and protect minimum stream flows.
- Maintain and protect natural instream habitat structure and complexity.
- Maintain or restore a diverse riparian corridor.
- Provide protective fish screens at all water diversions.
- Maintain tributary streambank stability and integrity.
- Activate the stream flow gauge on White River below White River Falls to help quantify water conservation.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce upland sediment delivery from unstable slopes and road system drainage.

Research and Evaluation Strategies

- Determine life history characteristics of redband trout in the habitat complex.

3.5. Lower Crooked River Assessment Unit

The Lower Crooked River Assessment Unit includes the lower Crooked River drainage below Bowman and Ochoco dams, including lower Ochoco Creek and McKay Creek.

Key Findings

- The lower Crooked River currently supports redband trout. It historically also supported populations of several other focal fish species, including summer steelhead, spring Chinook salmon and Pacific lamprey.
- Core redband trout populations currently exist in the Crooked River in the eight-mile reach below Bowman Dam and from Hwy 97 to Lake Billy Chinook, in Ochoco Creek from Ochoco Dam to confluence with the Crooked River, and in McKay Creek headwaters.
- Historically spawning summer steelhead and redband trout were distributed throughout the stream systems.
- Anadromous fish were extirpated from the assessment unit by construction of Pelton Round Butte Complex dams.
- Ochoco and Bowman dams are the upper limits of this assessment unit and have no provisions for fish passage.
- Re-introduction of anadromous fish species is dependent upon development of effective fish passage at the Pelton Round Butte Complex, as well as at Opal Springs Dam.
- Four permanent and one seasonal irrigation diversion on Crooked River and one on lower Ochoco Creek (Country Club Dam) are fish passage barriers.

- The Crooked River and Ochoco Creek flow regimes have been altered to facilitate irrigation and winter water storage.
- Historically the stream corridors in this assessment unit above the Highway 97 crossing had complex riparian vegetative communities where beaver were abundant.
- Watershed and stream corridor degradation and irrigation withdrawal in the McKay Creek system contribute to flashier flows, and produce low or intermittent seasonal flow in many stream reaches.
- Stream temperatures frequently fail to meet water quality standards during summer months in Crooked River below Prineville, Ochoco Creek and the McKay Creek system.
- Crooked River downstream from Bowman Dam generally does not meet water quality criteria for total dissolved gases during spill and/or periods of substantial discharge.
- A number of springs between Highway 97 and Lake Billy Chinook add more than 1,000 cfs of high quality to lower Crooked River, which has an average flow of 1,562 cfs at its confluence with Lake Billy Chinook.
- Stream channels have been altered throughout the assessment unit.
- Channel alterations, low stream gradient, degraded riparian vegetation and eroding stream banks contribute to high sediment loading throughout the assessment unit.
- Road construction and location in and along stream corridors has resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices have removed riparian vegetation along stream reaches.
- Uplands in the watershed are degraded with reduced ability to collect and store runoff and maintain soil stability.
- Historically periodic fires were an important component in maintaining upland vegetative species diversity, watershed health and native grasslands.
- Western juniper has become invasive in many upland areas as the native vegetation was degraded. The change in upland vegetative types resulted in more flashy stream flow regimes.
- Sediment from uplands, including cropland, rangeland, forests and road system run-off, degrades stream substrate.
- Stream channel scouring has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes.
- Crooked River for eight miles downstream from Bowman Dam and from the National Grasslands Boundary to Opal Springs (river miles 8 to 17.8) are included in the National Wild and Scenic River System.
- Low summer stream flow and high water temperature limit redband trout distribution and production in the assessment unit excluding the National Wild and Scenic River reaches.
- Most of the terrestrial habitat in this assessment unit was historically shrub-steppe and juniper woodlands in about equal acreages amounting to nearly one million acres, and this condition remains currently. However, the plant diversity and growth condition of the shrub-steppe habitat has degraded. Currently, significant areas of grassland (34,000 acres) and lodgepole pine forest (90% of the 84,000 acres) that existed historically in the area are gone. Restoration of grassland areas where this habitat existed historically would benefit grassland wildlife species including greater sage grouse and golden eagle.

- Decadent areas of shrub-steppe need to be rejuvenated through fire or other means to restore sage grouse habitat.
- Aspen groves and cottonwood groves and willow swamps present historically in this assessment unit have been lost, degrading habitat for the Columbia spotted frog and other wildlife.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes required in the Lower Crooked River Assessment Unit by 2030 to achieve the vision for the Deschutes River Subbasin in the next 25 years. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Provide fish passage at Pelton Round Butte Complex and within the assessment unit.
- Provide suitable habitat conditions for adult and juvenile summer steelhead life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 700 to 1,000 naturally produced adult summer steelhead into assessment unit streams.
- Provide suitable habitat capacity for potential production of up to 1,016 summer steelhead adults returning annually to the subbasin.
- Achieve a summer steelhead population productivity of 4.4.
- Provide suitable habitat conditions for adult and juvenile spring chinook life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 750 to 1,000 naturally produced spring Chinook salmon into Crooked River.
- Provide suitable habitat capacity for potential production of up to 1,052 spring Chinook adults returning annually to the subbasin.
- Achieve a spring Chinook population productivity of 5.5.
- Provide suitable habitat conditions for Pacific lamprey.
- Maintain the genetic and life history diversity of the wild indigenous redband trout.
- Maintain existing riparian habitat vegetation and structure and restore degraded riparian and stream habitat, especially backwaters and oxbow sloughs and springs and seeps, to restore beaver populations in 50% of their historical range by 2030.

Habitat Objectives

- Maintain or restore 497 acres of riparian habitat, as described in the following habitat complex discussions, along fifty-five miles of stream.
- Provide suitable habitat conditions for adult and juvenile redband trout life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness of redband trout in the assessment unit.
- Increase minimum stream flows to provide efficient fish passage to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the assessment unit and Deschutes River.
- Restore and maintain upland vegetative conditions, especially lodgepole pine forests and grasslands where these habitats formerly existed, to improve overall

watershed health to increase water infiltration, retention and permeability rates, and soil stability.

- Restore aspen groves, cottonwood groves, and willow swamps to at least 50% of former areas to restore habitat for the Columbia spotted frog and other wildlife.
- Manage large areas of shrub-steppe to rejuvenate growth stages and restore native forbs to restore sage grouse habitat.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Crooked River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore watershed function, beginning in the headwater areas and progressing downstream to restore fish distribution and abundance to meet biological and habitat objectives.
- Prioritize and plan future habitat restoration to protect or restore core habitat for redband trout populations and expand their distribution and abundance.
- Restore and protect historic habitat for reintroduced populations of summer steelhead, spring Chinook salmon and Pacific lamprey.
- Increase minimum stream flows and channel habitat complexity, and provide fish passage at all artificial barriers to support production of resident and anadromous focal fish species during all life stages and provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Improve upland management to increase water infiltration, retention and permeability rates and soil stability.
- Improve upland conditions by returning to earlier vegetative successional stages, which will help to rejuvenate springs and increase forbs and grass cover.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and fish and wildlife species diversity to meet biological objectives.
- Restore riparian and floodplain woody vegetative species diversity including willow, cottonwoods and aspen.
- Restore oxbow sloughs, backwaters, springs and seeps to produce areas with good wildlife species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and moderate stream temperature.
- Take appropriate measures to insure that stray, out-of-basin hatchery fish are not introduced if downstream fish passage is developed.

Management Strategies for Habitat Complexes

Three habitat complexes contain connected or similar habitats for focal fish populations in the Lower Crooked River Assessment Unit.

Crooked River mainstem, from Bowman Dam to Lake Billy Chinook
McKay Creek Habitat Complex
Ochoco Creek, from Ochoco Dam to Crooked River mainstem

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.5.1. Crooked River Mainstem (Lake Billy Chinook to Bowman Dam)

Key Findings

- Four permanent dams and one seasonal dam on Crooked River are complete barriers or obstacles to upstream fish passage.
- Some water intakes are unscreened or poorly screened to prevent fish losses.
- Water storage in Prineville Reservoir and downstream flow regulation reverses the historic hydrograph between Bowman Dam and Crooked River Feed Canal (RM 56) in most years.
- Cold water discharge of 180 to 200 cfs from Prineville Reservoir generally keeps summer water temperatures between Bowman Dam and the Crooked River Feed Canal in the 47° F to 50° F range.
- The Lower Crooked River from the National Grasslands boundary to Dry Creek is designated as a National Wild and Scenic River.
- Summer water temperatures in the lower Crooked River from the mouth to Baldwin Dam (RM 0-51) do not meet State water quality criteria. The reach also does not meet criteria for bacteria (summer) and pH (all year).
- The Crooked River from Baldwin Dam to Prineville Reservoir (RM 51-70) generally does not meet water quality criteria for total dissolved gases during periods of reservoir spill and/or substantial discharge.
- Low stream flow, loss of natural floodplain and riparian function contribute to high water temperatures downstream from the Crooked River Feed Canal.
- The Crooked River has also been identified as having the potential for limitations related to dissolved oxygen, total dissolved gas and nutrients.
- Minimum summer flow drops to 10 cfs from the North Unit Irrigation District pump station (RM 28) to Highway 97 (RM 18).
- Springs between Highway 97 and Lake Billy Chinook add more than 1,000 cfs of high quality to the lower Crooked River, which has an average flow of 1,562 cfs at its confluence with Lake Billy Chinook.
- Channel alteration, loss of riparian areas along stream corridors, and the influence of upstream dams eliminated most instream habitat complexity and channel sinuosity, while increasing stream bank erosion and channel sedimentation.
- Riparian habitat in some reaches is degraded because of channel alteration and livestock grazing.
- Stream sediment loading originates from soil disturbance by livestock, tillage of cropland, and from road drainage in the upland portions of the assessment unit.
- Continual stream turbidity is usually associated with colloidal clay that remains in suspension after erosion in the Upper Crooked River Assessment Unit.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain a minimum instream flow of 80 cfs from Bowman Dam to Lake Billy Chinook to support the reestablishment of anadromous populations.
- Meet state temperature standards for salmonid spawning and rearing.

- Reduce channel width-to-depth ratio in Prineville Valley reach (RM34-57) to less than 15.
- Increase instream habitat complexity by 25%.
- Reduce substrate embeddedness by 30%.
- Reduce substrate sedimentation by 30%.
- Provide protective fish screens at all water intakes.
- Restore 25% of the historic oxbow sloughs and backwater habitat.

Sub-Watershed Strategies

- Increase riparian function by 50%.
- Restore fish passage at all artificial barriers.
- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, realign, and/or maintain roads to reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs, wetlands, and riparian areas to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore stream meander, oxbow sloughs, and backwaters to improve wildlife habitat and increase beaver numbers and distribution.

Operational and Policy Strategies

- Work with BOR to allocate unallocated Prineville Reservoir storage to increase minimum stream flow in Crooked River below Bowman Dam.
- Work with irrigation districts and individual water users to enhance instream flows by seeking opportunities such as water leases, water purchases, water transfers, or other conservation measures.
- Work with watershed council and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife, especially beaver, and fisheries through restored natural hydrology.
- Work with ODFW, Warm Springs Tribes, NOAA Fisheries, USFWS and Deschutes Valley Water District to re-establish fish passage at Opal Springs Hydroelectric Project.
- Work with other dam owners/operators to provide fish passage in Crooked River below Bowman Dam.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.

- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Implement comprehensive watershed assessment for Prineville Valley reach of Crooked River.
- Monitor water quality and quantity to document changes from restoration projects.
- Evaluate the success of any anadromous fish re-introductions.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Monitor beaver population abundance and distribution.

3.5.2. McKay Creek Habitat Complex

Key Findings

- Degradation of upland watershed conditions has contributed to a more flashy stream flow regime.
- Loss of riparian areas, channel alterations and effects of a more flashy flow regime has eliminated most instream habitat complexity.
- Riparian habitat degradation and stream sediment loading have originated from agricultural and forest management practices, including livestock grazing, and a dense road system.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio.
- Summer water temperatures in McKay Creek and tributaries do not meet State water quality criteria.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Low stream flow and high water temperatures have resulted from the cumulative effects of water withdrawal, loss of natural floodplain and riparian function and severe channel scour and incision.
- Following the 1998 flood, diversion structures were replaced with new structures that provide fish passage and protection screens.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a perennial flow with a minimum flow of 6 cfs at the stream's confluence with Crooked River. Work toward long-term goal of meeting instream water right flow of 21 cfs measured at the stream's confluence with Crooked River.
- Reduce stream temperatures to meet State water quality standards.
- Reduce channel width-to-depth ratio to less than 10.
- Reduce channel incision by 50%
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable habitat types.
- Reduce substrate fine sediment by 30%.
- Reduce stream substrate embeddedness by 30%.
- Screen all water intakes.

- Provide fish passage at all artificial barriers.

Sub-Watershed Strategies

- Increase riparian function by 50%, including restoration of diverse riparian vegetative corridors.
- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain forest and farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Restore natural grasslands, early-succession shrub lands, and cover areas such as aspen and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity, and support restoration of beaver populations.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Re-establish summer steelhead and Pacific lamprey into historic habitat.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate the success of any anadromous fish re-introductions.

- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor beaver population abundance and distribution.

3.5.3. Ochoco Creek (Ochoco Dam to Crooked River)

Key Findings

- Historically the stream corridor was characterized by a complex riparian vegetative community where beaver were abundant.
- Water storage in Ochoco Reservoir and downstream flow regulation has altered the historic hydrograph between Ochoco Dam (RM 11) and Prineville.
- The stream's riparian corridor has been degraded by agricultural practices, channel alteration and urbanization.
- Instream habitat complexity has been lost due to channel alterations, loss of sinuosity and the loss of the riparian corridor.
- Stream substrate sedimentation has been accelerated by erosion of unstable stream banks and a low stream gradient.
- The Country Club Dam is a barrier to fish passage.
- Summer water temperatures in the ten-mile reach of Ochoco Creek below the dam do not meet State water quality criteria.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a minimum flow of 6.5 cfs at the stream's confluence with Crooked River. Work toward long-term goal of meeting instream water right of 23 cfs.
- Meet State water temperature criterion for salmonid spawning and rearing.
- Maintain the channel width-to-depth ratio to less than 12.
- Reduce channel incision and improve floodplain function.
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Reduce substrate fine sediment by 30%.
- Reduce stream substrate embeddedness by 30%.
- Screen all water intakes.
- Provide fish passage at all artificial barriers.
- Restore and maintain oxbows, sloughs, backwaters, springs and seeps to benefit fish and wildlife, and encourage an increase in beaver numbers and distribution.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain farm roads to reduce sediment delivery to streams.
- Install water guzzlers or other water sources for livestock and wildlife use, while protecting natural springs, riparian areas and associated wetlands.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.

- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Increase riparian function by 50%.
- Restore and protect riparian and floodplain habitat complexity.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout.
- Re-establish summer steelhead and Pacific lamprey.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Work with City of Prineville, Crook County and other land managers to develop riparian and stream corridor buffers.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the stream.
- Work with the Ochoco Irrigation District, watershed council and others to enhance instream flows through water leases, purchases, transfers and other conservation measures.

Research and Evaluation Strategies

- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management and development activities.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate the success of any anadromous fish re-introductions.
- Monitor beaver population abundance and distribution.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Investigate opportunities to increase minimum flows through improved water availability predictions that affect upstream reservoir storage and discharge, and through innovative approaches to water distribution and application.

3.6. Upper Crooked River Assessment Unit

The Upper Crooked River Assessment Unit covers the Upper Crooked River drainage above Bowman and Ochoco dams, including upper Ochoco Creek, north and south forks of the Crooked River and Beaver Creek.

Key Findings

- The Crooked River basin historically supported anadromous and resident species.
- Anadromous fish were eliminated from the upper Crooked River and Ochoco Creek watersheds by numerous factors, including construction of major dams in the lower watershed (Pelton Round Butte Project, Bowman and Ochoco).
- Redband trout are the only native game fish and focal fish species left in the Upper Crooked River Assessment Unit, and reside primarily in tributaries on public lands.

- Redband trout abundance varies considerably throughout the drainage, and is highly dependent upon climatic conditions. In some watersheds they have been extirpated.
- Some redband populations are isolated by seasonally dewatering of stream and river reaches, or sections of streams with lethal summer water temperatures.
- Redband trout populations are depressed throughout most of the assessment unit due to the effects of poor watershed health.
- Many riparian areas are degraded due to past and current management practices.
- Riparian area degradation has resulted in losses of oxbow sloughs, backwaters, willow swamps, springs, and seeps, aspen groves, and cottonwood groves.
- Irrigation water withdrawals have changed flow regimes in a number of reaches.
- Low summer flows reduce water quality and block fish passage in several areas.
- Irrigation diversions block passage, fragment and isolate fish populations, and strand individuals.
- Current habitat conditions favor warmwater tolerant fish species over coldwater dependent focal fish species that were historically the dominant species in the assessment unit.
- Soils in many areas are highly susceptible to precipitation driven erosion that has been exacerbated by historic and current land management practices.
- Extensive increases of conifers and western juniper forest habitats, and infestations of exotic grasses and forbs in riparian habitats is negatively impacting riparian vegetative communities and resulting in unstable stream conditions.
- All of the historic lodgepole pine forests in the assessment unit have been lost, amounting to a relatively small area of 17,000 acres
- About 93% of the historic grasslands habitats have been lost, amounting to a area of 56,000 acres.
- About 38 and 35% of the shrub-steppe and ponderosa pine forests, respectively have been lost in the assessment unit, amounting to large areas of 382,000 and 158,000 acres, respectively.
- Most losses in terrestrial habitat types represent large increases in juniper woodland habitat of 401,000 acres, other mixed conifer forest increases of 111,000 acres, and a conversion of 39,000 acres to agricultural uses.
- Aspen groves and cottonwood groves and willow swamps present historically in this assessment unit have been lost, degrading habitat for the Columbia spotted frog and other wildlife.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Upper Crooked River Assessment Unit to achieve the vision for the Deschutes River Subbasin in 25 years. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout in the Crooked River and tributaries above Ochoco and Bowman dams.

- Restore native resident fish populations, including redband trout and mountain whitefish, to historic habitats.
- Consider restoring native anadromous fish populations (including steelhead, chinook and Pacific lamprey) upstream of Bowman and Ochoco dams, if passage is achieved at Pelton Round Butte Project, Opal Springs Dam and other artificial barriers downstream from this assessment unit.
- Reconnect core redband trout populations across the assessment unit.
- Conserve genetic diversity of redband trout populations and provide opportunity for genetic exchange.
- Restore beaver colonies to 25% of historic areas.
- Restore Columbia spotted frogs to 25% of historic areas.
- Conserve and restore where possible shrub-steppe habitats to conserve and restore greater sage grouse populations to 75% of former areas.

Habitat Objectives

- Protect, restore and maintain 1,971 acres of riparian habitat along 219 miles of stream.
- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and migratory patterns.
- Provide efficient fish passage to all historic fish habitat in the assessment unit.
- Increase minimum stream flows.
- Restore and maintain upland vegetative conditions to improve overall watershed health.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the upper Crooked River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Restore habitat for native anadromous fish populations in the upper Crooked River drainage upstream of Bowman and Ochoco dams, if passage is achieved at Pelton Round Butte Project, Opal Springs Dam and other artificial barriers within and downstream of the assessment unit.
- Reconnect core redband trout populations across the assessment unit.
- Conserve genetic and life history diversity and provide opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for remnant redband trout populations and expand their range, rather than beginning work on the most degraded stream reaches where redband trout have been extirpated.
- Increase summer flows and channel habitat complexity, and remove artificial barriers to support production of residual core redband trout populations during all life stages and provide connectivity to areas where good riparian habitat exists now or did historically.

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to restore beaver populations and Columbia spotted frog populations through restoration of woody vegetation, oxbow channels, backwaters, and seeps and springs, cottonwood groves, willow swamps, and aspen groves.

Management Strategies for Habitat Complexes

Seven habitat complexes contain connected or similar habitats for focal fish populations in the Upper Crooked River Assessment Unit.

North Fork Crooked River Complex
Beaver Creek Complex
Upper Crooked River, from reservoir to South Fork/Beaver Creek confluence
Ochoco Creek Complex
Upper Crooked River Small Tributaries
South Fork Crooked Complex
Camp Creek Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.6.1. North Fork Crooked River Habitat Complex

Key Findings

- The North Fork complex contains the most widespread, interconnected, redband trout population in the assessment unit.
- Redband trout are self-sustaining in the North Fork Crooked River complex.
- Residual core redband trout populations include the Deep Creek watershed and North Fork canyon above Upper North Fork Falls. Secondary populations are the mainstem and headwater tributaries to the North Fork above Big Summit Prairie.
- This higher elevation area is close to headwater springs and generally has cooler water temperatures and more favorable streamflows relative to other areas in the subbasin. Portions of the North Fork Crooked river canyon are relatively inaccessible and undisturbed compared to other areas in the assessment unit.
- Upper and lower North Fork falls isolate fish populations in the upper watershed from the rest of the assessment unit.
- Redband trout are moderately abundant in streams with good habitat and cool water. Redband trout are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.

- Impoundments, irrigation diversions and channelization have altered historic wetland conditions in Big Summit Prairie and degraded channel conditions in the lower North Fork, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- The North Fork Crooked River from one mile above the mouth to its source (RM 1-33.3), excluding Big Summit Prairie, is a federally designated Wild and Scenic River. Designations include Wild (11.1 miles), Scenic (9.5 miles) and Recreational (11.7miles). The reaches are managed to protect the outstanding remarkable values associated with their designation.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25%.
- Reduce fine substrate sediment by 25%.
- Reduce maximum stream temperature by 25%.
- Restore and maintain instream habitat complexity.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Increase riparian function by 50% to help restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on stream flows.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.2. Beaver Creek Complex

Key Findings

- Redband trout are self-sustaining in the Beaver Creek Complex.
- Residual core redband trout populations in the Beaver Creek complex include Wolf Creek, North Fork Beaver, South Fork Beaver drainage above Swamp Creek, and Sugar Creek.
- This higher elevation area is close to headwater springs and has cooler water temperatures and more favorable streamflows relative to other areas in the subbasin.
- Much of Beaver Creek and tributaries are unshaded, with streamside vegetation consisting of primarily grasses, some sedge, and an occasional willow or cottonwood.
- Summer flows in Beaver Creek and lower tributaries range from 0 to 5 cfs. Streamflows are over appropriated, with more than 160 cfs of out-of-stream water rights appropriated from Beaver Creek and its tributaries.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production in the mainstem Beaver Creek.
- Beaver Creek has a relatively low gradient. Much of the stream has a substrate of fine sediments in pools and glides with occasional riffles of cobbles and boulders. Spawning gravel is very limited in much of the mainstem.
- Redband trout are moderately abundant in the core areas. They are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision or erosion, and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25%.

- Reduce maximum stream temperatures by 25%.
- Increase large wood / structure by 25%.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Increase riparian function by 50% and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watershed.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.3. Upper Crooked River, Prineville Reservoir upstream to South Fork/Beaver Creek confluence

Key Findings

- Redband trout are seasonally present and populations are severely depressed in the upper mainstem Crooked River.
- Much of the Crooked River is unshaded, with streamside vegetation generally consisting of grasses, sedge and willow.

- Summer flows in the upper Crooked River range from 0 to 7 cfs. Stream flow in the river is over-appropriated, with numerous temporary irrigation dams. Summer flow is severely reduced and sometimes intermittent, rendering it unsuitable for salmonid production and favorable for competing warmwater tolerant fish species.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production in the mainstem Crooked River.
- Severely eroded streambanks, with very little riparian vegetation occur along much of the river, and several portions have been channelized.
- Irrigation diversions and channelization have altered historic wetland and riparian conditions and degraded channel conditions in the complex, isolating populations of redband trout in tributaries.
- Poor riparian conditions due to livestock grazing, agricultural practices, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision or erosion, and reduced quality and quantity of habitat and stream flow.
- Poor watershed conditions have predisposed the river to extreme high and low flow events and increased susceptibility to anchor ice.
- Channel incision and separation of stream from its floodplain have increased bank erosion and changed riparian vegetation communities.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase stream flows within this section of the Crooked River.
- Restore and maintain instream habitat throughout the reach.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and increase fish distribution, population abundance, connectivity with adjacent core redband trout populations.

- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watershed.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.4. Ochoco Creek Complex (Upstream from Ochoco Dam)

Key Findings

- Redband trout are self-sustaining in the Upper Ochoco Creek complex.
- Residual core redband trout populations include East Fork Mill Creek and upper Ochoco Creek above the forest service boundary. Secondary populations are found in the mainstem Mill Creek above the mouth of Dry Creek, West Fork Mill Creek, and upper Marks Creek above Mt. Bachelor Pond.
- Portions of redband populations in Ochoco and Mill Creeks have interconnected and adfluvial life histories utilizing Ochoco Reservoir.
- Irrigation withdrawals from the lower reaches of Ochoco, Mill and Marks creeks result in low or intermittent summer stream flow and high water temperatures.
- Fish passage has been interrupted or permanently blocked at temporary or permanent diversion structures.
- The stream substrate has a high concentration of fine sediment originating from bank erosion, upland erosion, road drainage and livestock grazing.
- Higher elevation areas in this complex are close to headwater springs and have cooler water temperatures and more favorable streamflows relative to most other areas in the subbasin.
- Redband trout are moderately abundant in core areas. They are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.
- Impoundments, irrigation diversions and channelization have altered historic wetland condition in the complex and degraded channel conditions, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Mercury has been detected in sediments and fish samples from Ochoco Reservoir.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies
- Increase stream flows, particularly in lower stream reaches.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies
- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies
- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies
- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine sources of mercury and level of mercury contamination in Ochoco Reservoir and upstream tributaries.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.5. Upper Mainstem Crooked River and Small Tribs above Bowman Dam

Key Findings
- Small tributaries to Crooked River generally originate at lower elevation as small headwater springs on USFS lands and flow through a variety of plant

communities, including wet meadows and forested communities. Lower portions of most tributary streams flow through wider valleys with sagebrush and juniper communities in the uplands, and irrigated meadows and hay fields along the stream bottoms.

- Most redband trout populations are small and isolated from each other by habitat conditions in the mainstem Crooked River, tributary passage barriers, and intermittent stream flow.
- Tributary stream corridors are generally open with little to no shade.
- Some stream reaches are incised in drainages with highly erodible soils susceptible to annual erosion. Instream structure and riparian habitat are generally lacking on most stream reaches.
- Upstream water storage, water withdrawal for irrigation and lowered stream valley water tables result in low or intermittent flow and high water temperatures in many streams. Streamflows are over-appropriated for irrigation and storage.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production.
- Fish passage is frequently blocked by seasonal or permanent water diversions or storage structures without protective screens on diversions.
- The watershed’s reduced ability to retain and slowly release precipitation has produced flashy flow regimes in some streams.
- Stream substrate frequently contains high concentrations of fine sediment.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.

- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.
- Determine redband trout spawning and rearing times of year, and movement between habitat areas during different life stages.

3.6.6. South Fork Crooked River Complex

Key Findings

- The South Fork Crooked River does not appear to support a naturally reproducing stock of redband trout.
- Many streams in the South Fork Basin are intermittent or ephemeral.
- The South Fork Crooked River flows through a mixture of narrow, steep, rim rock canyons and areas of wider rim rock canyons and irrigated hay meadows. The riparian community is dominated by grass and sedge species, with very few willows or other woody species.
- Summer flows ranged from 2 to 9 cfs with numerous irrigation dams diverting much of the flow throughout the private lands. Over 100 cfs of out of stream water rights have been appropriated from the South Fork Crooked River.
- Much of the South Fork has a substrate of fine sediments, occasional riffles of cobbles and boulders, and spawning gravel is very limited.
- A series of springs create a base flow of approximately 25 cfs in the South Fork Crooked upstream from irrigation diversions.
- Base flow, land ownership patterns and watershed topography provide excellent opportunity for reintroduction of native redband trout.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum perennial stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and then maintain historic distribution, population abundance, connectivity and number of redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation and habitat restoration actions could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.

3.6.7. Camp Creek Complex

Key Findings

- Desertification of the Camp Creek drainage and the gradual transition to its present day condition of dry canyons and severely eroded streambanks occurred from the mid 1880's to 1905.
- Redband trout have been reported, but not recently observed in Camp Creek.
- Some Camp Creek tributaries begin at lower elevation as small springs on south facing slopes of the Maury Mountains on USFS lands and flow through a variety of plant communities, including forested communities and former wet meadows. Lower portions of tributary streams flow through wider valleys with sagebrush and juniper communities in the uplands and irrigated meadows and hay fields along the stream bottoms. Other tributaries drain the high desert area and generally only contribute flow following high intensity summer storms or during spring snowmelt.
- Tributary streams are generally open with little to no shade.
- Most tributary reaches are incised in drainages with highly erodible soils susceptible to annual erosion. Instream structure and riparian habitat are generally lacking on most stream reaches.

- Where livestock can be managed as planned, BLM managed reaches on the mainstem are heavily vegetated with sedges and other riparian type vegetation, promoting a more desirable channel width-to-depth ratio. In these segments, the channel bottom has deposited sediment and risen over 5 feet within the incised channel.
- Livestock trespass on BLM managed lands within other segments of the mainstem are retarding recovery of riparian vegetation and channel conditions.
- Upstream water storage, water withdrawal for irrigation and lowered stream valley water tables result in low or intermittent flow and high water temperatures in most of these streams. Streamflows are over appropriated.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting potential reintroduction of redband trout.
- Potential reintroduction of redband trout could be hampered by fish passage obstructions from seasonal or permanent water diversions or storage structures that lack protective screens on diversions.
- The watershed's reduced ability to retain and slowly release precipitation has produced flashy flow regimes in most streams.
- Stream substrate frequently contains high concentrations of fine sediment.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase or re-establish minimum perennial stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and then maintain historic redband trout distribution and connectivity to existing redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.
- Conduct surveys to verify the status of redband trout in the Camp Creek Complex and identify potential reaches suitable for reintroduction.

3.7. Middle Deschutes River Assessment Unit

The Middle Deschutes River Assessment Unit includes the 32 miles of the Deschutes River from the Reregulating Dam (RM 100) at the lower end of the Pelton Round Butte Complex to Big Falls (RM 132), and the Metolius River and Squaw Creek drainages.

Key Findings

- This reach of the Deschutes River historically supported anadromous fish production, with Big Falls blocking anadromous fish passage to upriver areas. Today, anadromous fish passage is blocked at the Pelton Reregulating Dam.
- Inflow from springs contributes to consistent flows and high water quality in the Deschutes and Metolius rivers and lower Squaw Creek.
- Efforts are underway to restore anadromous fish passage at the Pelton Round Butte Complex. Adequate passage would allow restoration of Pacific lamprey, sockeye and spring Chinook salmon and summer steelhead to their historical range in the middle Deschutes assessment unit, as well as provide connectivity for redband and bull trout populations fragmented by the hydroelectric complex.
- Squaw Creek has been a focal point for flow restoration projects in the basin because of its potential for anadromous production with reintroduction above Pelton Round Butte Complex.
- The 20-mile reach of the Deschutes from the top of Lake Billy Chinook to the Reregulating Dam is constrained by a series of reservoirs and dams that are managed by Portland General Electric and the Confederated Tribes of the Warm Springs Reservation of Oregon for hydroelectric production.
- Cottonwood groves and willow swamps thought to exist historically in the Squaw Creek drainages have been lost, along with beaver populations.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Middle Deschutes River Assessment Unit in next 25 years to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Provide suitable habitat conditions for adult and juvenile summer steelhead life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 1,600 to 1,850 naturally produced adult summer steelhead (EDT Projection) into assessment unit streams. This population would be distributed to the following stream systems: Metolius River 600 - 700, Squaw Creek 700 – 800 and Middle Deschutes River 300 – 350 fish when passage is established at the Pelton Round Butte and Squaw Creek dams.
- Provide suitable habitat conditions for adult and juvenile spring chinook life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 1,800 to 2,150 naturally produced spring Chinook salmon (EDT Projection) into assessment unit streams by 2030. This population would be distributed to the following stream systems: Metolius River 1,400–1,600, Squaw Creek 250–350 and Middle Deschutes 150-200 fish when passage is established at the Pelton Round Butte and Squaw Creek dams.
- Provide suitable habitat conditions for restored self-sustaining populations of sockeye salmon in the Metolius/Lake Billy Chinook and Link Creek/Suttle Lake habitat complexes when passage is re-established at the Pelton Round Butte Complex.
- Maintain or increase the life history diversity of the wild indigenous bull trout and redband trout in the assessment unit.
- Provide connectivity and opportunities for redband and bull trout migration between local core populations.
- Provide efficient fish passage for focal fish species to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Habitat Objectives

- Provide suitable habitat conditions for adult and juvenile redband and bull trout, and re-established Pacific lamprey, life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness in the middle Deschutes River, Squaw Creek and Metolius River.
- Restore/maintain upland vegetative conditions to improve overall watershed health to increase water infiltration, retention and permeability rates, and soil stability.
- Maintain or restore 867 acres of riparian habitat along ninety-six miles of stream to meet or exceed the interim habitat attribute objectives discussed in the following habitat complexes.
- Restore degraded riparian habitat to produce suitable beaver habitat in 25% of the historical beaver habitat.
- Restore 20% of oxbow sloughs and backwaters within former beaver habitat areas.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Middle Deschutes River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Prioritize and plan future habitat restoration to protect or restore habitat for core populations of redband and bull trout and expand their distribution to include historic range.
- Restore historic habitat conditions to support re-introduced Pacific lamprey, spring chinook and sockeye salmon and summer steelhead during all life stages.
- Provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore instream habitat complexity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation, oxbow sloughs, and backwaters.
- Insure that out-of-basin stray fish are prevented from entering the assessment unit when anadromous focal fish species are re-introduced.

Management Strategies for Habitat Complexes

Four habitat complexes contain connected or similar habitats for focal fish populations in the Middle Deschutes River Assessment Unit.

> Pelton Round Butte Complex, from Reregulating Dam to upper end of Lake Billy Chinook.
> Middle Deschutes River Habitat Complex, from Lake Billy Chinook to Big Falls.
> Metolius River Habitat Complex, including the Lake Creek system.
> Squaw Creek Habitat Complex, including Indian Ford and Snow creeks.

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.7.1. Pelton Round Butte Habitat Complex

Key Findings

- All anadromous fish passage in the Deschutes is currently blocked at the lower end of the Pelton Round Butte Complex (RM 100).
- All anadromous focal fish species were extirpated above the Pelton Round Butte Complex when fish passage failed for downstream migrating smolts.
- Plans are currently underway to re-establish anadromous fish populations above the complex.
- Potential plans for re-introduction of anadromous focal fish species above the Pelton Round Butte Complex call for partial or total transportation of juvenile and adult fish around the three hydro complex dams.
- Because of large water level fluctuations and associated safety issues, no public use is allowed at the reservoir between Pelton Dam and the Reregulating Dam.

Fish routinely enter the reservoir through the Pelton Dam turbines and pass the Reregulating Dam into the lower river.

- Two small tributaries enter the Deschutes River in Lake Simtustus, between Pelton Dam and Round Butte Dam. Seekseequa Creek, a seasonally dry stream, joins the lake from the west and Willow Creek joins it from the east.
- Habitat in Lake Billy Chinook is well-suited for kokanee, which rear in the reservoir and move into the Metolius River to spawn.
- Arms of the Deschutes, Metolius and Crooked rivers support a diverse sport fish community, including kokanee, redband, brown and bull trout. The Metolius River Arm also provides good habitat for juvenile and sub-adult bull trout.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Provide protective fish screens to facilitate anadromous fish passage at the Pelton Round Butte Complex.
- Re-establish passage of anadromous and resident focal fish species.
- Modify reservoir outlet structures to restore historic river water quality downstream of the hydro complex and facilitate juvenile anadromous fish out-migration or collection.

Operational and Policy Strategies

- Modify the Pelton Round Butte operating procedures to restore downstream water quality to meet State and Tribal water quality criteria.
- Take adequate precautions to prevent the passage of out-of-basin stray hatchery fish and fish diseases upstream of the hydro complex.
- Modify the Lake Billy Chinook outlet to facilitate efficient collection of downstream migrant salmonids and lamprey.

Research and Evaluation Strategies

- Evaluate the success of anadromous focal fish species re-introductions above the hydro complex.
- Evaluate the success and efficiency of juvenile downstream passage facilities.

3.7.2. Deschutes River, Lake Billy Chinook (RM 120) to Big Falls (RM 132)

Key Findings

- The Deschutes River from Lake Billy Chinook to Odin Falls is designated as a National Wild and Scenic River.
- The upper end of this reach experiences low summer flows due to upstream irrigation withdrawals. The reach gains a substantial amount of flow from groundwater releases before entering Lake Billy Chinook.
- The Deschutes River from Steelhead Falls to Big Falls exceeds 303(d) temperature criteria for salmonid spawning and rearing, and for pH.
- This reach of the Deschutes River is constrained by steep and moderate v-shaped hill slopes. Streambank stability is excellent and protected by non-erodible substrate and vegetation.
- Instream habitat remains in good condition and structural diversity is primarily provided by large boulders.

- Spawning gravel recruitment is naturally limited and is lacking below Steelhead Falls. Good gravel is found in the Foley waters above Steelhead Falls.
- The reach contains Steelhead Falls, which has the remains of an old fish ladder and is passable for fish at some flows.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase stream flow to meet the instream water right flow.
- Reduce stream temperature to meet State water quality criteria for salmonid spawning and rearing.
- Increase riparian function by 50%.
- Restore and/or maintain instream habitat complexity with a minimum of 20 pieces of large wood or comparable natural structure per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Restore connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Sub-Watershed Strategies

- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout and re-establish spring chinook and summer steelhead populations.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Determine life history characteristics of redband trout in this stream reach.
- Monitor the affects of increased stream flow and/or instream structural complexity.
- Monitor beaver population abundance and distribution.

3.7.3. Metolius River Habitat Complex

Key Findings

- The Metolius River from Lake Billy Chinook to Metolius Springs is designated as a National Wild and Scenic River. The reach from the headwaters to Candle Creek is also a State Scenic Waterway.
- The Metolius River is one of the largest spring-fed streams in Oregon.
- The Metolius system was once the primary producer of spring chinook in the upper subbasin.
- Redband trout are distributed throughout the system. Primary spawning areas are the Metolius River above Allingham Bridge, Abbot Creek and Lake Creek.

- Three bull trout populations exist in Metolius system (Whitewater River, Jefferson/Candle/Abbot complex, and Canyon/Jack/Heising/mainstem Metolius complex).
- Bull trout spawn in Jack, Canyon, Roaring, Candle and Jefferson creeks and in the Whitewater River. They rear in these streams, as well as in First and Brush creeks.
- Sockeye salmon once migrated up the Metolius River and into the Lake Creek-Suttle Lake complex to spawn. The native run of sockeye in Suttle Lake and Link Creek was reported extinct by 1940.
- Major tributaries to the Metolius include Lake, Spring, Jack, Canyon, Abbot, Candle and Jefferson creeks and Whitewater River.
- The spring-fed Metolius River and tributaries have generally consistent flow and high water quality, and stable channels.
- Stable flows within the Metolius River generally promote a healthy riparian corridor along the stream, with undercut banks, except where degraded by past forest fires, forest management and livestock and recreational use.
- Primary sources of sediment in the Metolius system are from landslides, recreational use, and runoff from logged and burned areas and road network.
- Low amounts of instream large woody debris limit fish habitat in the Metolius River and some tributary reaches.
- Cool spring-fed tributaries to the lower Metolius River (Jack, Canyon, Candle and Jefferson creeks and Whitewater River) contain abundant spawning gravel, undercut banks, side channels and wood. They provide high quality bull trout rearing habitat.
- While water quality is generally excellent throughout the Metolius system due to spring releases, temperatures in the lower Metolius River can exceed State water temperature criterion for bull trout during certain seasons of the year. Water temperatures in Lake Creek exceeds State water quality criteria for salmonids.
- Impassable dams are located on Spring Creek and Link Creek at the outlet of Blue Lake.
- An obstruction on Lake Creek just downstream from Suttle Lake is impassable to some life stages at some flows.
- Lake Creek diversions are unscreened. Screens and passage are being provided at the hydro facility on Link Creek.

<u>Management Strategies Specific to Habitat Complex</u>

In Channel Strategies

- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large woody debris or comparable natural structure per 100 meters of stream channel.
- Restore and maintain diverse riparian stream corridors by increasing riparian function 50%.
- Reduce stream substrate sedimentation by 30%.
- Reduce stream substrate embeddedness by 30%.
- Reduce non-spring fed (warm water) tributaries maximum stream temperatures by 25% by increasing shade and floodplain function.
- Increase primary pool habitat by 20% in suitable channel types.
- Provide screening at all water intakes.

- Provide fish passage at all artificial barriers.
- Restore oxbow sloughs and backwaters.

Sub-Watershed Strategies

- Restore and protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and moderate stream flows and temperatures.
- Manage riparian ecosystems to encourage restoration of beaver populations and restore recruitment of large woody debris.
- Stabilize roads, crossings and other sources of sediment delivery.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband and bull trout populations, and re-established Pacific lamprey, summer steelhead, spring Chinook and sockeye salmon populations.
- Work with agencies, watershed councils and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.

Research and Evaluation Strategies

- Initiate an assessment to quantify and evaluate the parameters used in the EDT analysis and determine reference conditions to meet in channel habitat restoration benchmarks for the Metolius River system.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion on tributaries with high adjacent hill slopes.
- Monitor the effects of habitat restoration on fish production.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Evaluate the re-introduction of focal fish species.
- Monitor beaver population abundance and distribution.

3.7.4. Squaw Creek Habitat Complex

Key Findings

- Squaw Creek was once the primary producer of summer steelhead in the assessment unit.
- Squaw Creek once also supported spring chinook production.
- Today redband trout exist throughout the watershed. The watershed also provides a primary spawning area for the redband trout population in the Middle Deschutes River.
- Squaw Creek below Alder Springs provides foraging habitat for bull trout. Adult bull trout have been found, but no spawning has been documented.
- Squaw Creek from the gaging station to source is a designated National Wild and Scenic River.
- Higher quality habitat conditions existed in Squaw Creek before the late 1800s when flow allocations for irrigation began. Historically natural flows created an abundance of off-channel habitats in unconfined reaches and provided deeper

pools for fish use during summer months. Diverse riparian vegetation grew along the streambanks and provided shade for off-channel and pool habitat.
- Streamflow in Squaw Creek is “flashy”, fluctuating from extremely high flow to low or intermittent flows.
- Flows in Squaw Creek remain generally undisturbed from the headwaters to RM 23.5 where most of the water is diverted for irrigation during summer months. Stream flows are over appropriated to support irrigation.
- The middle reach of Squaw Creek, below the two primary irrigation diversions, has had low to intermittent summer flow.
- Flows in Squaw Creek gradually improve downstream from the City of Sisters with discharge from springs and irrigation return flow. Springs near Camp Polk Road contribute 7 cfs to flows in Squaw Creek. A minimum flow of nearly 100 cfs discharges to the Deschutes River because of Alder Springs and other smaller groundwater springs.
- The stream generally fails to meet water quality criteria for maximum stream temperature between Alder Springs (RM 2) and the Squaw Creek Irrigation District diversion (RM 25).
- There has been extensive channel alteration from the USGS gage (RM 24.7) downstream to the Crooked River National Grasslands boundary (RM 5) resulting in a loss of sinuosity and stream length, with a corresponding increase in gradient.
- The lower half of the stream generally lacks riparian vegetation and instream structural complexity as the result of channel alteration, livestock grazing and development.
- The lower half of the stream has high percentages of fine sediment associated with erosion of unstable stream banks and livestock grazing.
- None of the irrigation diversions are fitted with fish screens and two irrigation diversion dams are fish passage barriers.
- An instream water right exists for Squaw Creek below the mouth of Indian Ford Creek. Flow levels are 50 cfs for March, April and May and 33 cfs for the rest of the year.
- Recent habitat restoration measures completed or underway include acquisition of water rights for conversion to instream rights, and water conservation measures designed to increase minimum summer flow.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase instream minimum flow to meet instream water right of 33 cfs below Indian Ford Creek.
- Restore fish passage to historical habitat in upper Squaw Creek.
- Restore and maintain instream habitat complexity by increasing large wood or other comparable natural structure by 25%.
- Decrease channel width to depth ratio to reference reach condition.
- Decrease channel incision by 50%.
- Increase primary pool habitat by 20%.
- Reduce stream substrate embeddedness by 30%.
- Reduce stream substrate sedimentation by 30%.
- Screen all water diversions to protect fish.

- Restore oxbow sloughs and backwaters.
- Reduce maximum stream temperature by to meet water quality standards.
- Increase riparian function by 50% by restoring diverse riparian vegetative corridors and near-stream alder, aspen and cottonwood groves to provide 50% stream shading and increase stream bank stability to 50%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Implement riparian grazing systems to increase ground cover and slow runoff and erosion.
- Re-vegetate and protect riparian and floodplain areas to restore shade and canopy, riparian cover and native vegetation along Squaw Creek and tributaries.
- Encourage beaver restoration.
- Arrest stream channel incision and restore natural sinuosity and gradient.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore fish passage to historical habitat and screen all water intakes.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband and bull trout populations and re-introduced Pacific lamprey, spring chinook and summer steelhead populations.
- Work with irrigation districts and individual water users to enhance instream flows by seeking opportunities such as water leases, water purchases, water transfers, or other conservation measures.
- Work with agencies, watershed council and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Work with the Deschutes National Forest and private landowners to protect and maintain healthy riparian stream corridors.
- Increase the numbers and distribution of beaver.

Research and Evaluation Strategies

- Determine reference conditions to meet in channel habitat restoration benchmarks for the Squaw Creek system.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the opportunities for restoring natural stream channel sinuosity and gradient.
- Evaluate the re-introduction of focal fish species.
- Evaluate the distribution of exotic fish species and potential affects on re-introduction of focal fish species.
- Monitor the effects of habitat restoration on fish production.

- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Determine life history characteristics of redband and bull trout in the habitat complex.
- Monitor beaver population abundance and distribution.

3.8. Upper Deschutes River Assessment Unit

Upper Deschutes River Assessment unit covers the Deschutes River drainage from Big Falls (RM 132) to Wickiup Dam (RM 222), including Little Deschutes River, Fall River, Spring River and Tumalo Creek.

Key Findings

- Historically, bull trout, redband trout, and whitefish were the indigenous salmonids in this segment of the Deschutes River.
- Wild fish species currently present are redband trout and mountain whitefish.
- Historically, the upper Deschutes provided suitable and plentiful habitat for widespread bull trout populations.
- Drastic alteration of the natural river flow regime caused by irrigation diversions, and the associated effects to aquatic and terrestrial habitat resulted in the extirpation of bull trout and has appreciably reduced the redband trout population.
- All of an estimated 37,000 acres of grassland wildlife habitat has been lost since historic times in this assessment unit.
- Fifty percent of lodgepole pine forests, amounting to 179,000 acres, have been lost since the mid-1800s.
- Fifty-seven percent, or 29,000 acres, of shrub-steppe habitat has also been lost since the mid-1800s.
- Fluctuations in water levels in the Deschutes River, resulting from changes in the outflow at Wickiup Dam that do not match natural seasonal flows, may preclude beaver colonies in this river channel and destroy aquatic habitat for other wildlife in backwaters and oxbow channels.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the Upper Deschutes River Assessment Unit needed in the next 25 years to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout and mountain whitefish.
- Conserve redband trout genetic diversity and provide opportunity for genetic exchange.
- Determine the feasibility of re-establishing a self-sustaining bull trout population within historic habitat.
- Restore beaver colonies to at least 20% of their historic habitat.

Habitat Objectives

- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and strategies.
- Improve the quality and quantity of aquatic and riparian habitat.
- Conserve or restore 1,406 acres of riparian habitat along 156 miles of stream.
- Restore and protect important wildlife habitats, including backwaters, oxbow sloughs, seeps and springs, and cottonwood groves, willows, and aspen groves for focal wildlife species.
- Conserve and restore grasslands, lodgepole pine forests, and shrub-steppe habitats to conserve and restore the wildlife species such as mule deer and golden eagle.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Upper Deschutes River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore core areas for redband trout, and work outward from these areas to expand distribution and abundance to meet biological and habitat objectives. Multi-species benefits would have priority.
- Conserve redband genetic diversity and provide opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for small or remnant redband trout populations and expand their range, rather than beginning work on the most degraded stream reaches.
- Restore spawning habitat in the mainstem between Wickiup Dam and Pringle Falls. Priority efforts include improving winter flows, restoring channel structure and selectively increasing spawning gravel availability.
- Restore juvenile rearing habitat within the mainstem by stabilizing flows and improving instream structure. Priority mainstem reaches include from Wickiup Dam to Pringle Falls, and near the mouths of Fall, Spring and Little Deschutes Rivers and Tumalo Creek.
- Protect and enhance spawning and rearing areas in tributary reaches and provide connectivity to mainstem.
- Protect and restore riparian habitat complexity, building on existing areas of good riparian habitats. Priority efforts should include restoration in areas where structural upgrade will encourage natural vegetative recovery. Native plant species should be used for riparian area re-vegetation, not exotic plant species.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.
- Set operational and policy standards at levels to meet biological objectives.

Management Strategies for Habitat Complexes

Four habitat complexes contain connected or similar habitats for focal fish populations in the Upper Deschutes River Assessment Unit.

Deschutes River Habitat Complex, from Big Falls to North Canal Dam
Tumalo Creek Habitat Complex
Deschutes River and tributaries from North Canal Dam to Wickiup Dam, except the Little Deschutes River
Little Deschutes River Habitat Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.8.1. Deschutes River from Big Falls to North Canal Dam

Key Findings

- Low summer flows reduce water quality and aquatic habitat conditions in the Deschutes River from North Canal Dam to Big Falls.
- Fish habitat quality and successful fish spawning between North Canal Dam and Big Falls have been severely reduced by irrigation water withdrawals from the river above North Canal Dam.
- No known core redband trout populations are present in this reach of the Deschutes River. Populations in the reach are highly variable due to fragmentation from barriers, low summer flows and high summer water temperatures. When flows are adequate below North Canal Dam notable increases in redband production are observed.
- The reach of the Deschutes River near the mouth of Tumalo Creek is a priority area for habitat restoration.
- Habitat effects due to flow alterations in the Deschutes River may be the most critical limiting factors in natural production of trout and whitefish in this section.
- The Deschutes River from Lake Billy Chinook to Odin Falls (RM 120-140) is a designated National Wild and Scenic River. Reaches from Sawyer Park to Tumalo Park and from Deschutes Market Road to Lake Billy Chinook are also designated as State Scenic Waterways.
- Modification of the flow regime and improvement of habitat is necessary to sustain healthy populations of trout and whitefish. This includes but is not limited to higher minimum flows, seasonal flow stabilization, screening of water intakes, and habitat restoration.
- Awbrey and Odin Falls are natural obstacles to upstream movement of fish.
- Big Falls is a complete barrier to upstream fish passage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat.
- Improve the river's flow regime by increasing the minimum summer flow to meet instream water rights.
- Prevent the loss of fish at unscreened intakes.

Sub-Watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive juniper populations to improve watershed health.

Operational and Policy Strategies

- Improve the river's flow regime to achieve aquatic resource and fish population objectives.
- Support current and future methods to improve water conservation and efficiency of water delivery systems to meet instream flow objectives.

Research and Evaluation Strategies

- Complete inventory an evaluation of current conditions of wetlands to restore and enhance water quality.
- Determine impacts of seasonally low stream flow combined with urban and rural run-off.
- Document life history characteristics and monitor population trends of trout and whitefish.

3.8.2. Tumalo Creek Habitat Complex

Key Findings

- Tumalo Creek once provided spawning and rearing habitat for a core redband trout population that migrated from the Deschutes River.
- Currently, fish passage from the Deschutes River to potential spawning and refuge areas in Tumalo Creek is restricted at the Tumalo Feed Canal diversion.
- Small populations of redband trout occur throughout the Tumalo drainage.
- A large portion of the summer flow is diverted for irrigation at RM 2.5, reducing trout production and raising water temperatures in the lower stream reach.
- Bridge Creek, a tributary to Tumalo Creek, provides about 50 percent of the total volume of water used by the City of Bend in a given year. During the summer peak demand times, deep wells provide most of the water needed to meet customer demand.
- There is a lack of pool habitat in reaches below Tumalo Feed Canal and in area burned by Bridge Creek Fire.
- Several stream sections lack trout cover (large wood) for rearing and feeding.
- Irrigation diversions are unscreened.
- During severe winters, anchor ice forms resulting in stream bottom scouring as the ice breaks up and moves downstream.
- Increased summer flows in the lower reach below Tumalo Feed Canal have improved summer water temperatures.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase instream structural habitat complexity in deficient reaches.
- Provide fish passage at all artificial structures and barriers.
- Install protective fish screening at water intakes.

Sub-Watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity, particularly in the Bridge Creek Burn area.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage increased number and distribution of beaver.

Operational and Policy Strategies

- Increase the minimum summer flow.
- Develop a coordinated water policy to secure and protect instream flow enhancements from conservation, leases, transfers and acquisitions.

Research and Evaluation Strategies

- Compare the condition of Tumalo Creek channel before and after the Bridge Creek Fire and determine management activity needed to restore habitat quality.
- Evaluate impacts of the Tumalo Irrigation Distirct diversion dam on bedload movement and determine appropriate actions to maintain channel function and improve fish spawning and rearing habitat.

3.8.3. Deschutes River and Tributaries from North Canal Dam to Wickiup Dam, except the Little Deschutes River

Key Findings

- The core redband trout population for this habitat complex exists in the Deschutes River from Benham Falls to Bend.
- The redband trout numbers between Benham Falls and Wickiup Dam are highly variable depending on the availability of adequate winter flows in consecutive years.
- Redband trout indigenous to the upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a provisional wild fish population and a state sensitive species.
- Redband trout above and below Benham Falls comprise one population.
- Priority reaches include the Deschutes River from Wickiup Dam to Pringle Falls, and near the mouths of Fall, Spring and Little Deschutes rivers.
- Nonnative brown and brook trout compete with redband trout for food and space.
- Several reaches in this habitat complex are federally designated and managed as Wild and Scenic Rivers: The Deschutes River from the Bend UGB to Lava Island Camp (172-175) as recreational; from Lava Island Camp to Sunriver (RM 175-186.2) as scenic; and from Sunriver to Wickiup Dam (RM186.2 to 226.7) as recreational. Reaches from the gage to General Patch Bridge and from Harper Bridge to the Bend Urban Growth Boundary are also State Scenic Waterways.
- Artificially high summer river flows and low winter flows produced by the water release schedule at Wickiup Reservoir accelerate soil erosion from sensitive river banks on the Upper Deschutes River above the City of Bend.
- Riparian and instream habitat is very difficult to restore on the Upper Deschutes between Wickiup Reservoir and the City of Bend due to current managed flow regime that has significantly altered the natural hydrograph.

- Modification of Deschutes River hydrology from Wickiup Dam to Benham Falls has resulted in wide variations in flows in what was once a relatively stable river, causing loss of habitat (spawning, rearing, and holding) which supported natural production of redband and bull trout in significant numbers.
- Modification of the current timing and distribution of flows in Deschutes River downstream of Wickiup Dam and habitat improvement is needed to sustain healthy trout and whitefish populations. This includes, but is not limited to, higher minimum flows, seasonal flow stabilization, screening of water intakes and habitat restoration.
- Modification of the current timing and distribution of flows in the upper Deschutes Subbasin, and implemention of water conservation actions will potentially change the timing of flows in the lower Deschutes River.
- The Deschutes River is confined to a series of reservoirs in the Bend area by four dams; North Canal Dam, Stiedel Dam, Pacific Power and Light Dam, and Colorado Street Dam.
- Habitat effects due to extreme high summer flows and extreme low winter flows in the Deschutes River above Benham Falls may be the most critical limiting factors in natural production of redband trout in this reach.
- In Fall and Spring Rivers (which are unaffected by irrigation diversions) the lack of abundant natural spawning gravel, instream woody structure, and pool habitat currently limits natural production of trout.
- Degradation of riparian and wetland habitat has contributed to a loss of habitat for Oregon spotted frog and other wildlife.

Management Strategies Specific to Habitat Complex

In-Channel Strategies

- Increase the quality and quantity of spawning habitat.
- Increase minimum stream flow in the Deschutes River to meet instream water right.
- Improve the quantity and diversity of instream habitat complexity.
- Provide fish passage and protective screening at river dams.
- Modify dams to provide fish passage.

Sub-watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Assist landowners with projects that replace non-native vegetation with native riparian plants.

Operational and Policy Strategies

- Improve the river's flow regime by increasing the minimum winter flow and reducing the summer peak flow.
- Initiate programs to meet minimum winter flow levels as identified by State instream water rights in Upper Deschutes River from Wickiup reservoir to North Canal Dam.

- Decrease sedimentation and turbidity levels in sections of upper Deschutes River from Wickiup Reservoir to North Canal Dam.
- Reduce erosion by implementing spring ramping rates (0.1 ft/ 4 hrs rising).
- Support programs that raise awareness of the valuable role wetlands play within the watershed.
- Initiate collaborative and interagency conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Support efforts to reduce river contaminants in storm water runoff.
- Support education and community awareness/outreach programs to increase public awareness of the unique nature of the Deschutes Subbasin and the positive effects of projects that conserve water and increase irrigation efficiency.

Research and Evaluation Strategies

- Monitor the trout and aquatic invertebrate populations in the Deschutes, Fall and Spring rivers.
- Monitor and evaluate the adequacy of existing down-ramping rates to minimize loss of fish and macroinvertebrates.
- Research and model the potential success of fish populations between Wickiup Reservoir and the North Canal Dam with stable annual water levels.
- Evaluate sources and effects of spikes in turbidity on fish habitat and populations.
- Evaluate impacts of urban and rural runoff and effects on fish populations and water quality.
- Support water quality monitoring between Wickiup Dam and North Canal Dam in order to evaluate the successes of management strategies.
- Conduct a redband trout life history study to identify spawning and rearing areas and better define population characteristics including distribution, size and age at maturity, spawning frequency, abundance and migration patterns.
- Monitor population trends of fishes in the Deschutes River and tributaries.
- Complete an inventory and evaluate of current conditions of wetlands and their ability to restore and enhance water quality.
- Evaluate the distribution and connectivity between Oregon spotted frog populations.

3.8.4. Little Deschutes River

Key Findings

- No known core redband trout populations exist in the Little Deschutes system.
- Remnant redband trout populations are found in the section of the Little Deschutes below Gilchrist Mill Pond and in Crescent Creek from the Crescent Cut-off Road to Hwy 58.
- Nonnative brown and brook trout compete with redband trout for food and space.
- Several reaches in the Little Deschutes drainage are federally designated as Wild and Scenic Rivers, including the Little Deschutes River from Hemlock Creek to the headwaters (RM 84-97), Crescent Creek from the County Road to Crescent Lake Dam (RM 18.5-30), and Marsh Creek from the mouth to headwaters (RM 0-15).

- The combination of an altered flow regime, historic grazing practices, and more recently urbanization of the river corridor has had the greatest impact on aquatic habitat conditions.
- Low summer flow compounds temperature problems in the lower river.
- Several reaches in this habitat complex exceed State water quality criteria: Little Deschutes for temperature (both spawning and rearing) from Crescent Creek to Hemlock Creek and for dissolved oxygen (both spawning and rearing) from mouth to Crescent Creek; Crescent Creek for summer temperature (mouth to RM 26.1) and Paulina Creek (RM 0-13.2). More data is needed for the Little Deschutes River from the mouth to Crescent Creek to determine if temperatures exceed criteria, and examine bacteria, nutrients and sediments. Crown Pacific holds an industrial NPDES permit to discharge cooling water and process wastewater into the Little Deschutes at the town of Gilchrist.
- Cover in the lower reach of the Little Deschutes is lacking. The combination of low flows, erosion, and degraded riparian condition have eliminated or substantially reduced those features that would normally provide stream cover.
- Groundwater levels are very high near the Little Deschutes River and increase in depth at higher land elevations.
- The majority of riparian/wetland habitat in the drainage is privately owned.
- Fire suppression may be the most important factor influencing vegetation patterns in the Little Deschutes drainage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat complexity and cover.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers and provide fish protection screens at water diversions.
- Increase minimum stream flow.
- Meet State water quality criteria for salmonid spawning and rearing.

Sub-watershed Strategies

- Reduce grazing impacts on riparian stream corridors.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage increased number and distribution of beaver.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of remnant redband populations. Restore core redband trout populations where possible.
- Work with water users to increase the efficiency of water delivery and management practices to increase the minimum summer stream flow.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.

3.9. Cascade Highlands Assessment Unit

Cascade Highlands Assessment Unit includes the Cascade Lakes and upper Deschutes River drainage above Wickiup Dam.

Key Findings

- Redband and bull trout were endemic to this assessment unit.
- Bull trout have been extirpated from all but the Odell Creek / Odell Lake habitat complex.
- Bull trout were last seen in Wickiup Reservoir in 1954.
- The remnant population of bull trout in the Odell Creek/ Odell Lake complex is the only resident, non-reservoir, adfluvial population remaining in Oregon.
- The goal of the USFWS recovery plan for bull trout in the Deschutes Recovery Unit is to ensure the log-term persistence of self-sustaining complex interacting groups of bull trout distributed throughout the species native range.
- Tributaries to Crane Prairie Reservoir provide about 13.5 miles of stream habitat for redband trout, over three quarters of which is in the upper most reach of the Deschutes River. One quarter of the habitat is in Deschutes River tributaries.
- The Deschutes River between Wickiup Reservoir and Crane Prairie Dam is approximately two miles in length and impacted by flow manipulation.
- Habitat restoration/enhancement opportunities exist in most streams.
- Ponderosa pine and lodgepole pine forests have been reduced by 80% since mid-1800s, and have been replaced by other mixed conifer type forests.
- High fluctuations in reservoir water levels leave large areas of aquatic habitat unsuitable for beaver and other wildlife, including lower sections of tributary streams and the Deschutes River between the reservoirs.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Cascade Highlands Assessment Unit to achieve the vision for the Deschutes River Subbasin within the 25-year planning horizon. These objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain current distribution of bull trout in Odell Lake Recovery Unit and determine the feasibility of re-establishing self-sustaining bull trout populations within historically occupied areas.
- Maintain stable or increasing trends in abundance of adult redband and bull trout.
- Conserve genetic diversity and provide opportunity for genetic exchange.

- Restore beaver colonies in tributaries above the influence of fluctuating reservoir water levels.

Habitat Objectives

- Maintain or restore 63 acres of riparian habitat along fourteen miles of stream.
- Protect, restore and maintain suitable habitat conditions for all redband and bull trout life history stages and strategies.
- Retain existing lodgepole pine and ponderosa pine forests, and restore these forests to historic areas wherever possible to benefit focal wildlife species, including white-headed woodpecker and mule deer.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Cascade HIghlands Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Expand core bull population and reconnect redband trout populations across the assessment unit.
- Conserve genetic diversity and provide opportunity for genetic exchange.
- Restore riparian habitat complexity, preferably to build on, or extend, areas where good riparian habitat exists now or did historically.
- Priority actions include restoration in areas where structural upgrade will raise the water table to maintain instream flows, and encourage natural vegetative recovery.
- Native plant species should be used for riparian area re-vegetation, not exotic plant species.
- Restoration projects should increase range and abundance of existing native redband and bull trout populations. Multi-species benefits would have priority.

Management Strategies for Habitat Complexes

Two habitat complexes contain connected or similar habitats for focal fish populations in the Cascade Highlands Assessment Unit.

Deschutes River and tributaries above Wickiup Dam
Odell Creek Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.9.1. Deschutes River and Tributaries above Wickiup Dam

Key Findings

- Core redband populations are found in Wickiup and Crane Prairie reservoir complexes. These populations adapted an adfluvial life history following reservoir construction. They spawn in the tributaries and rear in the reservoirs.
- The Deschutes River between Little Lava Lake and Crane Prairie Reservoir is the most important redband trout spawning area.
- Rainbow trout indigenous to the Upper Deschutes River and tributaries are considered an inland redband trout and are listed as a sensitive species.
- Loss of habitat complexity increases rainbow trout and whitefish vulnerability to predation, but the impact on abundance is unknown.
- Self-sustaining exotic fish populations are present and may affect indigenous fish populations.
- The Deschutes River from Lava Lake to Crane Prairie Reservoir is designated as a State Scenic Waterway.
- Altered flows from water storage and seasonal releases reduce fish habitat quality and use in the Deschutes from Crane Prairie Dam to Wickiup Reservoir.
- High summer water temperatures associated with surface reservoir releases reduce water quality in reach between Crane Prairie Dam and Wickiup Reservoir.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase the quality, quantity and distribution of salmonid spawning habitat.
- Increase instream structural habitat complexity by 25%.
- Maintain protective fish screens at water intakes.
- Provide upstream and downstream passage for fish at road culverts and artificial obstructions in streams above Crane Prairie Reservoir.

Reservoir Strategies

- Maintain large wood structure/cover in Crane Prairie Reservoir.
- Reduce/manage seasonal reservoir pool fluctuation.

Sub-watershed Strategies

- Restore and maintain riparian habitat along stream and reservoir margins.
- Reduce concentrated recreation and other impacts on riparian stream corridors.

Operational and Policy Strategies

- Reduce seasonal flow fluctuations in the river between Wickiup Reservoir and Crane Prairie Dam.
- Identify optimal ramping rates for flows in area between Wickiup reservoir and Crane Prairie.
- Investigate feasibility of providing upstream and downstream passage at Wickiup and Crane Prairie dams.
- Coordinate with irrigation districts to assure fish protection screens are installed and maintained at the Crane Prairie and Wickiup intakes.

Research and Evaluation Strategies

- Identify impacts of barriers and sites of entrainment for redband and bull trout populations.
- Conduct periodic stream surveys to determine fish distribution and population status.
- Develop and conduct research and monitoring studies to determine movement of focal fish species and seasonal use of different habitat areas.
- Evaluate interactions and competition between native trout populations and exotic species.
- Evaluate the timing and effects of flow management strategies on water quality, quantity.
- Investigate with the USFS, BOR, and irrigation districts the possibility of plugging subterranean water leaks in Crane Prairie Reservoir to better manage reservoir storage and outflow to enhance aquatic habitats.

3.9.2 Odell Creek Complex

Key Findings

- The Odell Lake Complex is recognized as a core area for bull trout.
- Trapper Creek provides the only known bull trout spawning area in the Upper Deschutes watershed.
- Increased bull trout abundance could potentially come from expansion of spawning and juvenile rearing habitat in Trapper, Maklaks and Odell Creeks and/or use of historic habitat in Crystal Creek and other areas.
- Core redband trout populations exist in Odell and Davis lakes and use Odell Creek for spawning.
- Summer water temperatures and pH levels in Odell Creek exceed State water quality standards.
- High fine sediments in tributaries may limit salmonid spawning potential.
- Minimum flows in Odell Creek are typically in September with maximums in June. Mean monthly flows measured between 1970 and 1992 were 158 cfs for June and 79 cfs for September.
- The aquatic insect community sampled in and analyzed from Odell Creek in 1991, indicated that the stream has reduced habitat complexity and moderate to high embeddedness.
- Self-sustaining exotic fish populations are present and may affect indigenous fish populations.

Management Strategies Specific to Habitat Complex

In-Channel Strategies

- Increase instream structural habitat complexity by 25%.
- Maintain of improve water quality in the bull trout core area or potential core areas.
- Maintain or restore habitat in and adjacent to Trapper Creek to benefit spawning bull trout.
- Restore impaired stream channel areas.
- Provide fish passage at artificial obstructions and eliminate entrainment.

Sub-Watershed Strategies

- Reduce sediment sources through road stabilization and improved drainage systems, etc.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.

Operational and Policy Strategies

- Increase angler education to prevent over-harvest and incidental angling mortality of bull trout.
- Develop, implement fish stocking polices to reduce stocking of non-native fishes that affect bull trout.
- Address the issues of fish passage and flow maintenance at the barrier dam at the Odell Lake outlet.
- Initiate partnerships and collaborative processes to protect, maintain and restore functioning core areas for bull trout and redband trout.

Research and Evaluation Strategies

- Analyze interactions among aquatic species in Odell Recovery Unit, including competition between bull and lake trout in Odell Lake, and competition and hybridization between bull and brook trout in Trapper Creek.
- Assess feasibility of re-establishing bull trout in Crystal Creek and Odell Creek.
- Monitor for fish pathogens.
- Assess water quality in Odell Lake complex and identify sources of water quality impacts.
- Quantify and evaluate sources of fine sediments in tributary stream substrates and impacts on native fish populations.
- Identify barriers or sites of entrainment for bull and redband trout.
- Continue research to determine bull trout presence/absence, timing and abundance in habitat areas.

4. Cookbook of Potential Actions

Actions taken on individual watershed to achieve the management strategies and meet the biological objectives with vary depending on the restraints and opportunities that are unique to a particular situation. The following list of actions and activities describe many of the possible approaches available for habitat restoration in the subbasin.

Category of Action and/or Activity

1. Water Conservation / Stream Flow Recovery

Convert water conveyances from open ditch to pipe or lined canal
Convert delivery system to sprinkler or drip
Convert from instream diversion to groundwater wells
Convert point of withdrawal from gravity to pump
Convert water right to instream right thru lease, purchase, agreement
Consolidate or improve irrigation diversion dams

2. Restore riparian stream corridor / floodplain function

Protect the stream corridor and floodplain from livestock grazing and soil and vegetative disturbances.
Provide upland water sources for livestock
Provide controlled stream access points with hardened banks, fords
Plant or seed native species
Implement stream bank stabilization measures

3. Restore instream habitat complexity

Protect riparian stream corridors for future large woody debris supply
Install habitat forming materials such as large wood and/or boulders in the channel
Maintain existing instream structure
Restore overhanging vegetation
Encourage the establishment of beaver populations
Restore oxbow sloughs and backwaters
Protect springs and seeps

4. Reduce instream sedimentation

Re-establish a functional riparian vegetative corridor and floodplain
Harden livestock stream crossings or controlled access points
Stabilize stream banks with bio-engineering or other techniques
Implement upland conservation buffers
Implement upland conservation farm plans and cropping methods
Control invasive and noxious vegetation and re-establish native plants in riparian and upland areas
Implement erosion control practices
Relocate or decommission roads
Reduce road runoff into streams

5. Restore fish passage at artificial obstructions

Restore perennial stream flow
Modify, breach or remove obstructions
Install and maintain fully functional fish ladders
Install and maintain fully functional fish screens
Bridge, culvert and road ford maintenance, removal or replacement.
Increase minimum stream flow
Reduce maximum stream water temperature

6. Reduce stream channel scour or incision

Protect the stream corridor and floodplain to restore riparian vegetation
Install streambank protection, i.e. bio-engineering
Install instream structures (rock and large wood)

7. Reduce maximum stream temperatures

Restore riparian and floodplain function
Reduce stream channel width
Restore floodplain water table with increased channel elevation
Restore or increase minimum perennial stream flow
Implement water conservation measures
Re-establish and maintain beaver populations

8. Reduce stream channel width

Protect or re-establish diverse riparian vegetation
Restore floodplain function
Install interim sediment collection traps within the floodway
Restore instream structure
Install streambank protection, i.e. bio-engineering

9. Improve upland watershed health

Restore native grasslands
Implement upland grazing systems to reduce runoff and erosion
Implement erosion control practices
Implement upland conservation buffers
Develop upland water sources for livestock and wildlife
Protect riparian habitat associated with upland springs and seeps

5. Consistency with ESA/CWA Requirements

Endangered Species Act Compliance

Many of the larger issues regarding impacts to listed species that are concerns at the scale of the Columbia Basin are not concerns in the Deschutes Subbasin. Wild summer steelhead are caught incidentally in the Deschutes River hatchery steelhead fishery and the Sherars Falls tribal and sport fisheries, but must be released unharmed. The only harvest of bull trout occurs in Lake Billy Chinook under very restrictive regulations. Hatchery summer steelhead are produced at Round Butte Fish Hatchery under the guidance of the Round Butte Fish Hatchery Genetic Management Plan. Only Deschutes stock summer steelhead are cultured at the hatchery. Actions that are comtemplated in this plan are consistent with information the Deschutes Subbasin planning team has received from NOAA Fisheries' Technical Recovery Team to protect existing healthy populations of summer steelhead, improve the health of the populations that have low productivity or are in low abundance and to seek ways to increase the production of summer steelhead in historic habitat in the Middle Deschutes Subbasin. In addition, recommendations from the draft Recovery Plan for the Middle Columbia ESU Recovery Unit were incorporated into the Subbasin Plan where such recommendations were consistent with the plan scope and Technical Guide for Subbasin Planners. Like the Subbasin Plan, the FCRPS BiOp, and other fishery conservation management plans within the Columbia River Basin, recovery plans should be based on the principles of adaptive management for those factors for decline that are not completely understood, or for which strategies for conservation are not well defined. The Subbasin Plan strengthens this approach by recognizing factors for decline that can be reversed or reduced, and those factors for decline that are at this point not completely understood..

Clean Water Act Compliance

In the Deschutes Subbasin, the Federal Clean Water Act is implemented in large part through the State's preparation of water quality standards, Total Maximum Daily Loads (TMDLs) and TMDL implementation processes of designated management agencies. The Oregon Department of Environmental Quality (ODEQ) has identified streams throughout the subbasin as water quality limited for temperature, dissolved oxygen, pH, fecal coli form bacteria, sedimentation, turbidity, and/or total dissolved gas. ODEQ's data collection for TMDLs is underway and is expected to be completed in 2005. Completion of TMDLs is slated for the end of 2006. Once the TMDL modeling process begins, it is likely that it will produce goals specific to attainment of water quality criteria throughout the Subbasin. It is unclear at this point whether or not these goals, such as specific numeric targets necessary for attainment, will be consistent with the management strategies outlined in this Plan. This document recognizes that both the subbasin planning and TMDL processes are adaptive in nature. Once TMDLs are established for the subbasin planning area, the plan will be re-evaluated on some designated time-frame to incorporate new findings and ensure consistency with TMDLs and/or new 303(d) listings. It should also be noted that the findings of the subbasin planning process will be utilized in the TMDL process.

Achievement of the TMDL, in part, occurs through implementation of nonpoint source management plans: the Agricultural Water Quality Management Area Plans (SB 1010), the Oregon Forest Practices Act, County Comprehensive plans, and Federal policies/plans on Forest Service lands. These plans vary from voluntary to proscriptive (though all should have reasonable assurance of implementation), and management oversight is normally conducted through the local, state or federal land use authority. Achievement of the TMDL also occurs through implementation of NPDES permits regulated by ODEQ. Initiative-based restoration/protection and public funding dovetails with TMDL implementation and is an important implementing mechanism. Subbasin Planning is recognized as a key effort that supports TMDL implementation, and will be recognized in the TMDL water quality management planning process.

6. Research, Monitoring and Evaluation

Research and monitoring programs have been on-going in some areas of the Deschutes Subbasin for many years. Biologists have collected anadromous fish data from the lower one hundred miles of the Deschutes River to estimate run size, in-river harvest and escapement for nearly forty years. This data collection includes statistical sport and tribal fish harvest monitoring, mark and recovery (modified Schnabel) population and escapement estimates and annual steelhead and Chinook spawning surveys. Life history studies have been completed on lower Deschutes summer steelhead, spring and fall Chinook and redband trout. A redband trout assessment was recently completed for the Crooked River drainage. There are ongoing studies on fall Chinook, bull trout and Pacific lamprey within the upper and lower subbasin. All of this existing data provided some general insight into how changes in habitat may have affected various focal fish populations. Some research, monitoring and evaluation of habitat changes — particularly those associated with recent habitat restoration projects — also provided important information that helps planners evaluate, focus and adjust restoration strategies.

During the assessments, however, biologist and planners often found that a lack of information about biological and environmental conditions in some individual watersheds hampered their efforts to clearly, and confidently, define environment/population relationships and identify needed restoration actions. In some cases, such as in some reaches of the upper Little Deschutes River drainage, little was known about the presence, distribution and life histories of redband trout populations. In other cases, not enough information was available about different habitat attributes to confidently rate their quality and assess potential gains in fish and wildlife production through habitat restoration. In many areas, little monitoring has occurred to accurately identify streamflow, water temperature and dissolved oxygen levels and fluctuation.

Many of these limitations are identified as key findings and addressed as research and evaluation management strategies at the assessment unit and habitat complex levels in the previous section. General research and monitoring and evaluation needs in the Deschutes Subbasin are also identified in Tables MP-1 and MP-2.

Table MP-1. Deschutes Subbasin Research Needs.

Research Need	Methods	Tools/Techniques
Focal Fish Life history Redband trout in middle and upper subbasin, Bull trout and Pacific lamprey in Lower Westside AU	Population status/distribution	Population sampling, tagging
	Habitat use and preference	Radio telemetry
	Interspecific relationships with exotic species (i.e. brook and Brown trout, three-spine stickleback, bass, Tui chub)	Population sampling, telemetry
	Migration patterns/timing	
Stray out-of-basin hatchery fish	Enumerate stray summer steelhead and Chinook salmon in the subbasin by species and origin	Count at Sherars Falls, Pelton and Warm Springs Hatchery traps and potentially tributary weirs (Buck Hollow, Bakeoven and Trout creeks)
	Estimate number of stray steelhead spawning in subbasin	Spawning surveys, trapping, tagging
	Evaluate disease risks	Collect random samples from stray steelhead and Chinook salmon
Habitat restoration treatments	Evaluate past projects affect on habitat restoration/recovery	Recover project documentation and evaluation data, if available
	Evaluate different treatments for same habitat deficiency	Conduct extensive literature review Review past or ongoing projects Establish control and reference plots
	Evaluate best opportunities for natural water storage/retention and flow augmentation	Geologic and groundwater investigations
	Evaluate most effective techniques or treatments for water temperature moderation	Establish control and reference streams and reaches.
	Evaluate the opportunities for restoring natural stream channel sinuosity and gradient.	Consult historic photos, maps, topography. Conduct surveys. Consult with landowner/manager

Table MP-2. Deschutes Subbasin Monitoring and Evaluation Needs.

Monitoring Need	Methods	Tools/Techniques
Population status & trends – focal fish	Estimate in-basin harvest	Continue statistical sampling programs
	Estimate annual population (run) size	Continue tag/recapture/population estimates Continue counts at Pelton/Warm Springs Install tributary weirs Continue and expand spawning surveys
	Estimate population productivity	Sample spawners for age, sex, and size
	Estimate number of out-of-subbasin stray steelhead and Chinook salmon	Record mark/tag info in creel and traps Continue tag/recapture/population estimates Seek 100% mark of all Basin hatchery fish Tributary weir monitoring
	Determine seasonal focal fish distribution	Continue and expand spawning surveys Presence/absence surveys
	Estimate juvenile/smolt production	Tributary enumeration, trapping
Stream Habitat Attribute baseline	Determine % riparian function by stream	Conduct AIP-type surveys
	Determine % fine sediments (embeddedness and intragravel)	Conduct AIP-type surveys
	Determine existing water quality (DO, Temperature, pH, pollutants, turbidity, etc)	Conduct AIP-type surveys
	Determine quantity/quality/distribution of instream structure	Conduct AIP-type surveys
	Determine instream habitat diversity (habitat types)	Conduct AIP-type surveys
	Determine channel/bank stability Record current stream flow	Conduct AIP-type surveys
Restoration Treatments	Determine effectiveness/response	Photo points and attribute monitoring as appropriate for the type of treatment
	Determine changes in: morphology, vegetation, water quality and quantity	Water quality monitoring Stream/Riparian/Floodplain Transects Upland watershed transects/photo points Utilize continuous recording flow gauge and temperature recorder.
Exotic fish	Determine affect on focal fish	Fish population monitoring Presence/absence surveys
Beaver	Determine changes in abundance and distribution	Population/presence absence surveys

Coordination with Pacific Northwest Aquatic Monitoring Partnerships

This planning document recognizes the need for a disciplined, and well coordinated, monitoring and evaluation program to help confirm scientific assumptions, resolve key uncertainties and provide the basis for performance tracking and adaptive management. Collecting monitoring data in a way that data can be “rolled-up” to larger scales is essential for information gathered at the scale of watersheds or subbasins to support evaluations at larger geographic scales, such as province or Evolutionarily Significant Unit. The Warm Springs Tribes and ODFW currently follow monitoring protocols developed for the Oregon Plan for Salmon and Watersheds. These protocols are standardized and are being coordinated with regional standards through Pacific Northwest Aquatic Monitoring Partnerships (PNAMP) discussions.

The PNAMP provided “Considerations for monitoring in subbasin plans” on May 4, 2004. We generally agree with and support the intent and direction of these guidelines. However, key elements of the Partnership’s recommendations have yet to be developed (e.g. the Strategic Monitoring Framework, a data management plan, etc.). For this reason and due to the extremely short time available to respond to these suggestions, we have been unable to incorporate specifically the Partnership’s monitoring recommendations. Rather, we offer here some perspectives on how parties to the Deschutes Subbasin Plan can integrate their monitoring efforts into a regionally consistent framework. This is a forward-looking effort and, although it is to a degree a “plan to develop a plan”, that cannot entirely be avoided since so many critical elements are yet to be developed at a regional level.

The PNAMP guidance includes recommended principles for coordinated monitoring. These principles are organized into four issue areas. This subbasin plan incorporates those principles as follows.

1. Principles for Resource Policy and Management

Discussions by the Deschutes Coordinating Group and with natural resource managers in the subbasin have consistently identified answers to the following questions as central to having a successful fish and wildlife restoration program.

a. What are the trends over time in the productivity, abundance and distribution of focal species identified in this plan?
b. What are the trends over time in the amount, quality, and distribution of the habitats upon which these focal species depend?
c. Considering the subbasin as a whole, are habitat conditions showing a net improvement or a net degradation?
d. Which habitat restoration strategies are most effective and most cost-effective (not necessarily the same thing) at i) improving habitat conditions and ii) affecting the performance of focal species populations?

The Deschutes Coordinating Group will work with ODFW, the Warm Springs Tribes, the U.S. Forest Service, and other natural resource agencies to establish a monitoring and evaluation technical team by August 31. The technical team will evaluate how present monitoring efforts in the subbasin address policy questions, identify gaps in existing efforts, and suggest how the efforts could be improved. The team will report its findings and recommendations to the Deschutes Coordinating

Group by January 31, 2005. The Deschutes Coordinating Group will then sponsor an M&E workshop by 4/31/05 to review and refine recommendations in the report and identify changes (including additional effort needed) to be proposed and implemented in FY06. This additional information will be formally incorporated into the subbasin plan during the Council's subsequent rolling review period.

2. Principles for Efficiency and Effectiveness

The report and workshop described above will identify opportunities for agencies to coordinate monitoring efforts to address policy questions. The seven specific PNAMP principles in this category will be part of the workshop agenda also. Recommendations that are possible within existing programs and budgets will begin being officially coordinated in FY06.

Local agency offices within the Deschutes Subbasin do not have the staff and other resources to participate directly in PNAMP. Rather, they will rely on the federal, state, and tribal representatives who do participate in PNAMP to disseminate relevant material and provide local support for regional monitoring needs and coordination. This is a function the PNAMP Steering Committee could likely provide.

3. Principles for Scientific Soundness

Some of the seven principles in this category (e.g. integrated monitoring and shared goals and objectives) will be wholly or partially met as described above when addressing other principles. Other principles (e.g. regional consensus on status and trend monitoring, guidelines on multiple spatial and temporal scales) will be developed by others at a regional level. We intend to incorporate these when they become available and within the rolling review process of the Power and Conservation Council.

Still other principles in this category (e.g. statistically precise monitoring designs) will require expertise not normally available locally. Perhaps these technical resources can be provided by a state or regional group dedicated to working with local subbasin groups to translate regional agreements into effective implementation by local programs and projects. The TOAST model is an example of the type of technical support we feel would be effective.

4. Principles for Sharing Information

The five information sharing principles in this category are largely beyond the resources of local agency and tribal offices. We have neither the necessary skills locally, nor a budget able to provide those skills.

Our immediate information sharing strategy is to call upon existing regional information management projects to provide the expertise and guidance to meet these principles. We will begin this process by using the StreamNet system to archive the technical work done for this plan. This will consist of the GIS and tabular data files used in the assessment. These reach-specific files will form the basis of future monitoring efforts.

We will look to the Northwest Environmental Database Network to develop regional strategies and standards for information sharing. That project has the breadth of concept and technical expertise to effectively integrate monitoring information into a broader fish and wildlife data management system.

List of References

Allison, I.S. 1979. Pluvial Fort Rock Lake, Lake County, Oregon. Oregon Department of Geology and Mineral Industries, Special Paper Number 7.

Anderson, C.W., 2000. Framework for Regional, Coordinated Monitoring in the Middle and Upper Deschutes River Basin, Oregon. U.S. Geological Survey Open-File Report 00-386.

Aney, W.M., M.L. Montgomery and A.B. Lichens. 1967. Lower Deschutes River, Oregon; discharge and the fish environment. Lower Deschutes Flow Study Final Report. Oregon State Game Commission, Portland, Oregon.

Ashley, Paul and Stacy Stoval. 2004. American Beaver. Species Account written for the Southeast Washington Ecoregional Assessment.

Bakeoven Watershed Council (BWC). 1996. Bakeoven Watershed Action Plan. Wasco County Soil and Water Conservation District. The Dalles. Oregon.

Borovicka, Robert. 1956. Oregon State Game Commission Annual Report.

Borovicka, Robert. 1953. Oregon State Game Commission Annual Report.

Brun, C. V. and R.R. Dodson. 2002. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation: 2001 Annual Report. BPA. The Dalles, Oregon.

Brun, C.V. 2000. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation. 1999 Annual Report. BPA. The Dalles, Oregon.

Brun, C.V. and R.D. Dodson. 2001. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation: 2000 Annual Report. BPA. The Dalles, Oregon.

Brun, C.V. 1999. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation, 1998 Annual Report. Bonneville Power Administration, Portland, Oregon.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout; distribution, life history, limiting factors, management considerations, and status.. Oregon Department of Fish and Wildife, Portland, OR.

Buckley, G L. 1992. Desertification of the Camp Creek drainage in central Oregon, 1826-1905. Master's Thesis, University of Oregon, Eugene, Oregon.

Bull, E. L., and M. P. Hayes. 2001. Post-breeding season movements of Columbia spotted frogs (RANA LUTEIVENTRIS) in northeastern Oregon. Western North American Naturalist.

Burke, J. 1997. ODFW Aquatic Inventory Project Stream Report; Crooked River. Survey from Lake Billy Chinook to Bowman Dam. Oregon Department of Fish and Wildlife, Corvallis.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-27.

Burt, Henry William. 1976. A Field Guide to the Mammals: North America north of Mexico. Houghton Mifflin Co.

Cai, Qian. 2002. Certified estimates for Oregon, Its Counties and Cites, July 1, 2002. Population Research Center, Portland State University.

Central Oregon Intergovernmental Council (COIC). 2002. Central Oregon Community Investment Plan.

Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS). 1992. Integrated Resources Management Plan for the Forested Area, Warm Springs Indian Reservation of Oregon. 1992.

Confederated Tribes of the Warm Springs Reservation of Oregon and Warm Springs Power Enterprises (CTWS). 1999(a). Pelton Project Final License Application. Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, Oregon.

Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS). 1999(b). Integrated Resources Management Plan and Project Assessment for the Non-forested and Rural Areas. Confederated Tribes of the Warm Springs Reservation of Oregon. Warm Springs, Oregon.

Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS). 1999(c). The People’s Plan, Executive Summary of the Comprehensive Plan for the Year 2020. Confederated Tribes of the Warm Springs Reservation of Oregon. Warm Springs, Oregon.

Cramer, S.P. and R. Beamesderfer. 2001. Population Dynamics, Habitat Capacity and a Life History Simulation Model for Steelhead in the Deschutes River, Oregon. Prepared for Portland General Electric. Portland, Oregon.

Crook County Historical Society. 1981. The history of Crook County, Oregon. Taylor Publishing Company. Dallas, Texas.

Crooked River Local Advisory Committee (CRLAC). 2003. Draft Crooked River Agricultural Water Quality Management Area Plan. Crooked River Local Advisory Committee with assistance from Oregon Department of Agriculture and Crook County Soil and Water Conservation District. Prineville, Oregon.

Crown Pacific. 1998. Land Exchange Final Environmental Impact Statement. Bend, Oregon.

Csuti et al. 2001. Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History. Oregon State Univ. Press, Corvallis, Or.

Curran, J.H. and J.E. O'Connor. 2003. Formation and evolution of valley-bottom and channel features, lower Deschutes River, Oregon. Pages 95-119 In: J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Curtis, J. 1994. Squaw (Why-Chus) Creek Watershed Assessment. Deschutes Soil and Water Conservation District. Bend, Oregon.

Eddy, D. 1996. July 8 and 9, 1996 thunderstorm damage assessment for Wasco county agricultural land and streams. Unpublished memo, Natural Resources Conservation Service, The Dalles, Oregon.

Engelking, M. 2002. Potential for Introduction of Myxobolus cerebralis into the Deschutes River Watershed in Central Oregon form Adult Anadromous Salmonids. American Fisheries Society Symposium 29:25-31.

Fassnacht, H. 1998. Frequency and Magnitude of Bedload Transport Downstream for the Pelton Round Butte Complex, Lower Deschutes River, Oregon. Portland General Electric. Portland, Oregon.

Fassnacht, H, E.M. McClure, G.E. Grant, and P.C. Klingeman 2003. Downstream effects of the Pelton-Round Butte Hydroelectric Project on bedload transport, channel morphology, and channel-bed texture, Lower Deschutes River, Oregon. Pages 169-201 In: J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Ferry, B., E. Schwartz, and R. Klumph. 1979. Physical and biological stream survey North Fork Crooked River and tributaries excluding Committee Creek and Deep Creek watersheds. Administrative Report No. 79-1. Oregon Department of Fish and Wildlife, Prineville, Oregon.

Frey. 1942. Personal notes summarized in Nielson (1950).

Friends of LaPine Public Library. 2002. History of LaPine pioneers. Maverick Publications, Bend, Oregon.

Gabrielson, Ira N. and Stanley G. Jewett. 1970 ed. Birds of the Pacific Northwest, With Special Reference to Oregon. (Formerly: Birds of Oregon.) Dover Publications, Inc. New York.

Gannett, M.W., M.Manga, and K.E. Lite, Jr. 2003. Groundwater hydrology of the upper Deschutes Basin and its influence on streamflow. Pages 31-49 In J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Gannett, M., K. Lite Jr., D. Morgan and C. Collins. 2001. Ground-water Hydrology of the Upper Deschutes Basin, Oregon. U.S. Department of Interior U.S. Geological Survey. Water Resources Investigations Report 00-4162.

Gannett, M.W., M.Manga, and K.E. Lite, Jr. 2003. Groundwater hydrology of the upper Deschutes Basin and its influence on streamflow. Pages 31-49 *In* J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Gray, E. 1986. Roughing it on the Little Deschutes River, 1934-1944: A History of a Sawmill Camp and Its People. KM Printing, Eugene, Oregon.

Griggs, James. 1967. Fall River Stream Survey. Oregon State Game Commission.

Hallock, L.A. and McAllister, K.R. 2002. Columbia Spotted Frog. Washington Herp Atlas.

Hatton, Raymond R. 1996. Oregon's Sisters Country: A Portrait of Its Lands, Waters, and People. Maverick Publications. Portland, Oregon.

Hardin, T. 1993. Summary report: Crooked River instream flow study. Hardin-Davis, Inc., Albany, Oregon.

Hibbard, E. A. 1958. Movements of beaver transplanted in North Dakota. J. Wildl. Manage. 22(2):209-211.

Hodgdon, H. W., and J. H. Hunt. 1953. Beaver management in Maine. Maine Dept. Inland Fish Game, Game Div. Bu 11. 3. 102 pp.

Hosman, K. J., L.L. Ely, and J.E. O'Connor. 2003. Holocene paleoflood hydrology of the Lower Deschutes River, Oregon. Pages 121-146 In J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Hostick. Gary. 2004. Deschutes Subbasin Wildlife Assessment. Ecological Services, Inc. Bend, Oregon.

Hough, George. 2002. Components of Population Change 1990-2000, Oregon, and Its Counties. Census 2000 for Oregon, Population Research Center, Portland State University.

Hubler, S. 2000. Upper Deschutes River basin remap: 1997-98 vertebrate summary. Oregon Department of Enviornmental Quality, Biomonitoring Section. Technical Report – BIO 00-008. Portland, OR.

Hudson's Bay Record Society. 1971. Peter Skene Ogden's Snake Country Journals: 1827-28 and 1828-29. Edited by Glyndwr Williams, PH.D, The Hudson's Bay Record Society, London, England.

Huntington, C.W. 1985. Deschutes River spawning gravel study. Buell and Associates, Inc. for the Bonneville Power Administration. BPA Project No. 83-423. Bonneville Power Administration. Portland, Oregon.

Huntington, C., T. Hardin, and R. Raymond. 1999. Water temperatures in the Lower Deschutes River, Oregon. Portland General Electric Company. Portland, Oregon.

IBIS. 2004. Interactive Biological Information System. Northwest Habitat Institute, Corvallis, OR www.nhi.org

Idaho Department of Fish and Game, Idaho Department of Parks and Recreation, Bureau of Land Management, Regions 1 and 4 of U.S. Forest Service, and U.S. Fish and Wildlife Service. 1995. Habitat Conservation Assessment and Conservation Strategy: Spotted Frog (Rana pretiosa). (Draft) Idaho State Conservation Effort.

Independent Scientific Group (ISG). 1996. Return to the River: Restoration of Salmonids Fishes in the Columbia River Ecosystem. Northwest Power Planning Council, Portland, Oregon.

Interior Columbia Basin Technical Recovery Team. 2003. Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units Within the Interior Columbia River Domain. NOAA Fisheries

Jefferson County Soil and Water Conservation District (JCSWCD). 1996. Trout Creek Watershed Resource Inventory, Problem Assessment, and Treatment Alternatives. Edited by Natural Resource Conservation Service and sponsored by Jefferson County Soil and Water Conservation District. December 1996.

Johnson, David H. and Thomas A. O'Neil (managing directors). 2001.Wildlife-Habitat Relationships in Oregon and Washington.. Oregon State Univ. Press, Corvallis, Or. 768 p.

Johnson, R. D. Smith, L. Nelson, S. Kuk, and S. Galentine. 1994. North Fork Crooked River subbasin, 1994 stream survey report. Big Summit Ranger District, Ochoco National Forest, Prineville, Oregon.

Kostow, K. 2002. Oregon Lampreys: Natural History Status and Analysis of Management Issues. Oregon Department of Fish and Wildlife. Portland, Oregon. Lande, R. 1995. Breeding plans for small populations, based on the dynamics of quantitative genetic variance. In *Population Management For Survival and Recovery*, Eds. J.D. Ballou, M. Gilpin, and T.J. Foose, pp. 318-340. Columbia University Press, New York.

Lamson, K. and J. Clark. 2003. Draft White River Watershed Assessment, Working Copy. Prepared by Wasco County Soil and Water Conservation District for the White River Watershed Council. Principal Authors: Karen Lamson, Northwest Service Academy, Trout Lake, WA. and Jennifer Shannon Clark, Wasco County Soil and Water Conservation District, The Dalles OR. 2003

Lewis, S.D. 2003. Oncorhynchus mykiss monitoring in Squaw Creek. In: Notebook, 2002 Pelton Round Butte Fisheries Progress Report, December 2003. Portland General Electric Company. Portland, Oregon.

Lewis, S.D. and R. Raymond. 2000. Lower Deschutes River dissolved oxygen study, 1999 Pelton Round Butte Hydroelectric Project FERC 2030. Portland General Electric Company. Portland, Oregon.

Lichatowich, Jim. 1999. Salmon Without Rivers: A History of the Pacific Salmon Crisis.

Lichatowich, J., R. Williams and J. Nathan. 1998. A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River. Prepared for Portland General Electric, Portland, Oregon.

Lindsay, R.B., B.C. Johasson, R.K. Schroeder and B.C. Cates. 1989. Spring chinook salmon in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife Information Reports (Fish) 89-4, Portland, Oregon.

Linzey, D. and C. Brecht. 2002. Website accessed on 26 June 2003.
http://www.discoverlife.org/nh/tx/Vertebrata/Mammalia/Castoridae/Castor/canadensis.

Lower Deschutes Local Advisory Committee (LDLAC). 2002. Lower Deschutes Agricultural Water Quality Management Area Plan. Lower Deschutes Local Advisory Committee with assistance from Oregon Department of Agriculture and Wasco County Soil and Water Conservation District, The Dalles, Oregon.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR.

Mathisen, Leonard. 1985a. History of the Upper Deschutes River fisheries over the past 80 years. Unpublished report prepared for Deschutes County Community Development Department. Deschutes County River Study Workshop Series (Fisheries).

Mathisen, L. 1990. Upper Deschutes River water resource review. Bend, Oregon.

McClure, E. 1998. Spatial and Temporal Trends in Bed Material and Channel Morphology Below a Hydroelectric Dam Complex, Lower Deschutes River, Oregon. Prepared for Portland General Electric, Madras, Oregon.

McSwain, M. 1998-2000. Personal Communication with Crooked River Watershed Council staff, as referenced in Whitman (2002). Bureau of Land Management. Prineville, Oregon.

Meehan, W.R. 1982. Influence of forest and rangeland management on anadromous fish habitat in western North America. Pacific Northwest Forest and Range Experiment Station, USDA, Forest Service, Portland, Oregon.

Middle Deschutes Local Advisory Committee (MDLAC). 2001. Middle Deschutes Agricultural Water Quality Management Area Plan. Middle Deschutes Local

Advisory Committee with assistance from Oregon Department of Agriculture and Jefferson County Soil and Water Conservation District, Redmond, Oregon.

Minear, P.J. 1999. Historical Riparian Conditions and Large In-channel Wood, Deschutes River Oregon. Prepared for Portland General Electric, Hydro Licensing Department, Portland Oregon.

Mobrand Biometrics. 2003. Guidelines for Rating Selected Level 2 Environmental Attributes. P.71. Vashon, Washington

Mobrand Biometrics. 2003a. Guidelines for Rating Selected Level 2 Environmental Attributes. P.67. Vashon, Washington

Mobrand Biometrics. 2003b. Guidelines for Rating Selected Level 2 Environmental Attributes. P.86. Vashon, Washington

Moore, D., Z. Willey and A. Diamant. 1995. Restoring Oregon's Deschutes River, Developing Partnerships and Economic Incentives to Improve Water Quality and Instream Flows. Environmental Defense Fund and Confederated Tribes of the Warm Springs Reservation of Oregon.

Morris, R. L. and W. W. Tanner. 1969. The ecology of the western spotted frog, Rana pretiosa pretiosa Baird and Girard, a life history study. Great Basin Naturalist 2:45-81.

Mote, P. E. Parson, A. Hamlet, W. Keeton, D. Lettenmaier, N. Mantua, E. miles, D.W. Peterson, D.L Peterson, R. Slaughter, A. Snover. 2003. Preparing for Climatic Change: The Water, Salmon, and Forests of the Pacific Northwest. JISAO/SMA Climatic Impacts Group, University of Washington, Seattle, Washington.

Mote, P., M. Holmberg, N. Mantua. 1999. Executive Summary: Impact of Climate Change on Pacific Northwest. JISAO/SMA Climatic Impacts Group, University of Washington, Seattle, Washington.

Murray, D. F. 1961. Some factors affecting the production and harvest of beaver in the upper Tanana River Valley, Alaska. M.S. Thesis, Univ. Alaska, Anchorage.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35, 443p.

National Biological Information Infrastructure, 2004. www.nbii.gov.

Nehlsen, W. 1995. Historical Salmon and Steelhead of the Upper Deschutes River and Their Environments. Prepared for Portland General Electric, Portland, Oregon.

Nelson, L., C. Kunkel, et al. 2001. Draft Deschutes River Subbasin Summary. Prepared for the Northwest Power Planning Council. Oregon Department of Fish and Wildlife.

Newton, J., and L. Nelson. 1998. Lower Deschutes River resident trout population inventory 1998. Oregon Department of Fish and Wildlife. The Dalles, Oregon.

Nielson, R. S. 1950. Survey of the Columbia River and its tributaries, Part V. Special Scientific Report: Fisheries No. 38. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C.

Northwest Power Planning Council (NPPC). 2001. Technical Guide for Subbasin Planners. Council document 2001-20.

O'Connor, J.E., G.E. Grant, J.H. Curran and H. Fassnacht. 1999. Geomorphology of the Deschutes River below the Pelton Round Butte Dam Complex, Oregon. Prepared for Portland General Electric, Portland, Oregon.

O'Connor, J.E. G.E. Grant, and T.L. Haluska. 2003a.. Overview of geology, hydrology, geomorphology, and sediment budget of the Deschutes River Basin, Oregon. Pages 7-29. In J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

O'Connor, J.E., J.H. Curran, R.A. Beebee, G.E. Grant, and A.Sarna-Wojciki. 2003b. Quaternary geology and geomorphology of the Lower Deschutes River Canyon, Oregon. Pages 73-94 In J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Olsen, E.A., R.B. Lindsay, W.A. Burck. 1991. Summer steelhead in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife Information Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon. Unpublished draft.

Oosterhout, G. 1999. PasRAS: A Stochastic Simulation of Chinook and Sockeye Life Histories – Pelton Round Butte Hydroelectric Project FERC No. 2030. Decision Matrix, Inc. Canby, Oregon.

Oregon Department of Environmental Quality (ODEQ). 1988. Statewide Assessment of Non-point Pollution. Portland, Oregon.

Oregon Department of Environmental Quality (ODEQ). 2000. Draft City of Prineville Wastewater Facility Plan. Bend, Oregon.

Oregon Department of Environmental Quality (ODEQ). 2002. State of Oregon 303(d) list for water quality limited streams.

Oregon Department of Fish and Wildlife (ODFW) and Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS). 1990. Deschutes River Subbasin Salmon and Steelhead Production Plan. Prepared for the Northwest Power Planning Council, Columbia River Basin system planning.

Oregon Department of Fish and Wildlife (ODFW). 1992. Buck Hollow Physical Habitat Survey, Columbia District, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 1995. Bakeoven Physical Habitat Survey, Columbia District, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 1996(a). Upper Deschutes River Subbasin Fish Management Plan. Prepared by T. Fies, J. Fortune, B. Lewis, M. Manion and S. Marx. Upper Deschutes Fish District, Oregon Department of Fish and Wildlife, Bend, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 1996(b). Metolius River Subbasin Fish Management Plan. Prepared by T. Fies, B. Lewis, M. Manion and S. Marx. Upper Deschutes Fish District, Oregon Department of Fish and Wildlife, Bend, Oregon.

Oregon Department of Fish and Wildlife (ODFW) 1996c. Crooked River Subbasin Fish Management Plan. Prepared by A. Stuart, S. Thiesfeld, T. Nelson and T. Shrader. Ochoco Fish District, Oregon Department of Fish and Wildlife, Prineville, Oregon.

Oregon Department of Fish and Wildlife (ODFW). 1997. Lower Deschutes River Subbasin Fish Management Plan. Mid-Columbia Fish District, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Oregon Department of Fish and Wildlife. 2002. Oregon Furbearer Trapping and Hunting Regulations, July 1, 2002 through June 30, 2004.

Oregon Department of Fish and Wildlife. 2003. Oregon’s Mule Deer Management Plan.

OSGC (Oregon State Game Commission). 1970. Stream Habitat Inventory.

Oregon Water Resources Department (OWRD). 1998. Statistical Summaries of Streamflow. Salem, Oregon.

Portland General Electric (PGE). 1999. License Application for the Pelton Round Butte Hydroelectric Project. Volume II. Portland, Oregon.

Portland General Electric (PGE) and Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS), 2001. Final Joint Application Amendment for the Pelton Round Butte Hydroelectric Project.

Ratliff, D., E. Schulz and S. Padula. 2001. Pelton Round Butte Project fish passage plan, second edition. Portland General Electric Company, Portland, OR and The Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, Oregon.

Ratliff, D.E., S.L. Thiesfeld, W. Weber, A.M. Stuart, M. Riehle, and D.V. Buchanan. 1996. Distribution, life history, abundance, harvest, and limiting factors of bull trout in the Metolius River and Lake Billy Chinook, Oregon, 1984-1994. Oregon Department of Fish and Wildlife, Information Report No. 96-7. Portland, Oregon.

Reaser, J.K. 1997. Amphibian declines: Conservation science and adaptive management. Doctoral Dissertation. Stanford University.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S.D.A., Forest Service, Intermountain Research Station, General Technical Report INT-302. Ogden, Utah.

Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1966. Birds of North America. Golden Press, New York.

Runyon, J. and J. Allen. 2002. Trout Creek Watershed Assessment, Part Two: Condition Evaluation and Action Opportunities. Prepared for the Bonneville Power Administration and Trout Creek Watershed Council by Watershed Professionals Network. Corvallis, Oregon.

Rutherford, W. H. 1964. The beaver in Colorado. Colo. Dept. Game, Fish and Parks Dept., Tech. Publ. 17.

Schroeder, R.K, and L.H. Smith. 1989. Life History of rainbow trout and effects of angling regulations. Deschutes River, Oregon. Oregon Department of Fish and Wildlife. Portland, Oregon.

Schulz, E.E. 1997. Upper Deschutes River Literature Review: Crooked River, Metolius River, Squaw Creek and Upper Deschutes River References. Portland General Electric, Madras, Oregon.

Slough, B. G., and R. M. F. S. Sadleir. 1977. A land capability classification system for beaver (Castor canadensis Kuhl). Can. J. Zool. 55(8):1324-1335.

Spruell, P. and F.W. Allendorf. 1997. Nuclear DNA analysis of Oregon bull trout. Final Report to Oregon Department of Fish and Wildlife. Division of Biological Sciences, University of Montana, Missoula.

Stuart, A., Grover, D. and Thiesfeld, S. 1996. Redband Trout Investigations in the Crooked River Basin. Oregon Department of Fish and Wildlife

Svendsen, G. E. 1980. Seasonal change in feeding patterns of beaver in southeastern Ohio. The Journal of Wildlife Management, 44:285-290.

Upper Deschutes Local Advisory Committee (UDLAC). 2003. Upper Deschutes Agricultural Water Quality Management Area Plan. Upper Deschutes Local Advisory Committee with assistance from Oregon Department of Agriculture and Deschutes Soil and Water Conservation District, Redmond, Oregon.

USDI, Bureau of Land Management and Bureau of Reclamation (BLM, BOR). 1992(a). Lower Crooked River Chimney Rock Segment Management Plan and Environmental Assessment. Prineville District, Bureau of Land Management and Pacific Northwest Region, Bureau of Reclamation, Prineville, Oregon.

USDI, Bureau of Land Management and Bureau of Reclamation (BLM, BOR). 1992(b). Lower Crooked Wild and Scenic River (Chimney Rock Segment) Management Plan.

Prineville District, Bureau of Land Management and Pacific Northwest Region, Bureau of Reclamation.

USDI, Bureau of Reclamation (BOR) and State of Oregon Water Resources Department (OWRD). 1997. Upper Deschutes River Basin Water Conservation Study. Special Report. Crook, Deschutes and Jefferson Counties, Oregon.

USDI, Bureau of Land Management (BLM). 2001. Analysis of the Management Situation (AMS) for the Upper Deschutes Resource Management Plan and Environmental Impact Statement (RMP/EIS). Prineville District, Bureau of Land Management, Prineville, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2002a. Chapter 7, Deschutes River Recovery Unit, Oregon. 62P. *In*: U.S. Fish and Wildlife Service. Bull Trout *(Salavelinus confluentus)* Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2002b. Chapter 8, Odell Lake Recovery Unit, Oregon. 53P. *In*: U.S. Fish and Wildlife Service. Bull Trout *(Salavelinus confluentus)* Draft Recovery Plan. Portland, Oregon.

U.S. Forest Service (USFS). 1989. Physical Stream Surveys. Department of Agriculture, Forest Service. Deschutes National Forest. Bend, Oregon.

U.S. Forest Service (USFS). 1994. Upper Deschutes River Resource Assessment Draft. United States Department of Agriculture, Forest Service. Deschutes National Forest.

U.S. Forest Service (USFS). 1994a. Odell Pilot Watershed Analysis. United States Department of Agriculture, Forest Service, Deschutes National Forest, Crescent Ranger District. Crescent, Oregon.

U.S. Forest Service (USFS). 1995a. Metolius Wild and Scenic River Management Plan. Draft Environmental Impact Statement. United States Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Rangers District, Sisters, Oregon.

U.S. Forest Service (USFS). 1995b. White River Watershed Analysis. United States Department of Agriculture, Forest Service, Mount Hood National Forest, Barlow Ranger District.

U.S. Forest Service (USFS). 1995c. North Fork Crooked River Watershed Analysis Report. Department of Agriculture, Forest Service, Ochoco National Forest, Big Summit and Paulina Ranger districts.

U.S. Forest Service (USFS). 1995d. Trout Creek Watershed Analysis Report. Department of Agriculture, Forest Service, Ochoho National Forest, Prineville Ranger District, Prineville, Oregon.

U.S. Forest Service (USFS). 1995e. Cascade Lakes Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Bend Ranger District, Bend, Oregon.

U.S. Forest Service (USFS). 1995f. Forks/Bridge Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest.

U.S. Forest Service (USFS). 1995g. A Late Successional Reserve Overview. Department of Agriculture, Forest Service, Deschutes National Forest.

U.S. Forest Service (USFS). 1995h. Davis late Successional Reserve Assessment. Department of Agriculture, Forest Service, Deschutes National Forest, Crescent Ranger District, Crescent, Oregon.

U.S. Forest Service (USFS). 1996a. Metolius Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Rangers District, Sisters, Oregon.

U.S. Forest Service (USFS). 1996b. Metolius Wild and Scenic River Management Plan. Final Environmental Impact Statement. Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Rangers District, Sisters, Oregon.

U.S. Forest Service (USFS). 1996c. Metolius Late Successional Reserve Assessment. Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Rangers District, Sisters, Oregon.

U.S. Forest Service (USFS). 1996d. Upper Deschutes Wild and Scenic River and State Scenic Waterway Comprehensive Management Plan. Department of Agriculture, Forest Service, Deschutes National Forest, Bend, Oregon.

U.S. Forest Service (USFS). 1997a. Big Marsh Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Crescent Ranger District, Crescent, Oregon.

U.S. Forest Service (USFS). 1997b. Big Marsh Late Successional Reserves. Department of Agriculture, Forest Service, Deschutes National Forest, Crescent Ranger District, Crescent, Oregon.

U.S. Forest Service (USFS). 1997c. Browns/Wickiup Watershed Analysis and Brown/Round Mountain Late Successional Reserve Assessment. Department of Agriculture, Forest Service, Deschutes National Forest, Bend-Fort Rock Ranger District.

U.S. Forest Service (USFS). 1998a. Bend Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Bend Ranger District. Bend, Oregon.

U.S. Forest Service (USFS). 1998b. Sisters/Why-chus Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Ranger District. Sisters, Oregon.

U.S. Forest Service (USFS). 1998c Marks Creek Watershed Analysis. Department of Agriculture, Forest Service, Ochoco National Forest, Big Summit Ranger District.

U.S. Forest Service (USFS). 1998d. Integrated Natural Fuels Management Strategy. Volume II. Apendices. Department of Agriculture, Forest Service, Deschutes National Forest. Bend, Oregon.

U.S. Forest Service (USFS). 1999a. Deep Creek Watershed Analysis. Department of Agriculture, Forest Service, Ochoco National Forest, Paulina Ranger District.

U.S. Forest Service (USFS). 1999b. Odell Watershed Analysis. Department of Agriculture, Forest Service, Deschutes National Forest, Crescent Ranger District, Crescent, Oregon.

U.S. Forest Service (USFS). 1999-2001. Geographic Information Systems Database. Department of Agriculture, Forest Service, Ochoco National Forest, Prineville, Oregon.

U.S. Forest Service (USFS). 2000. Cache Late Successional Reserve (LSR) Assessment. Department of Agriculture, Forest Service, Deschutes National Forest, Sisters Rangers District, Sisters, Oregon.

U.S. Forest Service (USFS). 2001a. Maury Mountains Watershed Analysis. Department of Agriculture, Forest Service, Ochoco National Forest, Prineville, Oregon.

U.S. Forest Service (USFS). 2001b. Addendum to the Mill Creek Watershed Analysis, Hash Rock Fire Effects. Department of Agriculture, Forest Service, Ochoco National Forest, Prineville Ranger District, Prineville, Oregon.

U.S. Geological Survey (USGS). 1989. Water Resources Data, Oregon Water Year 1989. U.S. Geological Survey, Water-Data Report OR-89-1, Volume 1, Eastern Oregon. Portland, Oregon.

United States Geological Survey. 1914. Water supply paper 344; Deschutes River Oregon and its utilization.

Walker, Thomas. Physical Stream Survey. Deschutes National Forest. 1991.

Walter, P. 2000. Channel Habitat Type, Riparian and Channel Condition Assessment for Ochoco, Mill, McKay and Marks Creeks, Crooked River Basin Oregon. Master’s Thesis. Department of Planning, Public Policy and Management. University of Oregon: Eugene Oregon.

Wasco County Soil and Water Conservation District and USDA Natural Resources Conservation Service(WCSWCD/NRCS). 1990. Buck Hollow Watershed Enhancement Plan -- Environmental Assessment. Wasco County SWCD, The Dalles, Oregon.

Wasco County Soil and Water Conservation District (WCSWCD). 1996. Bakeoven Watershed Enhancement Plan – Monitoring Plan. Wasco County SWCD, The Dalles, Oregon.

Watershed Forum. 1997. Evolving Visions and Values for the Future of the Deschutes River Basin.

Watershed Professionals Network (WPN), 2002a. Trout Creek Watershed Assessment. Prepared for Bonneville Power Administration and Trout Creek Watershed Council. Corvallis, Oregon.

Watershed Professionals Network, 2002b. Little Deschutes River Subbasin Assessment. Prepared for Upper Deschutes Watershed Council, Bend, Oregon.

Whitman, Tina. 2002. Crooked River Watershed Assessment. Crooked River Watershed Council, Prineville, Oregon.

Wise, T. 2003. Metolius River Bull Trout Redd Surveys 2001-2002. Unpublished. Oregon Department of Fish and Wildlife, Bend, Oregon.

Yake, K.E., 2003. Upper Deschutes Subbasin Assessment. Upper Deschutes Watershed Council, Bend, Oregon.

Zimmerman, C.E. and D.E. Ratliff. 2003. Controls on the distribution and life history of fish populations in the Deschutes River: geology, hydrology, and dams. Pages 51-70 In J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Zimmerman, C.E. and D.E. Ratliff. 2003. Controls on the distribution and life history of fish populations in the Deschutes River: geology, hydrology, and dams. Pages 51-70 *In* J.E. O'Connor and G.E. Grant, Editors. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Water Science and Application 7. American Geophysical Union. Washington, DC.

Zimmerman, C.E., G.H. Reeves. 2000. Population structure of sympatric anadromous and non-anadromous Oncorhynchus mykiss; evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57: 2152-2162.

Zimmerman, C.E., G.H. Reeves. 2002. Identification of steelhead and resident rainbow trout progeny in the Deschutes River, Oregon, revealed with otolith microchemistry. Transactions of the American Fisheries Society 131: 986-993.

Personal Communications

Brun, Chris. Fish Biologist. Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, Oregon. Personal communication, 2003.

Calvin, D. Wildlife Biologist, Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, Oregon. Personal communication, 2004.

Carey, C. Wildlife Biologist, Oregon Department of Fish and Wildlife, Bend, Oregon. Personal communication. 2004.

Clark, J. Wasco County Soil and Water Conservation District. The Dalles, Oregon. Personal communication. 2004.

Clowers, G. Wildlife Biologist, consulting. Madras, Oregon. Personal communications. 2004.

French, R. Oregon Department of Fish and Wildlife. The Dalles, Oregon. Personal communication, 2004.

Gauvin, M. 2003. Natural Resources Department, Confederated Tribes of Warm Springs Reservation of Oregon. Personal communication.

George, S. 2004. Oregon Department of Fish and Wildlife. The Dalles, Oregon. Personal communication, 2004.

Gilbert, N. U.S. Fish and Wildlife Service. Bend, Oregon. Personal communications, 2004.

Gorman, K. Oregon Department of Water Resources. Bend, Oregon. Personal communications, 2004.

Hanf, J. Bureau of Land Management, Prineville, Oregon. Personal communications, 2004.

Kohl. K. Oregon Department of Fish and Wildlife. The Dalles, Oregon. Personal communications, 2004.

Kunkel, C. Oregon Department of Fish and Wildlife. The Dalles, Oregon. Personal communication, 2004.

Lamb, B. Oregon Department of Environmental Quality. Bend, Oregon. Personal communications, 2004.

Marx, S. Oregon Department of Fish and Wildlife. Bend, Oregon. Personal communication, 2004.

Marx, S. 2003. Upper Deschutes River Subbasin Trout Update. Personal communication. Oregon Department of Fish and Wildlife. Bend, Oregon.

Ratliff, D. Portland General Electric Co. Madras, Oregon. Personal Communication, 2004.

Weldon, M. Confederated Tribes of the Warm Springs Reservation of Oregon. Personal communication. 2004.

Acronyms and Abbreviations

AIP	Aquatic Inventory Project
AU	Assessment Unit
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
cfs	cubic feet per second
COIC	Central Oregon Intergovernmental Council
COID	Central Oregon Irrigation District
Council	Northwest Power and Conservation Council
CRLAC	Crooked River Local Advisory Committee
CTWS	Confederated Tribes of the Warms Springs Reservation of Oregon
CRITFC	Columbia River Inter-Tribal Fish Commission
CRP	Conservation Reserve Program
CWA	Clean Water Act
DCG	Deschutes Coordinating Group
DEQ	Oregon Department of Environmental Quality
DMA	Designated Management Area
DO	dissolved oxygen
EDT	Ecosystem Diagnosis and Treatment
EIS	Environmental Impact Statement
ENSO	El Nino – Southern Oscillation
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HE	Habitat Element
HEP	Habitat Evaluation Procedures
HGMP	Hatchery Genetic Management Plan
Huc	habitat
IBIS	Interactive Biological Information System
IHN	Infectious Hematopoietic Necrosis
ISG	Independent Scientific Group
ISRP	Independent Scientific Review Panel
JAR	Juvenile Adult Ratio
KEC	Key Environmental Correlate
KEF	Key Environmental Function
KEG	key environmental correlates
LAC	Local Advisory Committee
LWD	large woody debris
MDLAC	Middle Deschutes Local Advisory Committee
n/a	not available or not applicable
NEPA	National Environmental Protection Act
NOAA	National Oceanic and Atmosphere Administration
NOAA Fisheries	National Marine Fisheries Service (formerly NMFS)

NMFS	National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
NRC	National Research Council
NRCS	USDA National Resources Conservation Service
NTUs	Nephelometric Turbidity Units
OAR	Oregon Administrative Rules
OCG	Oregon Coordinating Group
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ORS	Oregon Revised Statutes
OOSE	Out of Subbasin Effects
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
PasRas	Passage Risk Assessment Simulation
PDO	Pacific Decadal Oscillation
PGE	Portland General Electric
pH	Alkalinity-Acidity Scale
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PFT	Pelton Fish Trap
PUD	Public Utility District
QHA	Qualitative Habitat Assessment
RM	river mile
RBH	Round Butte Fish Hatchery
SAR	Smolt Adult Ratio
SWCD	Soil and Water Conservation District
TID	Tumalo Irrigation District
TMDL	Total Maximum Daily Load
TOAST	Technical Outreach and Assistance for Subbasin Teams
TRT	Technical Recovery Team
TSS	Total Suspended Sediment
UDLAC	Upper Deschutes Local Advisory Committee
UGB	urban growth boundary
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
Warm Springs Hatchery	Warm Springs National Fish Hatchery
Warm Springs Tribes	Confederated Tribes of the Warm Springs Reservation of Oregon
WSNFH	Warm Springs National Fish Hatchery
WQI	water quality index

Draft
Deschutes Subbasin Plan

May 28, 2004

Deschutes Subbasin Planning Team Leaders

Project Manager, Joanne Palmer
Writer/Planner, Barbara Taylor
Fish Assessment, Jim Newton
Wildlife Assessment, Gary Hostick
Outreach, Patricia Gainesforth
Inventory, Darcy McNamara
Mapping, Mark Garner

Disclaimer

The goal of the Northwest Power and Conservation Council was for the subbasin plans to result from collaborative efforts within each subbasin. In the Deschutes Subbasin, all parties with information relevant to the planning process were provided the opportunity to participate in this process. As a result, there were many different stakeholders providing information contributing to the plan results. Submission of this plan does not imply that all parties who participated agree with the specific results in all sections of the plan. We intend that all parties have an additional opportunity to respond to the plan during the public comment period that will be provided by the Council.

Focal Fish Species Characterization

APPENDIX I

This chapter describes the fish species selected to evaluate the health of the Deschutes Basin ecosystem and the effectiveness of management actions in the basin. These species were selected because they have special ecological, cultural or legal status. The chapter provides information on each focal species. In particular, it describes the status of each focal species population, as well as its historic and current distribution within the Deschutes Subbasin. It also discusses historic and current artificial production programs and harvest within the subbasin, and the relationship between artificial and naturally produced populations.

Focal Species Selection

The Deschutes River Basin supports more than thirty species of indigenous and introduced fish. Indigenous salmonids comprise six of the species and include Chinook salmon, summer steelhead, sockeye salmon, redband trout, bull trout and mountain whitefish. Five introduced salmonid species present in the subbasin include Coho salmon, brown trout, cutthroat trout, brook trout and lake trout.

Five of the thirty fish species in the Deschutes River Basin have been chosen as aquatic focal species for this subbasin plan: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead/redband trout (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), sockeye salmon (*Oncorhynchus nerka*) and Pacific Lamprey (*Lampetra tridentata*) (Table 1). The five species were selected by the Fish Technical Team, a group of fish and natural resource experts brought together to provide technical advice during the subbasin planning process. The team selected the focal species based on their significance and ability to characterize the health of the ecosystem and the effectiveness of management actions. The list of focal species was then adopted by the Deschutes Coordinating Committee for use in subbasin planning. Criteria used in selecting the focal species included a) designation as a federal threatened or endangered species, b) cultural significance, c) local significance, and d) ecological significance, or ability to serve as indicators of environmental health for other aquatic species. Generally these selected species also have population status, distribution and habitat use data available that will be of assistance in future decision making. Table 2 shows the various fish species found within the Deschutes River Basin.

Table 1. Deschutes River Basin Focal Species.

Species	Scientific name	Status	Distribution	Significance
Chinook Salmon	*Oncorhynchus tshawytscha*	Proposed for ESA listing – not warranted at this time	Lower 100 miles of Deschutes River, Warm Springs River system and Shitike Creek	High tribal cultural value, High non-tribal value
Summer Steelhead	*Oncorhynchus mykiss*	Steelhead ESA-Listed Threatened for Mid-Columbia ESU	Lower 100 miles of Deschutes River and tributaries	High Tribal cultural value, High non-Tribal value
Redband Trout		Redband Trout Proposed for ESA listing – not warranted at this time	Throughout the subbasin. Some populations fragmented	High Tribal cultural and non-Tribal value
Bull Trout	*Salvelinus confluentus*	ESA-Listed Threatened for Mid-Columbia ESU	Metolius River / Lake Billy Chinook habitat complex and lower Deschutes River, Warm Springs River, Shitike Creek	High Tribal cultural and non-Tribal value
Sockeye Salmon	*Oncorhynchus nerka*	Not listed	Major subbasin lakes and reservoirs and tributaries streams	High Tribal cultural and non-Tribal value
Pacific Lamprey	*Lampetra tridentata*	State Protected Species	Lower 100 miles of Deschutes River and Warm Springs River system and Shitike Creek	High Tribal cultural value

Table 2. Historical and Current Fish Species in the Deschutes River Basin.

Common Name	Scientific Name	Origin	Status	Abundance
Pacific lamprey	*Lampetra tridentata*	indigenous	present	Moderate
Summer steelhead	*Oncorhynchus mykiss*	indigenous	present	Moderate
Chinook salmon	*Oncorhynchus tshawytscha*	indigenous	present	Moderate
Coho salmon	*Oncorhynchus kisutch*	introduced	present	locally abundant
Kokanee	*Oncorhynchus nerka*	introduced	present	abundant
Atlantic salmon	*Salmo salar*	introduced	present	rare
Sockeye Salmon	*Oncorhynchus nerka*	indigenous	present	rare
Redband trout	*Oncorhynchus mykiss*	indigenous	present	Moderate to locally abundant
Bull trout	*Salvelinus confluentus*	indigenous	present	very rare
Mountain whitefish	*Prosopium williamsoni*	indigenous	present	very abundant
Brown trout	*Salmo trutta*	introduced	present	abundant
Brook trout	*Salvelinus fontinalis*	introduced	present	abundant
Cutthroat trout	*Oncorhynchus clarki lewisi*	introduced	present	moderate
Lake trout	*Salvelinus namaycush*	introduced	present	low
Largemouth bass	*Micropterus salmoides*	introduced	present	moderate
Smallmouth bass	*Micropterus dolomieui*	introduced	present	low
White crappie	*Pomoxis annularis*	introduced	present	low
Black crappie	*Pomoxis nigromaculatus*	introduced	present	low
Brown bullhead catfish	*Ictalurus nebulosus*	introduced	present	locally abundant
Carp	*Cyprinus carpio*	introduced	present	low
Bluegill	*Lepomis macrochirus*	introduced	present	moderate
Shorthead sculpin	*Cottus confusus*	indigenous	present	locally abundant
Reticulate sculpin	*Cottus perplexus*	indigenous	present	unknown
Redside Shiner	*Richardsonius balteatus*	indigenous	present	locally abundant
Speckled Dace	*Rhinichthyys osculus*	indigenous	present	locally abundant
Longnose dace	*Rhinichthys cataractae*	indigenous	present	low
Chiselmouth	*Acrocheilus alutaceus*	indigenous	present	moderate
Largescale sucker	*Catostomus macrocheilus*	indigenous	present	locally abundant
Bridgelip sucker	*Catostomus columbianus*	indigenous	present	moderate
Northern Pike Minnow	*Ptychocheilus oregonensis*	indigenous	present	moderate
Three-spine stickleback	*Gasterosteus aculeatus*	introduced	present	locally abundant
Tui chub	*Gila* (Siphateles) *bicolor*	introduced	present	very abundant
Blue chub	*Gila* (Gila) *coerulea*	introduced	present	locally abundant

Aquatic Focal Species Population Delineation and Characterization

Chinook Salmon

Columbia River Chinook salmon, including those that return to the lower Deschutes River, are separated into spring (before June), summer (June/July) and fall (after July) races by their passage at Bonneville Dam. In the Deschutes Basin, spring and fall Chinook, and probably summer Chinook, returned annually to spawn in the draining, though the summer run may have been lost after construction of the Pelton Round Butte Complex. Trap counts before construction of Pelton and Round Butte dams show that a number of Chinook were caught before September 1, excluding spring Chinook (Jonasson and Lindsay 1988). There were also two peaks in the run at Sherars Falls (RM 44), a July peak and a September peak. Jonasson and Lindsay (1988) suggested that, based on the timing of Chinook passing the falls and those trapped at the Pelton Fish Trap, the summer run spawned above the dam site at a higher rate than those that migrated in the fall. Jonasson and Lindsay (1988) concluded, however, that because of the presence of Pelton and Round Butte dams, there is no longer a mechanism to spatially separate summer and fall runs and that there is no longer a distinction between the two races (Nehlsen 1995).

Today, two races of Chinook salmon, spring Chinook and summer/fall Chinook, are believed to spawn and rear in the Deschutes subbasin. Both races are indigenous to the subbasin. Its possible that separate summer and fall races exist, however they are currently treated as one race. Managers based this decision on the fact that, while the existence of two peaks in run timing at Sherars Falls suggests that both summer and fall races return to the Deschutes River, there remains a lack of detectable reproductive isolation between the early and late segments of the run. Both segments of this run appear to spawn in the same areas and interbreeding between the two has been suspected for many years, suggesting that only one run exists. For this plan discussion the summer/fall Chinook will be considered as fall Chinook salmon.

Spring Chinook

Importance

Spring Chinook salmon are an indigenous anadromous species with great in-basin and out-of-basin values to the tribal and non-tribal citizenry. Historically, this was a more robust population with a much greater freshwater distribution. The population was able to migrate to and from the ocean when flow conditions were optimum in the Columbia and Deschutes river systems (i.e. high spring flows), which minimized problems associated with barriers, disease and predators. It was also able to access a number of Deschutes River tributaries for spawning and rearing that are no longer accessible (i.e., Metolius River system, Crooked River system, and Squaw Creek).

Spring Chinook are currently restricted to habitat areas below the Pelton Reregulating Dam (RM 100). Spawning and primary juvenile rearing habitat exists in Shitike Creek and the Warm Springs River system. Currently Portland General Electric and Warm

Springs Power Enterprises (co-FERC License applicants) are pursuing efforts to reintroduce anadromous fish upstream of Round Butte Dam. The intent of the plan is to restore sockeye and spring Chinook salmon, and summer steelhead to their historical range in the upper Deschutes River basin, including the Crooked River below Ochoco and Bowman dams.

Spring Chinook salmon in the basin are one of the focal species that will be used to evaluate the health of the Deschutes River ecosystem and compare the effectiveness of various proposed management actions. They were selected as a focal species based on their ecological value and their cultural and local significance.

- ***Species designation:*** Spring Chinook salmon are not an ESA-listed species in the Deschutes River subbasin or the Mid-Columbia ESU.
- ***Species recognition:*** An important food source for Native Americans for thousands of years. Historically fish were harvested at a number of sites within the subbasin, including the traditional Sherars Falls site on the lower Deschutes River (RM 43). Spring Chinook have also provided an important recreational fishery for other fishers. This fishery is also predominantly associated with the Deschutes River immediately downstream from Sherars Falls.
- ***Special ecological importance:*** An important food source for a variety of subbasin wildlife. Chinook salmon die shortly after spawning and thus contributed an important source of nutrients that have wide-reaching benefits to the biota of the subbasin, including aquatic insects, aquatic and semi-aquatic plants and, indirectly, terrestrial plant species.
- ***Tribal recognition:*** Important tribal cultural, subsistence and commercial value. Historically salmon was a primary food source for tribal members and the foundation of an important trade economy between various tribes. Today this species continues to have strong cultural and religious values for many Native Americans throughout the Pacific Northwest, including the Confederated Tribes of the Warm Springs Reservation of Oregon (Confederated Tribes). Fishing is still the preferred livelihood of some tribal members.

Population Data and Status

Considerable data have been collected on spring Chinook salmon populations in the lower Deschutes River subbasin during the past thirty years. These data have been collected independently and jointly by biologists and technicians with the Oregon Department of Fish and Wildlife and Confederated Tribes.

Abundance

Harvest and escapement information indicates that an average of 1,780 wild spring Chinook returned annually to the Deschutes River from 1977 through 2003. Annual returns have varied considerably during this time, ranging from 241 to 3,460 fish (Table 3) (French and Pribyl 2004). These estimates reflect harvest and escapement information collected for the Deschutes River and key tributaries since 1977. Biologists have estimated the total spring Chinook harvest each year since 1977 (except 1985 and 1986) by conducting statistical harvest surveys of the tribal subsistence and sport fisheries on the Deschutes River at Sherars Falls (RM 44). Spring Chinook escapement to spawning tributaries is based on Warm Springs National Fish Hatchery (Warm Springs Hatchery) counts. With the exception of a small number of wild spring Chinook that spawn downstream from the hatchery or in Shitike Creek, all others are captured or automatically counted at the hatchery.

Table 3. Run size of wild spring Chinook salmon (adults and jacks) in the Deschutes River, 1977-2002 run years (French and Pribyl 2004).

	Harvest		Brood Stock	Escapement	
Run Year	Tribal	Recreational	For RBHe/	to WSNFH	Total
1977	391	1,107	194	1,606a/	3,298
1978	173	512	115	2,660	3,460
1979	203	345	89	1,395	2,032
1980	113	337	60	1,002	1,512
1981	0	0	0	1,575	1,575
1982	201	502	0	1,454	2,157
1983	190	355	0	1,541	2,086
1984	0	0	0	1,290	1,290
1985	131	704	0	1,155	1,990
1986	22d/	122	0	1,711	1,855
1987	408	501	0	1,783	2,692
1988	241	629	0	1,647	2,517
1989	265	519	0	1,409	2,193
1990	297	775	0	1,867	2,939
1991	111	485	0	817	1,413
1992	142	563	0	1,065	1,770
1993	126	251	0	538	915
1994	0	0	0	435	435
1995	4	0	0	237	241
1996	57	2	0	1,287	1,346
1997	0	0	0	870	870
1998	45	0	0	271	316
1999	0	0	0	493	493
2000	326	14	0	2,705	3,045
2001	170	5	0	2,252	2,427
2002	184	3	0	1,440	1,627
2003	7	0	0	1,519	1,566

The Warm Springs River supports most spring Chinook spawning in the Deschutes River system. Since 1977, escapement above Warm Springs Hatchery (RM 11) has averaged 1,279 adults and ranged from 162 to 2,625 spring Chinook annually. Tribal fisheries staff has also counted spring Chinook redds in the Warm Springs River system since 1982. The average number of redds counted per year has been approximately

338 redds, with a range from 62 in 1995 to 751 redds in 2001 (Table 4) (French and Pribyl, 2004).

A small spring Chinook run also returns annually to Shitike Creek. Spawning ground counts show that an average of 49 adult spring Chinook escaped annually to Shitike Creek between 1982 and 1995 (ODFW 1997). Escapement is composed of wild spring Chinook. Redd counts for Shitike Creek from 1986 to 2002 are summarized in Table 4 (Gauvin. 2003). Of 17 spring Chinook carcasses sampled during redd counts in Shitike Creek from 1986 through 1995, no hatchery origin spring Chinook were found, (CTWS, unpublished data).

Table 4. Spring Chinook Salmon redd counts by index areas in the Warm Springs River Basin and Shitike Creek, 1986 – 2002 (Gauvin, 2003) (French and Pribyl, 2004).

	Warm Springs River Basin				
Year	**Beaver Creek 23.9 km**	**Mill Creek 10.1 km**	**Warm Springs River, 30.9 km**	**Total Redds**	**Shitike Creek 20.9 km**
1986	93	32	303	428	17
1987	101	23	360	484	13
1988	83	29	289	401	28
1989	100	27	288	415	17
1990	163	64	320	547	25
1991	65	10	171	246	22
1992	36	15	112	163	12
1993	27	11	109	147	11
1994	48	18	100	166	19
1995	16	3	46	65	9
1996	92	27	204	323	6
1997	76	28	258	466	33
1998	42	17	65	114	13
1999	30	7	89	126	11
2000	172	71	415	658	52
2001	141	120	491	752	82
2002	47	17	161	225	28
2003				262	

Capacity

A wild spring Chinook stock recruitment model developed by Bob Lindsay, an ODFW research biologist, in the 1980s suggests an optimum spawning escapement goal of 1,300 adult spring Chinook and a minimum of 1,000 adults upstream from the barrier dam at Warm Springs Hatchery. The model was originally developed based on wild spring Chinook returns to Warm Springs River. Additional data has been added as it has become available and the model now includes 23 complete brood years (Gauvin, 2003). Wild spring Chinook escapements of this suggested magnitude are believed to allow for pre-spawning mortality, sufficient natural selection to provide genetic variability, and maintenance of evolutionary potential (ODFW 1997).

The EDT Model estimated that current spring Chinook habitat in the Lower Deschutes Westside Assessment Unit has the capacity to return approximately 2,800 adult fish to the subbasin annually. With moderate habitat restoration (Preferred Alternative) the habitat capacity could increase the annual run to the subbasin to approximately 3,800 adult fish. If fish passage is restored at the Pelton Round Butte Project, Opal Springs Dam and small irrigation diversion dams on lower Crooked River (below Bowman Dam), Ochoco Creek (below Ochoco Dam) and Squaw Creek and there is moderate habitat improvement (Preferred Alternative) the subbasin's habitat has he capacity to return up to approximately 5,600 adult spring Chinook annually to the subbasin.

Portland General Electric has investigated spring Chinook salmon production potential upstream of the Pelton Round Butte Project as part of the FERC re-licensing process. As part of this investigation, a consultant for PGE developed a model, referred to as the PasRAS model, which evaluates the relative importance of different mortality and habitat factors that could affect re-introduced spring Chinook salmon (Ratliff 2003). Modeling results suggest that from 347 to less than 1,000 adult spring Chinook would be available annually to spawn upstream of the hydro project. These numbers are extremely tentative because of the uncertainty associated with the parameters for parr survival. The PasRAS model also indicated that downstream migrant collection efficacies at the hydro project needed to be better than those observed on the Columbia River in order to initially establish and maintain a sustainable spring Chinook run above the project (Oosterhout 1999).

Life History Diversity

Wild spring Chinook adults enter the Deschutes River in April and May. The run arrives at Sherars Falls in mid-April and peaks in early to mid-May. Most spring Chinook salmon pass above Sherars Falls by mid-June. Approximately 80% of the Deschutes River race of spring Chinook return to the river after 2 years in the ocean (age-4 at spawning). Roughly 5% return as 3-year old jacks (or jills) and 15% as age-5 adults (PGE 1999). The majority of wild spring Chinook spawners are believed to return to spawning grounds on the Warm Springs Reservation in Shitike Creek and the Warm Springs River system. Juvenile spring Chinook rear within these Deschutes tributaries, as well as in the Deschutes River.

Wild spring Chinook salmon spawning in the Warm Springs River occurs primarily above the hatchery. Only 3% of all spring Chinook redds counted in the Warm Springs River from 1982 through 1995 were downstream from the hatchery (CTWS unpublished data). The lack of spawning below the hatchery may be a response to summer water temperatures in the reach that approach the upper limit for Chinook spawning (Fritsch and Hillman 1995). Fish managers have no evidence that wild spring Chinook spawn in either the mainstem lower Deschutes River or tributaries other than the Warm Springs River or Shitike Creek (ODFW 1997).

Wild spring Chinook salmon begin arriving at Warm Springs Hatchery in late April or early May, once water temperatures exceed 50°F, and continue until late September. The run peaks at the hatchery by the first of June, with a second smaller peak in late August or early September. In most years, approximately 70% of the run arrives at the hatchery by June 1 and 90% by July 1 (Lindsay et al. 1989). Most of the fish that pass the hatchery are believed to hold in the Warm Springs River canyon within about seven miles upstream of the hatchery until August when they continue upstream to the spawning areas (ODFW 1997).

Sampling of fish passing through a trap on the Warm Springs River at the hatchery shows that wild spring Chinook returning to spawn in the upper Warm Springs River system average 4% age-3 (jacks), 78% age-4 and 18% age-5. There are very few age-6 spring Chinook observed in the population. The age distribution has been very consistent from year to year, ranging from 63% to 83% age-4 fish. Females comprise about 62% of the age-4 and age-5 fish returning to the Warm Springs River (ODFW 1997).

Spawning in the Warm Springs River system begins the last week in August, peaks by the second week in September, and is completed by the last week in September (Lindsay et al. 1989). The average fecundity of spring Chinook salmon returning to Warm Springs Hatchery (wild and hatchery populations) was 3,300 eggs per female for 1978 through 1985 (ODFW 1997).

Time of entry and locations and type of adult holding areas in Shitike Creek are unknown, although both are believed to be similar to those in the Warm Springs River. Spawning in Shitike Creek is believed to occur at about the same time as in the Warm Spring River.

Spring Chinook salmon in the Warm Springs River probably begin emerging from the gravel in February or March. Information on completion of emergence in the Warm Springs River is not available, but may be similar to the John Day River where emergence is completed by May. Juvenile spring Chinook migrate from the Warm Springs River in two peaks, a fall migration from September through December, and a spring migration from February through May (Lindsay et al. 1989). The fish migrating in the fall are age-0, range in size from 3.1 inches to 4.3 inches fork length, and do not have a smolt appearance. Most spring migrants are age-1 fish ranging in size from 3.5 inches to 5.1 inches fork length, and have the bright silver coloration characteristic of smolts (ODFW 1997).

Wild spring Chinook salmon that migrate from the Warm Springs River in the fall at age - 0 appear to rear over winter in the Deschutes or Columbia rivers before entering the ocean the following spring at age-1. During research conducted in the late 1970's, spring Chinook salmon marked in the fall as age-0 migrants from the Warm Springs River were recaptured in the Deschutes River the following spring. Wild spring Chinook salmon smolts generally migrate through the Columbia River in April and May at age-1 based on recoveries of marked smolts (Lindsay et al. 1989).

The Shitike Creek spring Chinook population is a small race of fish with the average adult size ranging from 8 to 10 pounds. The age distribution has been very consistent, ranging from 63% to 83% age-4 fish. Spring Chinook in Shitike Creek are believed to follow a similar life history strategy to those in the Warms Springs River system. Time of entry and locations and type of adult holding areas are unknown, but are believed to be similar to those in the Warm Springs River. Spawning in Shitike Creek is also believed to occur at about the same time as in the Warm Spring River.

The EDT Model estimated that the current spring Chinook population has approximately 95% genetic diversity. With moderate habitat restoration the diversity would increase to 96%. If spring Chinook access were restored to the Middle Deschutes and Lower Crooked River assessment units the genetic diversity of the total population would initially drop to 33%.

Productivity

In most years, the number of wild spring Chinook returning to the Deschutes River has exceeded 1,300 adults, the replacement level suggested by the stock-recruitment model to maintain the stock. However, poor returns were observed from the 1989, 1990, 1991, 1993, 1994, and 1995 brood years (ODFW 1997). The 1996 and 1997 brood year's — the last complete brood years — also returned recruits well above the replacement level, indicating a fairly healthy and productive stock (French and Pribyl 2003).

Tribal biologists have estimated the number of spring Chinook juveniles emigrating from the Warm Springs River since 1975. Those estimates are summarized from 1975 – 1994 in Table 5 (ODFW 1997).

Table 5. Estimated number of wild juvenile spring Chinook that migrated from the Warm Springs River, 1975-94 brood years (CTWS unpublished data) (ODFW 1997).

	Time of Migration		
Brood Year	**Fall**	**Spring**	**Total**
1975	25,795	43,250	69,045
1976	47,041	26,043	73,084
1977	25,125	25,204	50,329
1978	74,727	57,216	131,943
1979	24,930	25,628	50,558
1980	20,579	14,656	35,235
1981	29,238	14,647	43,885
1982	67,719	30,594	98,313
1983	89,396	31,101	120,497
1984	61,970	34,827	96,797
1985	35,991	38,333	74,326
1986	47,125	35,651	82,776
1987	59,195	27,508	86,703
1988	56,007	40,365	96,372
1989	42,720	33,154	75,874
1990	51,340	47,914	99,254
1991	14,576	14,056	28,632
1992	25,471	29,332	54,803
1993	14,196	13,842	28,038
1994	51,085	N/A	N/A

The EDT Model estimated that the current productivity of wild subbasin spring Chinook salmon is 5.4. With moderate habitat restoration productivity could increase to 6.0. The model also estimated if fish passage was restored at the Pelton Round Butte Project, Opal Springs Dam and small irrigation diversion dams on lower Crooked River (below

Bowman Dam), Ochoco Creek (below Ochoco Dam) and Squaw Creek and there is moderate habitat improvement (Preferred Alternative) the productivity of the subbasin's spring Chinook would be 4.6.

Carrying Capacity

The current smolt production capacity of the Warm Springs River system is estimated to be 132,000 smolts (ODFW 1977). The total number of fall and spring migrants (age-0 and age-1 spring Chinook) from the Warm Springs River ranged from 28,038 fish to 131,943 fish for the 1975 through 1993 broods (CTWS unpublished data). Survival of juvenile spring Chinook salmon in the Warm Springs River appears to be density dependent. Survival of 1975 through 1990 broods (Table 6), the last to be completed, from egg deposition to migration was highest at low egg densities, which has compensated for low spawner abundance (ODFW 1997).

Table 6. Abundance and survival estimates of wild spring Chinook salmon at various life stages in the Warm Springs River, 1975-95 brood years. Numbers represent fish surviving to spawn in the Warm Springs River and their recruitment back to the Deschutes River (ODFW 1997).

Survival (%)

Brood Year	Females (redds)[a]	Males	Millions of eggs	Migrants	Adult Returns	Egg to Migrants	Migrant to adult
1975	808	539 [b]	2.669	69,045	1,891	2.6	2.7
1976	1,066	653 [b]	3.521	73,084	1,547	2.1	2.1
1977	699	428 [b]	2.309	50,329	1,691	2.2	3.4
1978	796	467	2.671	131,943	2,009	4.9	1.5
1979	359	220	1.309	50,558	2,077	3.0	4.1
1980	117	63	0.403	35,235	1,162	8.7	3.3
1981	157	114	0.539	43,885	1,807	8.1	4.1
1982	433	233	1.430	---	2,770	6.9	---
1983	438	304	1.447	120,497	2,743	8.3	2.3
1984	429	274	1.417	96,797	2,344	6.8	2.4
1985	398	254	1.315	74,326	2,274	5.7	3.1
1986	428	395	1.414	82,776	2,938	5.9	3.5
1987	484	447	1.599	86,703	1,372	5.4	1.6
1988	401	290	1.325	96,372	1,830	7.3	1.9
1989	415	277	1.133[c]	75,874	564	6.7	0.7
1990	547	321	1.462[c]	99,254	453	6.8	0.5
1991	246	210	0.632[c]	28,632	---	---	---
1992	163	199	0.432[c]	54,803	---	---	---
1993	147	106	0.399[c]	28,038	---	---	---
1994	166	111	0.474[c]	---	---	---	---
1995	65	94	0.173	---	---	---	---

---

[a] Number of redds includes those counted in Warm Springs River below Warm Springs Hatchery.

[b] Number of males based on average percentages of males (0.38) in 1977-1985 runs.

[c] Number of eggs based on average eggs per female for all fish spawned at Warm Springs Hatchery.

Population Trend and Risk Assessment

The Deschutes spring Chinook populations are small and, as such, are at greater risk from a number of factors, including environmental catastrophe, loss of genetic variability, environmental change, poor migration and ocean-rearing conditions and over-harvest. In addition, the population’s freshwater spawning and rearing habitat is concentrated in several small geographic areas. The two populations have had a number of brood years that were too small to withstand in-subbasin tribal and/or recreational harvest and still meet the spawner escapement goals agreed upon by ODFW and the Confederated Tribes.

Survival of juvenile spring Chinook salmon in the Warm Springs River appears to be density dependent. Habitat problems, including low stream flow, associated with drought conditions, reduce the habitat's juvenile Chinook carrying capacity. Other human activities also threaten the fish population. For instance, Beaver Creek, one of the Warm Springs River tributaries important for spawning and juvenile rearing, closely borders US Highway 26. Traffic accidents on this stretch of highway have released hazardous chemicals into the stream with devastating impacts. There is an ongoing risk of similar incidents that could have a profound impact on this salmon population. Highway maintenance activities adjacent to the same reach have inadvertently introduced appreciable quantities of sand and crushed gravel into the stream as a result of winter road sanding operations.

The Shitike Creek salmon population remains very small. Redd counts in Shitike Creek indicate an estimated average spawning escapement of 49 adult spring Chinook annually from 1982 to 1995. This population may be at genetic risk from a very small gene pool. There is insufficient information on production potential and adult escapement to develop a stock recruitment model for this population (ODFW 1997). The Warm Springs Tribes and USFWS have been outplanting adult spring Chinook in Shitike Creek for the past three years. The effects of this program have yet to be determined.

Unique Population Units

Oregon's Wild Fish Population List recognizes natural production of spring Chinook from two separate subbasin populations, one in the Warm Springs River and one in Shitike Creek. Both stream systems are located on reservation lands. Currently, however, there is not enough information available to determine if the two groups have enough genetic differences to qualify as separate populations (ODFW 1997).

Estimate of Desired Future Condition for Long-term Sustainability

The Deschutes subbasin spring Chinook salmon populations should include a composite annual adult run to the river that provides tribal and non-tribal harvest opportunities, as well as adequate spawner escapement to perpetuate the populations. It is important that the annual wild spring Chinook spawner escapement in the Warm Springs River above Warm Springs Hatchery be maintained with a minimum of 1,000 fish.

Distribution

Current Distribution/Spatial Diversity

Spring Chinook in the Deschutes River subbasin are currently constrained to areas below the Pelton Round Butte Complex. Fish passage facilities were provided at Pelton and Round Butte dams, which were completed in 1958 and 1964, respectively. However, by the late 1960's it became apparent that the upriver runs could not be sustained naturally with these facilities, due primarily to inadequate downstream passage of juveniles through the project. By 1970 the remnant population(s) was limited to the lower Deschutes and Warm Springs rivers and Shitike Creek.

Historic Distribution

Spring Chinook salmon historically spawned in the mainstem Deschutes River below Big Falls (RM 132), Shitike and Squaw creeks, and the Warm Springs, Crooked and Metolius river systems. There may have also been spring Chinook spawning in other tributaries, but there are no data or observations to confirm use of these other streams.

In the Crooked River system, spring Chinook distribution once extended into the upper watershed. In 1826, Peter Skene Ogden remarked on a weir for taking salmon that the Indians had built the previous summer just below the confluence of the North Fork and Crooked River (Nehlsen 1995). A report by Frey (1942) states that Chinook used Ochoco Creek extensively before Ochoco Dam was built. It also cites reports of Chinook in the upper Crooked River 40 to 50 years before (1892-1902) and in Beaver Creek 30 to 40 years before (1902-1912) (Nehlsen 1995).

Historically, the Metolius basin was a major producer of spring Chinook, supporting runs of several hundred spawning adult fish annually. Counts of spawning salmon in the Metolius River and tributaries (Lake, Spring, and Jack creeks) and Squaw Creek, plus salmon trapped at the Oregon Fish Commission weir on the Metolius, totaled 765 fish in 1951 and 512 fish in 1953, the highest years recorded. These fish migrated as far as the headwaters, near where the springs surface, and into Lake Creek to spawn and rear (ODFW 1996).

The extent of historic spring Chinook production in Squaw Creek remains unclear as habitat alterations in the late 1800s and early 1900s restricted spring Chinook distribution to the lower channel. Records of spawning salmon and redds in Squaw Creek from 1951-1960 showed a high count of 30 in 1951 and 0 by 1960 (Nehlsen 1995).

Differences in Distribution Due to Human Disturbance

Completion of the Pelton Round Butte Complex resulted in the extirpation of the anadromous spring Chinook population in the Deschutes River above RM 100 by 1970. It also blocked migration to spawning and rearing habitat in the Metolius River, lower Crooked River and Squaw Creek.

Spring Chinook distribution in the Crooked River drainage likely declined in the early 1900s because of extensive water diversions and the development of power plants near the mouth that barred upstream migration during low flows. Opal Springs Dam, constructed in 1921on lower Crooked River, was a partial barrier to migratory fish. Large irrigation dams on Ochoco Creek (Ochoco Dam) and Crooked River (Bowman Dam), completed in 1921 and 1961 respectively, eliminated this run or the potential to re-establish a run upstream of those sites. Ochoco and Bowman dams were constructed with no fish passage facilities. In 1982, Opal Springs Dam was rebuilt as a larger dam, retrofitted to produce hydroelectric power, and as such became a complete passage barrier to migratory resident fish (ODFW 1998).

In the Squaw Creek drainage, spring Chinook distribution likely declined in the late 1800s. A canal constructed in 1895 left the stream dewatered near the town of Sisters, and by 1912 summer flow in the Sisters area was entirely diverted for irrigation (Nehlsen 1995). This limited spring Chinook access to habitat in lower Squaw Creek.
Spring Chinook in the Metolius drainage probably maintained access to historical habitat areas until construction of the Pelton Round Butte Complex. However, some spring Chinook habitat was lost because of log drives in the 1920s and through the removal of instream large woody debris.

Artificial Production

Artificial propagation of spring Chinook salmon within the subbasin began in 1947 with construction of the Oregon Fish Commission Metolius Hatchery on Spring Creek. Approximately 125,000 spring Chinook were reared annually at this facility (Wallis 1960). Today hatchery spring Chinook salmon smolts are reared and released from two hatcheries in the subbasin: Round Butte Fish Hatchery, operating since 1973, and Warm Springs Hatchery, operating since 1980 (ODFW 1997).

Current Hatchery Production

As the operator of the Pelton Round Butte Complex, Portland General Electric is obligated to return 1,200 adult Round Butte Hatchery-origin spring Chinook (600 females) annually to the Pelton Fish Trap at the base of the Pelton Reregulating Dam. The company constructed and funds operation of Round Butte Hatchery by ODFW to mitigate for lost production of wild spring Chinook salmon and summer steelhead above the project. The hatchery raises approximately 300,000 spring Chinook yearling smolts annually for release into the Deschutes River. The hatchery also releases approximately 230,000 yearling spring Chinook salmon smolts annually immediately below the Pelton Reregulating Dam to meet adult mitigation requirement. Approximately 65,000 to 70,000 additional yearling smolts are released at the same site each year as part of an ongoing study to evaluate innovative fish rearing cells in the former Pelton fish ladder (ODFW 1997).

Brood stock was collected from the wild run passing Sherars Falls during the low hatchery run years of 1977 through 1980. Since 1981, most hatchery brood stock has been collected from fish returning to the Pelton fish trap (ODFW 1997). Brood stock collected for the current program at Round Butte Hatchery includes approximately 300 adults and 30 jacks held to meet mitigation requirements mandated by the FERC license to PGE to operate the Pelton Round Butte Complex. An additional 200 adults and 50 jacks are held to provide brood stock for the increased ladder-rearing program funded by BPA. Brood stock has also been acquired from Warm Springs Hatchery on years when inadequate numbers of fish returned to the Pelton Fish Trap. Fish for brood stock are collected throughout the run, proportional to their abundance, to maintain diversity in the time of return. From 1985 to 1994, unmarked spring Chinook made up 5.1% to 39.4% of the brood stock held for spawning at Round Butte Hatchery. Since 1995, only adult spring Chinook originating from Round Butte Hatchery (verified from coded wire tags) are used in the hatchery brood stock (French 2003).

The spring Chinook salmon production program at Round Butte Hatchery currently consists of two different rearing techniques. Both techniques result in the release of full term smolts that rapidly migrate through the lower Deschutes River. This is believed to minimize interaction with wild fish. One technique involves rearing juvenile Chinook salmon at the hatchery until the spring of their second year (age-1+), and then trucking them 10 miles downstream for release immediately below Pelton Reregulating Dam. The second scenario involves rearing juvenile Chinook salmon at the hatchery until fall of the year following egg-take (Age-0+) and trucking them to Pelton ladder in November where they over winter in rearing cells until they are allowed to migrate volitionally the following April at age-1+ (ODFW 1997).

Rearing juvenile spring Chinook in the Pelton ladder has proven to be a unique and effective technique for increasing adult spring Chinook returns. Smolts reared in the ladder have shown higher smolt-to-adult return rates than smolts reared in the hatchery environment (Smith 1991). For example, average return rate for five brood years from 1977 to 1983 of spring Chinook (adults and jacks) reared in the ladder was 1.6%. Average return rate of spring Chinook (adults and jacks) reared in hatchery ponds during the same time period was 0.5% (Lindsay et al. 1989). Spring Chinook smolts rear well in the ladder, apparently benefiting from the semi-natural rearing conditions and volitional migration. Chinook in the Pelton Ladder are generally fed once per day, five days per week, compared to multiple daily feedings in the hatchery rearing ponds (ODFW 1997).

Warm Springs Hatchery was constructed on the Warm Springs River after the Warm Springs Tribes Tribal Council requested that the Bureau of Sport Fisheries and Wildlife (now the U.S. Fish and Wildlife Service) determine the feasibility of a permanent fish hatchery on the reservation. Warm Springs Hatchery was authorized by Federal Statute 184, on May 31, 1966 to stock Warm Springs reservation waters with salmon and trout. The U.S. Fish and Wildlife Service operates the hatchery on lands leased from the tribe (ODFW 1997).

Warm Springs Hatchery rears only spring Chinook salmon. Rearing other species at the facility was abandoned due to water temperature and fish health problems (USFWS 2003). The design capacity of the hatchery is 1.2 million smolts, but the current production goal is the release of up to approximately 750,000 juveniles (USFWS 2003). Approximately 10% of the brood voluntarily migrates from the hatchery in the fall as age-0 fish. The rest of the brood is released as age-1 smolts the following spring. The original brood stock for the hatchery was taken from wild spring Chinook returning to the Warm Springs River. The Hatchery and Genetics Management Plan identifies Warm Springs River spring Chinook as the stock of choice to be used at the facility. Actual current spring Chinook production varies according to brood stock availability. The annual brood stock collection goal is a maximum of 630 adult salmon (USFWS 2003).

Wild spring Chinook have been incorporated into the Warm Springs Hatchery brood stock 14 of 18 years of operation but have been used only one year in the last five due to insufficient wild spring Chinook escapement. Eggs from Round Butte Hatchery were obtained for production at Warm Springs Hatchery in 1981, 1983, 1994, and 1995 due to low returns of hatchery-reared adults to Warm Springs Hatchery (ODFW 1997).

An adult hatchery spring Chinook out-planting program was initiated in Shitike Creek in 2000. Hatchery–origin fish in excess of Warm Springs Hatchery or Tribal needs have been released annually into the stream below Peters Pasture (RM 23). Numbers of Chinook out-planted include 159 fish in 2000, 200 fish in 2001 and 80 fish in 2002. This program is scheduled to continue whenever there are adequate numbers of hatchery adults available at Warm Springs Hatchery (Gauvin 2003).

Historic Hatchery Production

An early hatchery supplementation program in the Deschutes subbasin was the incubation of eggs of unknown Columbia Basin stock from Carson National Fish Hatchery in hatch-boxes in the Warm Springs River in 1958. Records also show the release of juvenile hatchery fish into the subbasin in 1961 from an unknown stock of fish obtained from Carson National Fish Hatchery. Additional juvenile hatchery fish were released in the subbasin in 1961 and 1962 and have been released annually since 1964 (ODFW 1996). Hatchery jacks and adults have also been released in the Deschutes drainage. Hatchery-origin jacks were out-planted into the subbasin in 1970 and adults were out-planted into the subbasin in 1968 and 1970 (ODFW 1997).

Non-indigenous stocks introduced into the subbasin include the Santiam stock and unknown Columbia basin stocks of fish obtained from Carson and Eagle Creek national fish hatcheries. The contribution of these releases to the current genetic makeup of wild spring Chinook in the subbasin is unknown (ODFW 1997). Several releases of Deschutes River stock were made from McKenzie, Oak Springs, Wizard Falls, and Fall River hatcheries before completion of Round Butte Fish Hatchery.

Effect of Straying/Ecological Consequences

The effect of stray, out-of-basin origin spring Chinook into the Deschutes Subbasin is unknown. There have been stray spring Chinook adults observed in the subbasin, but numbers have apparently been low. In the past, hatchery-produced spring Chinook from other locations in the Columbia Basin have been released without distinguishing tags or external marks. This has made it impossible to determine the origin of some adult salmon captured at the Pelton and Warm Springs River fish traps or speculate on the incidence of straying (ODFW 1997).

A few stray hatchery spring Chinook are recovered annually in the Deschutes River sub-basin. They have included jacks and adults coded wire tagged and released as juvenile fish at sites located over a wide geographical area. Coded wire tags have been recovered from spring Chinook released as juveniles in subbasins located in Washington and Idaho, as well as coastal subbasins that include the Rogue River in Oregon and the Trinity River in California (ODFW 1997). Initially, some out-of-subbasin stray hatchery spring Chinook captured at the Pelton Fish Trap each year could potentially have been used for brood stock in the Round Butte Hatchery program if they were unmarked or marked with the same fin mark as Round Butte Hatchery origin returns. Hatchery brood stock identification measures have now been implemented to insure that stray fish are not incorporated into the hatchery brood stock. Only coded-wire tag verified Round Butte Hatchery origin adults have been used for the hatchery brood stock since 1995 (French. 2003). The consequences of the past use of potential out-of-basin strays in the Round Butte Hatchery brood stock are unknown.

Over the years, there have been a few out-of-subbasin hatchery stray spring Chinook observed at Warm Springs Hatchery based on coded wire tag recoveries. These fish could have been spawned with the Warm Springs stock. The results from using these out-of-subbasin stray hatchery fish for brood stock are unknown.

It does not appear that Round Butte Hatchery origin spring Chinook stray into the natural production area within the Warm Springs River system. Spring Chinook released directly from Round Butte Hatchery home to the Pelton Fish Trap with a great degree of affinity; only 2.5% of all coded wire tagged spring Chinook recovered at the Warm Springs Hatchery trap during return years 1990 through 1994 were Round Butte Hatchery origin (unpublished coded wire tag recovery data, Pacific States Marine Fisheries Commission tag recovery files). There is no evidence to suggest that significant numbers of hatchery origin spring Chinook currently spawn in the wild (ODFW 1997).

Further, carcasses from hatchery brood stock are available for outplanting into the Warm Springs River after spawning as a means of providing stream nutrient enrichment. All carcasses used for this purpose are screened for disease before outplanting. In addition, carcasses are eviscerated and heat-baked to prevent the possible transmission of disease (USFWS 2003).

Relationship between Natural and Artificially Produced Populations

ODFW, USFWS and the Warm Springs Tribes have conscientiously worked to maintain the characteristics of the hatchery produced spring Chinook as close to the wild population as possible. Hatchery-origin spring Chinook salmon returning to Pelton Fish Trap in numbers greater than those needed for brood stock at Round Butte Hatchery are provided to the Warm Springs Tribes for ceremonial and subsistence use (ODFW 1997).

In the Warm Springs system, only spring Chinook indigenous to the Warm Springs River are used for brood stock. Brood fish are currently collected throughout the run in proportion to their time of return, based on direction from the 2003 Warm Springs Hatchery and Genetic Management Plan. Approximately 70% of the fish are collected from late April through May, with a minimum of 90% collected by July 1. To reach full capacity at the hatchery, wild fish can be used for hatchery brood stock after 1,000 wild spring Chinook have been passed above the hatchery to spawn. To maintain genetic diversity in the hatchery stock, a minimum of 10% wild brood stock is incorporated into each hatchery brood if wild fish returns are sufficient to meet escapement goals above Warm Springs Hatchery.

Subbasin Harvest

Harvest of spring Chinook salmon has been ongoing for hundreds, if not, thousands of years. Systematic monitoring of tribal subsistence and sport harvest has only occurred during the past twenty five years. These data have been collected by ODFW and Confederated Tribes personnel.

Current harvest

Harvest of spring Chinook salmon at Sherars Falls has been monitored since 1977 with a statistical harvest survey. From 1977 through 1993, harvest of hatchery and wild spring Chinook averaged 1,002 and 737 fish, respectively. Harvest rates of wild and hatchery spring Chinook salmon are similar, averaging 32% for the wild stock and 36% for the hatchery stock (ODFW 1997). The spring Chinook season was closed in 1981, 1984, 1994 and 1997 for recreational and tribal fishers based on the low predicted return of wild spring Chinook. From 1995 to 2003, recreational angling for spring Chinook was closed or restricted to help insure adequate wild spring Chinook spawner escapement. Tribal fishing was also closed or restricted during this period (Table 7).

Table 7. Expanded statistical harvest estimates of spring Chinook (April 16 – June 15) at Sherars Falls, Deschutes River, by year. Trial includes dipnet, hook and line, and snagging (1987 snagging only). Does not include released fish (French and Pribyl, 2004).

			Sport				Tribal			
			Wild		Hatchery		Wild		Hatchery	
Year	Anglers/ Fishers	Hours	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
1995 a/										
1995 b/	95	442					3	1	35	0
1996 c/	2,495	14,128	2	0	304	39				
1996 c/	296	1,431					57	0	130	6
1997 a/										
1997 b/										
1998 a/										
1998 d/	203	1,067					45	0	53	0
1999 a/										
1999 d/	30	252					0	0	8	11
2000e/	6160	36,558	8	6	2,454	348				
2000d/	463	2,428					299	27	491	72
2001e/	4998	24,493	0	5	1,550	941				
2001d/	323	1,498					169	1	352	31
2002e/	6254	20,590	3	0	2,101	207				
2002d/	254	1,228					179	5	703	12
2003e/	3,912	20,857	0	0	1,339	72				
2003f/							7	0	316	4

a/ Sport season closed.
b/ Tribal season Friday through Sunday during April.
c/ Sport season Wednesday, Saturday, Sunday April 1 to June 30. Tribal season varied.
d/ Tribal harvest allowed by tribal resolution.
e/ Wild release required by sport anglers, seven day per week sport season April 15 to June 15.
f/ Tribal harvest allowed by tribal resolution with mandatory release of wild fish.

Coded wire tag recoveries from wild spring Chinook tagged as juveniles in the Deschutes River from 1977-79 brood years, the only lower Deschutes River subbasin wild spring Chinook to be coded wire tagged, showed that 33% of total harvest for those brood years was in the ocean, 24% in the Columbia River, and 43% in the lower Deschutes River (ODFW 1997).

Historic Harvest Levels

There is little historic (i.e. pre-1977) subbasin harvest data available. Historically, there has been a tribal dip net and set net fishery at the Sherars Falls site for hundreds of years. There has also been an important non-Indian fishery at the same site for nearly one hundred years. In addition, a commercial fishery at the mouth of the Deschutes River occurred from approximately 1880 to 1900 with nets across the river, which "*practically blocked the ascent of all the fish*" (ODFW 1996). Historical accounts, stories and photos from the 1800s and early 1900s also describe salmon runs in the Crooked River system. Ogden's journals in the 1820s first documented salmon in the Crooked River when the explorer found an Indian barrier for taking salmon below the confluence of the North and South forks of the Crooked River (Ogden 1950; Buckley 1992). In addition, historical stories and photos from the early 1900s show huge catches of salmonids in the lower Crooked River.

Fall Chinook

Importance

Fall Chinook salmon are an anadromous species indigenous to the subbasin, with high in-basin and out-of-basin values to tribal and non-tribal fishers. Big Falls on the Deschutes River historically blocked all upstream migration of anadromous salmonids, including fall Chinook. However, it is not known whether fall Chinook distribution extended past Steelhead Falls, or even much above the site of the Pelton Round Butte Complex. Historical distribution for this mainstem Deschutes River spawner was truncated by the construction of the Round Butte Hydroelectric Complex at RM 100.

Fall Chinook were selected as a focal species based on an evaluation of their ecological, cultural and legal status. As discussed below, fall Chinook provide significant ecological and tribal value.

- ***Species designation:*** The Mid-Columbia ESU Chinook populations, including the Deschutes River population, were proposed for ESA listing, but it was determined that a listing was not warranted.

- ***Species recognition:*** Fall Chinook salmon in the Deschutes subbasin have provided an important food source for Native Americans over hundreds, if not thousands of years. Historically fish were harvested primarily at the traditional Sherars Falls site on the lower Deschutes River (RM 44). These Chinook salmon have also provided an important recreational fishery. This fishery is also predominantly centered on the Sherars Falls area of the Deschutes River.

- ***Special ecological importance to subbasin:*** These salmon not only provided an important protein source for Native Americans living in the subbasin, but they provided an important food source for a variety of wildlife. Fish, that were not consumed, contributed an important source of nutrients that had wide-reaching benefits to the biota of the subbasin, including aquatic insects, aquatic and semi-aquatic plants and, indirectly, some terrestrial plant species. Fall Chinook are the largest race of salmon utilizing the Deschutes River subbasin. They regularly till the river's gravel substrate during spawning. The regular loosening of the substrate helps to prevent cementing or embeddedness, which is beneficial to the production of macro invertebrates and other aquatic species.

- ***Tribal recognition:*** The fall race of Chinook salmon has strong cultural and religious values for many Native Americans throughout the Pacific Northwest, including the Confederated Tribes. These fish have long had important tribal cultural, subsistence and commercial value. Salmon are considered part of the spiritual and cultural identity of the Indian people. Historically the salmon were the center of an important trade economy between various tribes. They served as a primary food source for tribal members and continue to be an essential aspect of their nutrition. Fall Chinook were generally preferred for drying because their flesh contained less oil than the spring Chinook. Fishing is still the preferred livelihood of some tribal members.

Population Data and Status

Abundance

Fall Chinook abundance in the lower Deschutes River has increased in recent years. From 1977 to 2003, the run size of adult fall Chinook salmon into the lower Deschutes River averaged 7,146 fish and ranged from 2,813 to 20,811 fish annually (Table 8). From 1997 through 2003, the run size of fall Chinook (adult and jack) into the lower Deschutes River averaged 11,677 fish annually, ranging from 4,061 fish to 22,101 fish (French and Pribyl 2004).

The number of fall Chinook escaping to mainstem spawning grounds has also increased. The annual estimated spawning escapement of adult fall Chinook averaged 6,145 fish from 1977 to 2003, and ranged from a low of 2,205 fish in 1984 to a high of 20,678 in 1997 (Table 8). Annual spawning escapement of jacks averaged 3,937 fish from 1993 to 2003 (Table 8 and 9) (French and Pribyl, 2004). Annual spawning escapement of adult fall Chinook upstream from Sherars Falls averaged 2,438 fish for the period 1977 through 2003 and 2,597 fish for the period 1993 through 2003. Annual spawning escapement of adult fall Chinook from the mouth of the Deschutes River up to Sherars Falls averaged 3,708 fish for the period 1977 through 2003, and 7,237 fish for the period 1993 through 2003 (French and Pribyl 2004).

Capacity

The fall Chinook population appears capable of maintaining total production with an average spawning escapement of approximately 4,000 adults to the Deschutes River. In the years following implementation of the U.S./Canada Salmon Treaty, the number of fall Chinook returning to the river annually has increased markedly.

The EDT Model estimated that current fall Chinook habitat in the Lower Deschutes Westside Assessment Unit has the capacity to return approximately 16,277 adult fish to the subbasin annually. With moderate habitat restoration (Preferred Alternative) the habitat capacity could increase the annual run to the subbasin to approximately 17,826 adult fish.

Life History Diversity

Fall Chinook salmon spawn throughout the lower Deschutes River from the mouth to Pelton Reregulating Dam. The upper six miles of the lower Deschutes River (Dry Creek to Pelton Reregulating Dam) were heavily utilized for spawning in the 1970's and early 1980's. From 1972 through 1986, about 46% of all redds counted were counted in four sample areas above Dry Creek (RM 94.8). These four areas represent only 16% of the area surveyed for redds from the river mouth to the dam (Jonasson and Lindsay 1988). Huntington (1985) found approximately 55% of the suitable spawning gravel for Chinook salmon in the upper three miles of the river, from Shitike Creek to Pelton Reregulating Dam.

Managers have never documented spawning in any of the Deschutes River tributaries. Spawning of fall Chinook begins in late September, reaches a peak in November, and is completed in December. Researchers have observed carcasses of spawned out fall Chinook salmon from late September to late December with the peak number of carcasses noted during the last half of November. Ripe males and females have, however, been captured in the Pelton Fish Trap in early December (ODFW 1997). Emergence of fall Chinook fry from the gravel begins in January or February and is completed in April or May. They begin their ocean migration the same spring. Juvenile fall Chinook salmon begin their migration to the ocean from May to July at age-0. The downstream migration through the Columbia River occurs from April to August, with the median passage in June and July. A small percentage of the juvenile fall Chinook remains in the lower Deschutes River over winter and emigrate in the spring at age-1 (ODFW 1997).

The EDT Model estimated that the current fall Chinook population has approximately 53% life history diversity. With moderate habitat restoration the diversity would increase to 60%.

Productivity

The estimated adult fall Chinook salmon run to the Deschutes River from 1999 to 2003 averaged 9,942 fish and ranged from 3,981 to 12,590 fish (French and Pribyl, 2004). This may be some measure of stock productivity when in-river and ocean rearing conditions are favorable. The larger run sizes observed in recent years may also be related to improvements in Deschutes River juvenile rearing habitat. All production of fall Chinook salmon in the subbasin is from wild stock.

Information on survival rates for fall Chinook salmon in the lower Deschutes River subbasin is not available (ODFW 1997). Survival data will be available when fish that have recently been coded-wire-tagged by Tribal staff begin returning to the river as adults. This tagging of naturally-produced juveniles began in 2000 (Brun 2003).

Lower Deschutes River fall Chinook are susceptible to *Ceratomyxosis*, the disease caused by the myxosporidian parasite Ceratomyxa shasta (*C. shasta*). Juvenile fall Chinook salmon seined from the lower Deschutes River before May 4 in 1978 and June 8 in 1979 were not infected with *C. shasta*. Infection rates increased for groups of fish seined from the river until July 7 of 1978 (56% infected) and July 16 of 1979 (90% infected), and then steadily decreased to low infection rates in September of both years (Ratliff 1981). It is possible that most juvenile fall Chinook salmon avoid contracting *Ceratomyxosis* by migrating to the ocean before July when high numbers of infective units of *C. shasta* are present in the river. The ongoing juvenile fall Chinook tagging project has shown many fall Chinook juveniles are present in the river upstream of Sherars Falls during July. The cooler water temperatures above Sherars Falls may act to delay out-migration of juveniles, thus forcing these late migrants to migrate through the warmer water below Sherars Falls during June and July. By contrast the juveniles rearing in the river downstream from Sherars Falls appear to leave the river by early June, when water temperatures begin to rise (Brun 2002).

The EDT Model estimated that the current productivity of wild subbasin fall Chinook salmon is 6.0. With moderate habitat restoration productivity could increase to 7.1.

Table 8. Run size of adult fall Chinook salmon in the Deschutes River, by year (French and Pribyl 2003).

Year	Harvest	Escapement	Run
1977	1,861	5,631	7,492
1978	1,971	4,154	6,125
1979	1,592	3,291	4,883
1980	1,951	2,542	4,493
1981	1,837	3,183	5,020
1982	2,016	4,890	6,906
1983	1,496	3,669	5,165
1984	970	2,205	2,995
1985	807	2,645	3,452
1986	1,153	3,801	4,954
1987	2,057	4,097	6,154
1988	2,391	3,520	5,911
1989	1,730	4,770	6,500
1990	970	2,224	3,194
1991 a/	154	3,532	3,686
1992 b/	37	3,776	2,813
1993 b/	11	8,239	8,250
1994 b/	69	5,455	5,524
1995 b/	36	7,588	7,624
1996 b/	78	8,763	8,841
1997 b/	133	20,678	20,811
1998 c/	507	10,925	11,432
1999 c/	373	6,527	6,900
2000 d/	407	3,981	4,388
2001 b/	334	11,177	11,511
2002e/	975	3,940	13,244
2003e/	1078	12,590	13,668

a/ Sport and tribal Chinook season closed June 16 – September 30, 1991.

b/ Sport season closed. Tribal harvest limited differently by year.

c/ Sport season August 1 to October 31, Wednesdays, Saturdays, and Sundays only. Tribal harvest limited differently by year.

d/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap of 1,300 adult fall Chinook.

e/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap.

Table 9. Run size of jack fall Chinook salmon in the Deschutes River, by year.

Year	Harvest	Escapement	Run
1977	1,672	2,125	3,797
1978	1,597	2,708	4,305
1979	2,000	4,338	6,338
1980	1,507	1,904	3,411
1981	1,294	3,728	5,022
1982	1,506	3,360	4,866
1983	678	859	1,537
1984	987	1,237	2,224
1985	1,454	5,384	6,838
1986	1,428	5,872	7,300
1987	242	1,515	1,757
1988	245	1,859	2,104
1989	150	1,486	1,636
1990	140	727	867
1991 a/	59	1,746	1,805
1992 b/	4	2,483	2,486
1993 b/c/	0	NO ESTIMATE	
1994 b/	8	14,276	14,284
1995 b/	19	7,121	7,138
1996 b/	6	1,705	1,711
1997 b/	7	1,005	1,012
1998 d/	78	6,960	7,038
1999 d/	76	4,097	4,173
2000 e/	127	8,395	8,522
2001 b/	27	10,563	10,590
2002	75	1,169	3,707
2003 f/	78	3,264	3,342

a/ Sport and tribal Chinook season closed June 16 – September 30, 1991.

b/ Sport season closed. Tribal harvest limited differently by year.

c/ An insufficient number of tagged jack salmon were recovered during carcass surveys. No run size or escapement estimates for jack fall Chinook could be made.

d/ Sport season August 1 to October 31, Wednesdays, Saturdays, and Sundays only. Tribal harvest limited differently by year.

e/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap of 1,300 adult

f/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap.

Carrying Capacity

The Deschutes River fall Chinook salmon carrying capacity has not been determined. An accurate stock recruitment model, similar to that used to predict adult spring Chinook returns to the subbasin, does not exist for fall Chinook, but Tribal staff are in the process of developing a model (Brun, 2003). Managers feel that an average annual spawner escapement of 4,000 adults to the river, with a 2,000 escapement upstream of Sherars Falls, is the minimum spawner escapement needed to maintain this population (ODFW 1997).

Population Trend and Risk Assessment

Estimates of fall Chinook runs for the past twenty-five years indicate that this Chinook population has experienced some of its largest runs to the Deschutes River in the past ten years. This coincides with years of good ocean productivity (Tables 8 and 9) and may be directly associated with reduced ocean harvest following implementation of the U.S./Canada Salmon Treaty.

The risks to this population range from water quality to environmental catastrophe. Any reductions in river flow would likely result in increased water temperatures that would make these fish more vulnerable to parasites and disease. Elevated river temperatures prior to the smolt migration could produce appreciable losses from *Ceratomyxosis*. The major north – south rail line that closely borders the lower 86 miles of the Deschutes River also poses a threat. An accidental derailment and spill of hazardous material into the river could devastate all aquatic life from that point downstream. However, the population's complex life history patterns allow some built-in population protection from such a catastrophic scenario.

Unique Population Units

Deschutes River fall Chinook are managed as an upriver bright salmon race and are used as an indicator stock by the U.S./Canada Salmon Treaty. Schreck et al. (1986) classified populations of Columbia River Chinook salmon (wild and hatchery; spring, summer, and fall) into several broad groups of similar populations by cluster analysis of characteristics associated with body shape, meristics, biochemistry, and life history. Wild fall Chinook salmon from the Deschutes River were similar to eight hatchery and wild fall Chinook salmon populations that occur in the Columbia River basin from the Cowlitz River to the Hanford Reach, and were also similar to two hatchery spring Chinook salmon populations from the lower Columbia River. Deschutes River fall Chinook salmon were not genetically similar to summer Chinook salmon from the upper Columbia River or from the Salmon River. Details of the gene frequencies, meristic characters, and body shape characters of Deschutes River fall Chinook salmon can be found in Schreck et al. (1986).

Life History Characteristics of Unique Populations

It is uncertain if the lower Deschutes River fall Chinook run is composed of one or two populations. The adult run timing of this population(s) overlaps the accepted summer and fall Chinook run timing on the mainstem Columbia River. Evidence exists that two populations were historically present and may continue to exist. Galbreath (1966) reported several instances of Chinook tagged at Bonneville Dam during the summer Chinook migration (June 1 to July 31 at Bonneville Dam) being recovered later in the Deschutes River subbasin. Three of these tags were recovered in the Metolius River prior to the time anadromous runs were blocked by dams on the Deschutes River, suggesting that a portion of the Deschutes River Chinook population, potentially summer Chinook, spawned in the Metolius River and maintained spatial reproductive and hence racial separation. In the past 30 years, Deschutes River fishery managers have never been able to verify any temporal or spatial separation during spawning in the lower Deschutes River that could verify two distinct populations within the subbasin.

There has also been speculation about whether this is one population that spawns throughout the lower 100 miles of the Deschutes River or two populations; one spawning above Sherars Falls and one spawning below Sherars Falls. Beaty (1995) examined this question in detail but could not reach a definitive conclusion on the existence of two populations. Existing evidence supports both the one population concept and the two population concept (ODFW 1997).

The fall Chinook population(s) has two peaks in migration timing - one in June through August and one in late September and early October. Fish from the earlier migration peak tend to migrate further up the system and are captured at the Pelton Fish Trap at a higher rate than the later migrating group. During run years 1977 through 1986, about 28% of the fall Chinook that passed Sherars Falls did so before September 1. However, of the adults caught in the Pelton Fish Trap for those run years, 48% were caught by September 1 (Jonasson and Lindsay 1988).

This population's life history diversity is indicated by the number of age classes typically observed in the in-river fishery (Table 10). The average age class structure of lower Deschutes River fall Chinook during 1977 through 1986 brood years was 34% age-2 fish, 30% age-3 fish, 31% age-4, 5% age- 5, and less than 1% age-6 fish (Table 10). Approximately 96% of the returns during the same brood years had entered the ocean at age 0, and 4% had entered the ocean at age 1 (Jonasson and Lindsay 1988). Mean lengths of the four most common ages at return are shown in Table 10. In the lower Deschutes River subbasin, 21.3 inches is the length criterion to differentiate between fall Chinook jacks and adults for inventory purposes. Only 2% of age-2 fish are larger than 21.3 inches, and only 15% of age-3 fish are smaller than 21.3 inches (ODFW 1997). Data collected during Tribal fall Chinook salmon studies in 2001 and 2002 found the adult sex ratio of 51% male to 49% female, and 41% male to 59% female, respectively (Brun 2003). Information is not available regarding fecundity or adult length-weight relationship.

Table 10. Age-specific lengths of fall Chinook salmon sampled at Sherars Falls, 1978-83. (Jonasson and Lindsay, 1988).

Age [a/]	N	Mean Length (cm)	Length 95% CI [b/]	Length Range (cm)
2	866	43.9	0.3	20-59
3_1	644	61.7	0.9	34-88
3_2	39	55.3	1.9	48-80
4_1	852	85.5	0.5	61-108
4_2	41	78.8	2.7	61-92
5_1	153	93.0	1.1	74-109
5_2	46	95.5	2.8	78-133
6_1	3	94.0	11.4	90-99

a/ Age was determined by scale analysis.
b/ CI = confidence interval (+ or -).

Estimate of Desired Future Condition for Long-term Sustainability

Deschutes fishery managers have determined that a minimum spawner escapement of 4,000 adult fall Chinook is needed to sustain this population. A larger run to the mouth of the Deschutes River would provide for some in-river harvest and an adequate spawner escapement.

Distribution

Current and Historic Distribution

Fall Chinook salmon spawn and rear throughout the mainstem Deschutes River below Pelton Reregulating Dam. It remains unknown whether fall Chinook historically passed above Sherars Falls. Summer and fall flows in the lower Deschutes River may have historically limited distribution of fall Chinook salmon to 44 miles of river downstream from Sherars Falls before a fish ladder was built at the falls in the 1930's. However, it's possible that higher natural mainstem flow — which may have existed before development of extensive irrigation systems in Central Oregon in the late 1800s — was sufficient for fall Chinook passage at Sherars Falls throughout the summer and fall months. Construction of Pelton and Round Butte hydroelectric dams in 1958 and 1964, respectively, inundated spawning areas above river mile 100. Upstream passage was possible around the hydroelectric complex, but downstream passage facilities at the dams proved insufficient to sustain wild runs above the dams. The fall Chinook salmon run was extirpated above the Pelton Round Butte Complex by 1970.

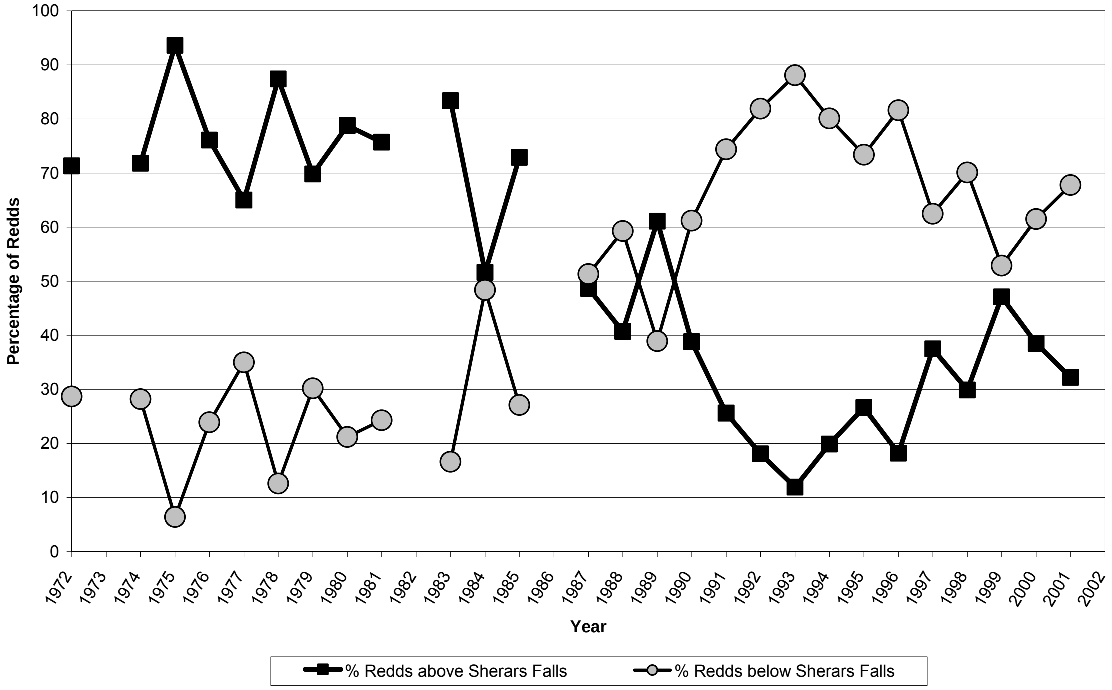
Differences in Distribution due to Human Disturbance

Construction of the Pelton Round Butte Complex may have eliminated several miles of historic spawning and rearing habitat. However, the bulk of the historic habitat remains available from the river mouth upstream to the Pelton Reregulating Dam.

Fall Chinook redd counts conducted from 1972 to 2002 suggest that a change in historic spawning distribution may have occurred and a higher percentage of spawning is now taking place downstream from Sherars Falls (Figure 1). From 1972 to 1987, an average of 76 percent of the fall Chinook redds found in the lower 100 miles of the Deschutes River were upstream from Sherars Falls. During years 1988 to 1995, an average of 30% of all redds counted were upstream from Sherars Falls (ODFW 1997). Radio telemetry data collected from adult Chinook tagged at Bonneville Dam appears to confirm the apparent shift in spawning distribution within the Deschutes River. Of the radio-tagged salmon spawning in the Deschutes River, 76% and 67% spawned downstream from Sherars Falls in 2001 and 2002, respectively (Brun 2002 and 2003).

Reasons for this shift in spawning distribution are unknown. Several factors may be responsible for causing the shift in fall Chinook spawning, including degradation of water quality, spawning gravel quality or quantity, increased egg-to-smolt survival below Sherars Falls associated with substantial riparian habitat recovery in this reach, adult passage problems associated with the Sherars Falls fish ladder, intensive water contact recreation above Sherars Falls, and over-harvest of the portion of the run destined to spawn above Sherars Falls (ODFW 1997).

Figure 1. Deschutes River Fall Chinook Salmon Spawning Distribution, 1972 – 2002 (French and Pribyl 2003).



Artificial Production

Introduction

Fall Chinook salmon culture was not listed as a condition on the Pelton Round Butte hydroelectric license. Fall Chinook hatchery production and/or juvenile releases have not occurred in the subbasin for more than twenty years, and no hatchery supplementation of this wild population is anticipated.

Historic Artificial Production

Fisheries managers out-planted Little White Salmon River Fish Hatchery fall Chinook salmon in the Warm Springs River without success in 1958, 1967, and 1968 (Table 11). There was also some experimental production of fall Chinook salmon at Round Butte Hatchery in the late 1970's. This project was discontinued because of poor returns, possibly due to *Ceratomyxosis* (Ratliff 1981).

Effect of Straying/Ecological Consequences

Few stray, out-of-subbasin origin fall Chinook had been observed in the Deschutes River until the past two years. However, managers now believe there is substantial interaction between wild Deschutes fall Chinook and other stray, hatchery origin summer or fall Chinook within the lower reaches of the Deschutes River. This conclusion is based on recent radio telemetry data and an ongoing Tribal fall Chinook study. The initial indications of no appreciable straying into the Deschutes River were masked by the difficulty of identifying stray fish. The lack of external markings for some Upper Columbia River Basin hatchery-origin fish makes it impossible to distinguish them as hatchery fish. Adult fall Chinook trapping at Sherars Falls during the past 25 years has not shown an appreciable number of fin-marked hatchery origin adults.

A Columbia Basin adult fall Chinook radio telemetry study has provided some insight into the straying of fish into the Deschutes River. Of the adult salmon radio tagged and released at Bonneville Dam, 47% and 54% of the adults tagged in 2001 and 2002, respectively, entered the Deschutes River but most did not remain to spawn. In 2001, 13% of these “dip-ins” migrated upstream to or above Sherars Falls (Brun 2002; Brun 2001). Tribal biologists recovering fall Chinook salmon carcasses following spawning estimate that only about one percent of the carcasses examined were fin-marked, out-of-subbasin stray salmon during 2001 and 2002. Coded wire tag recoveries from these fin-clipped carcasses originated predominantly from Klickitat River and Lyons Ferry fish hatcheries (Brun 2003). Nevertheless, it is difficult to thoroughly evaluate the extent of the interaction of stray fall Chinook since many Columbia Basin hatchery-origin fall Chinook can not be distinguished with any external mark or tag. The population co-exists with wild and hatchery-origin summer steelhead and spring Chinook salmon, but there are no known adverse effects from this association. It will be impossible to accurately estimate the number of stray hatchery salmon spawning in the river or estimate their effect on the Deschutes River population until all Columbia Basin hatchery-origin fall Chinook are distinctively marked.

Table 11. Releases of hatchery fall Chinook salmon in the lower Deschutes River subbasin (ODFW 1997).

Release Year	Hatchery and Stock	Number	Size	Location
1958	Spring Creek	300,000	Eggs	Warm Springs R.
1967	Little White Salmon	502,500	1,139/lb	Warm Springs R.
1968	Little White Salmon	1,000,000	856/lb	Warm Springs R.

Subbasin Harvest

Current Harvest

Harvest of fall Chinook salmon in the lower Deschutes River occurs primarily in a three-mile section from Sherars Falls downstream to the first railroad trestle (RM 41–44). This section of river is the only area of the lower Deschutes River where the use of bait is permitted by recreational anglers. A popular recreational fishery—and one of the last tribal dipnet subsistence fisheries for fall Chinook salmon in the region—typically occurs at Sherars Falls from early July to late October. Results from a statistical harvest survey of the recreational and tribal fisheries show that during years when recreational harvest of summer/fall Chinook was allowed, 88% of the recreational harvest of adult fall Chinook downstream from Sherars Falls took place in the Sherars Falls reach and the remaining 12% of the harvest occurred throughout the river as incidental captures in the recreational summer steelhead fishery. Managers have documented no target recreational fall Chinook fisheries outside of the Sherars Falls reach (ODFW 1997).

Recreational harvest averaged 320 adult fall Chinook and tribal harvest averaged 1,297 adult fall Chinook from 1977 to 1990, years when season length and harvest restrictions were not in place (Table 12). During the same time period, recreational harvest averaged 693 jack fall Chinook and tribal harvest averaged 372 jack fall Chinook (Table 11). Of the fall Chinook salmon that entered the lower Deschutes River from 1977 through 1990, 31% of the adults and 29% of the jacks were harvested in recreational and tribal fisheries (ODFW 1997).

From 1997 through 2003 recreational anglers could legally harvest fall Chinook during portions of five years. The average harvest during this period was 168 adults, with a range of 118 to 283 fish, and 66 jack salmon, with a range of 49 to 96 fish. Tribal fishers were able to fish each year during this seven-year period and they harvested an average of 404 adult salmon per year, with a range of 202 to 762 fish. At the same time their average jack harvest was 15 fish, with a range of 1 to 27 fish (French and Pribyl 2004).

Historic harvest

There are no estimates of annual harvest of fall Chinook salmon in the Deschutes River prior to 1977. However, the concentrated Tribal and sport fishery in the Sherars Falls reach has been ongoing for many years.

Table 12. Run size, harvest and escapement of wild fall Chinook salmon (adults and jacks) in the lower Deschutes River, 1977-2002 (French and Pribyl 2004).

	Harvest_			
Year	Tribal a/	Recreational	Escapement	Run Size
1977	2,280	1,253	7,756	11,289
1978	2,037	1,531	6,862	10,430
1979	1,991	1,601	7,629	11,221
1980	2,133	1,325	4,446	7,904
1981	1,786	1,345	6,911	10,042
1982	1,826	1,696	8,250	11,772
1983	1,549	625	4,528	6,702
1984	1,184	773	3,262	5,219
1985	1,449	812	8,029	10,290
1986	1,282	1,299	9,673	12,254
1987	1,676	621	5,612	7,911
1988	1,884	590	5,379	7,853
1989	1,446	419	6,199	8,064
1990	827	283	2,951	4,061
1991 b/	95	118	5,278	5,491
1992 c/	41	0	5,259	5,300
1993 d/	11	0	***NO ESTIMATE OF JACKS***	
1994 e/	77	0	19,731	19,808
1995 f/	53	0	14,709	14,762
1996 g/	90	0	10,468	10,552
1997 h/	210	0	21,683	21,823
1998 i/	359	188	17,885	18,470
1999 i/j/	256	183	10,624	11,073
2000 k/l/m/	382	214	12,376	12,910
2001 j/m/	360	0	21,740	22,101
2002	693	357	15,887	16,937
2003	2,937	1,174	15,854	19,965

a/ Combined dipnet and hook and line fisheries at Sherars Falls. Does not include left before 0700 sample in 1988 and 1989. Does not include tribal snagging harvest in 1987.

b/ Recreational and tribal fishery closed to Chinook salmon until October 1.

c/ Recreational fishery closed to salmon after June 16. Tribal fishery restricted to a 49 adult salmon harvest cap. Harvest windows: July 1 - 11, October 15 - 18, and October 30 - 31.

d/ Recreational fishery closed to salmon after June 18. Tribal fishery restricted to a 45 adult salmon harvest cap. Harvest windows: 6 AM Friday to 12 PM Sunday, July 9 to October 31.

e/ Recreational fishery closed to salmon after April 1. Tribal fishery not restricted June 16 to August 7. Tribal fishery closed August 7 to September 23. Tribal fishery restricted to 60 adult salmon harvest cap. Harvest windows: 6 AM Friday to 12 PM Sunday, September 23 to October 30.

f/ Recreational fishery closed to salmon after April 1. Tribal harvest allowed July 17 through July 29 and 6 AM to 9 PM Monday through Saturday, October 2 to December 31, 1995. Tribal harvest restricted to a 63 adult salmon harvest cap.

g/ Sport fishery closed 6/16 - 10/31. Tribal harvest up to 72 adults.

h/ Sport fishery closed. Tribal harvest up to 112 adults. Includes 69 hatchery origin adults (likely spring Chinook).

i/ Sport season 8/1 – 10/31 Wed., Sat. and Sun. only. Tribal harvest cap varies by year.

j/ Tribal fishers required to release wild steelhead.

k/ Sport season 8/1 to 10/31, 7 days per week.

l/ Tribal harvest cap of 1,300 adult fall Chinook.

m/ Tribal harvest cap of 300 adult fall Chinook, sport Chinook fishery closed 8-1-01, steelhead open.

Redband Trout

Redband trout are a hardy race of rainbow trout that is generally found in the more arid region east of the Cascade Mountains. Two distinct life forms of redband trout, resident redband trout and anadromous summer steelhead, are native to the Deschutes River subbasin. For this discussion, the subbasin's native resident redband trout will be referred to as redband trout, while hatchery rainbow trout will be referred to as rainbow trout.

Summer Steelhead

Historically, the Deschutes summer steelhead population was robust and widely distributed. Summer steelhead occurred throughout the mainstem Deschutes River below Steelhead Falls and in many of the larger tributaries, including the Crooked River and Squaw Creek systems (Nehlsen 1995). During high winter and early spring flows, they may have been able to negotiate Steelhead Falls, and migrated as far as Big Falls (RM 132.2). After construction of the Steelhead Falls fish ladder in 1922, fish could move upstream, regardless of flow conditions, to access some excellent gravel areas and cool spring-fed flows between Steelhead and Big falls (Nehlsen 1995).

Steelhead runs to the Crooked River drainage, the Deschutes River above RM 100, and Squaw Creek were eliminated by a series of large irrigation and hydroelectric dams on the Deschutes and Crooked rivers. In the Crooked River system, Ochoco Dam (Ochoco Creek) and Bowman Dam (Crooked River, RM 70) were completed in 1921 and 1961, respectively, with no fish passage facilities and blocked anadromous fish runs into Ochoco Creek and the upper Crooked River basin, respectively. Borovicka (1956) reported *"A concentration of steelhead in undetermined numbers was found below the dam of the Ochoco Lumber Co. on Ochoco Creek in the town of Prineville* (OSGC 1956)*.* Borovicka (1956) also reported *that "Steelhead were observed jumping at the Stearns Dam above Prineville on the mainstem of Crooked River". "Steelhead are able to pass the Stearns Dam during flood stages of the Crooked River"* (OSGC 1956)*.* Pelton and Round Butte dams were completed on the Deschutes River downstream of the confluence with the Crooked River in 1958 and 1964, respectively (ODFW 1996).

Today, summer steelhead return to spawn in the lower Deschutes River and several tributaries, including Buck Hollow, Bakeoven, Shitike, and Trout creeks and the Warm Springs and White rivers.

Importance

Summer steelhead are indigenous to the Deschutes River subbasin, with great in-basin and out-of-basin value to tribal and non-tribal fishers. Steelhead are one of the larger species of fish found in the subbasin and are an important component of the aquatic ecosystem. They were selected as a focal species based on an evaluation of their special ecological, cultural and legal status.

Demographically independent population delineation:
The Interior Columbia TRT identified 16 demographically independent populations in four major groupings and one unaffiliated area within the Mid-Columbia River Steelhead ESU shown on map on following page. The TRT based their delineation largely on the

basis of basin topography and habitat similarity, since data tended to be patchily distributed across the region. In particular, genetic studies in this ESU tended to be locally focused, with few overlapping loci to allow comparison across the broader geographic area, although some information was available within our groupings. Uncertainties about hatchery straying and interbreeding limited the TRT's ability to draw definitive conclusions from genetic data.

The Deschutes Subbasin falls within the Cascades Eastern Slope Tributaries grouping. Populations in this major grouping are united primarily by geographic proximity. The habitats they occupy are diverse, but the constituent rivers generally drain the eastern slope of the Cascades and the dry Columbia Plateau. There are two demographically independent steelhead populations, and one extirpated population in the Deschutes Subbasin.

Deschutes River Eastside Tributaries
Deschutes River Westside tributaries
Deschutes River above Pelton Dam

Deschutes River Eastside Tributaries (DREST-s). This population encompasses the mainstem Deschutes River from its mouth to the confluence of Trout Creek, and the tributaries entering the Deschutes from the east: Buck Hollow, Bakeoven, and Trout Creeks. Because of uncertainty concerning the relationship of mainstem spawners in the Deschutes Rivers and tributary populations, mainstem reaches were grouped with their respective tributary populations. The TRT separated the Deschutes River Eastside Tributaries population from other Cascade eastern slope populations by geographic distance (37 km to Fifteenmile Creek) and run timing (Deschutes steelhead are exclusively summer run fish), and from the Deschutes River Westside tributaries population on the basis of marked habitat differences, coupled with life-history differences. Eastside tributaries drain drier, lower-elevation areas than the Westside tributaries; consequently, flow patterns and water temperatures are quite different between the two areas. Steelhead in the two regions are temporally segregated, with eastside tributary fish spawning between January and April, and Westside tributary fish spawning between April and May (Olsen et al. 1992).

Deschutes River Westside Tributaries (DRWST-s). The TRT separated the Deschutes River Westside Tributaries population on the basis of habitat and life history characteristics. Included in this population are mainstem spawners from the mouth of Trout Creek upstream to Pelton Dam (current upstream barrier to anadromous fish), and the Warm Springs River and Shitike Creek. Recent work suggests that anadromous and resident females in this area are spatially isolated (Zimmerman and Reeves 2002), although males may not follow this pattern.

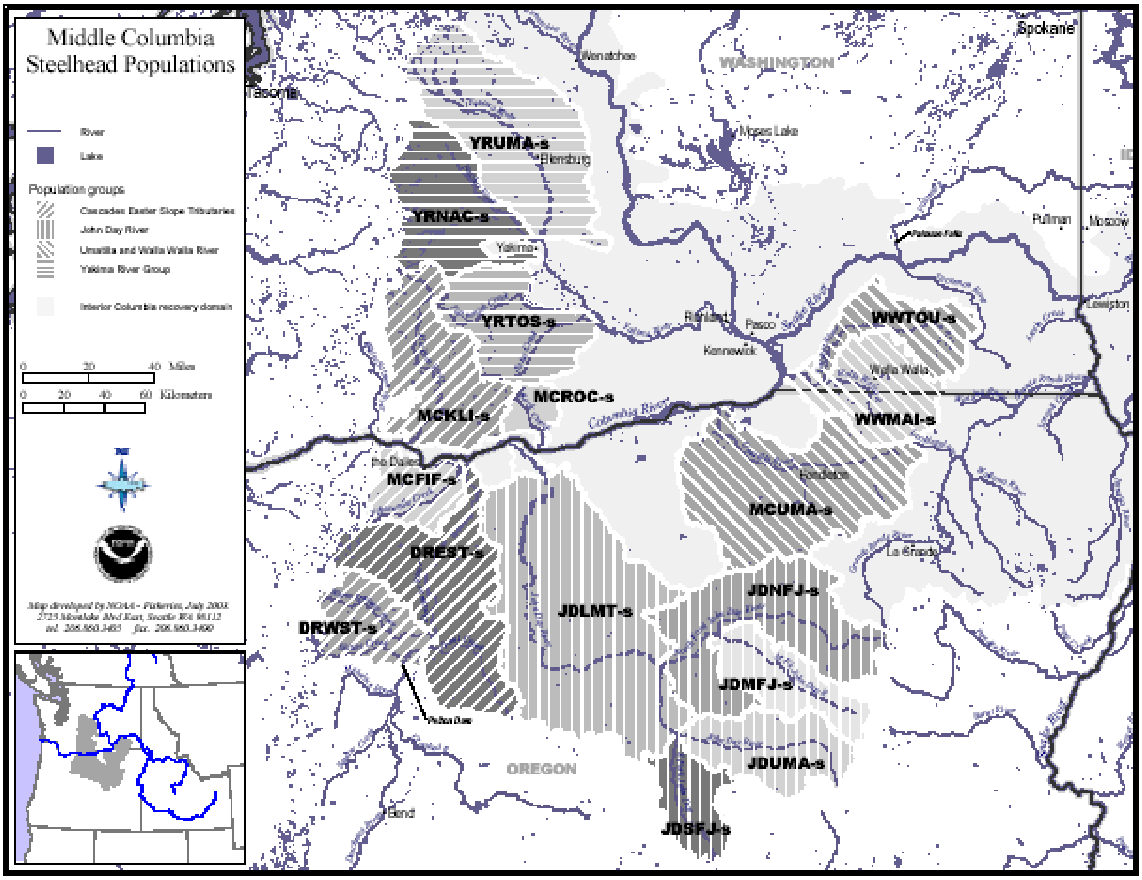


Figure VI-1. Mid-Columbia steelhead populations.

Interior Columbia River Salmon Populations July 2003 89

Deschutes River above Pelton Dam. The population structure of steelhead in the area now blocked by Pelton Dam is ambiguous. The population may have included multiple life histories, including spring-run fish (Nehlsen 1995). Historically, steelhead were found upstream to Big Falls (RM 132), in Squaw Creek and the Crooked River, and possibly in the Metolius River, with Squaw Creek and the Crooked River being particularly productive. The current resident population in this area may include remnant, residualized steelhead. It is likely that this area supported at least one independent population; in fact, genetic samples from the Crooked River are quite distinct from those from other areas of the Deschutes (Currens 1997).

- Summer steelhead within this ESU were federally listed as threatened on March 25, 1999 (NMFS 1999). In 1999, NOAA Fisheries concluded that the Deschutes River hatchery steelhead stock was not considered part of the ESU since it was not essential for the recovery of the wild steelhead population (NMFS 1999a).

- ***Species recognition:*** Summer steelhead in the Deschutes subbasin have provided an important food source for Native Americans over hundreds, if not thousands, of years. Historically, fish were harvested in the Deschutes River and tributaries. Summer steelhead have also provided an important recreational fishery for other non-tribal fishers. This fishery is now confined to the Deschutes River downstream from the Pelton Reregulating Dam.

- ***Special ecological importance to subbasin:*** Summer steelhead serve as an important food source for a variety of wildlife. The fish also contribute an important source of nutrients that has had wide-reaching benefits to the biota of the subbasin, including aquatic and semi-aquatic plants and terrestrial plant species. Steelhead spawners routinely till portions of the gravel substrate, although in different areas than the Chinook salmon. This loosening of gravel is beneficial for the production of macroinvertebrates and other aquatic species. Historically, steelhead potentially had one of the widest distributions of any of the anadromous fish species found within the subbasin, possibly exceeded only by the Pacific lamprey.

- ***Tribal recognition:*** Native Americans throughout the Pacific Northwest, including the Confederated Tribes of the Warm Springs, maintain strong cultural and religious values for summer steelhead and Chinook salmon. These fish have long had important tribal subsistence, ceremonial and commercial value.

Population Data and Status

Abundance

The estimated number of wild summer steelhead migrating over Sherars Falls (Table 13) has ranged from a low of 482 fish in the 1994/95 run year to a high of 9,624 in the 1985/86 run year, averaging 5,0053 fish annually for the period of record (1977/78 – 2002/03). The 1985 high escapement estimate was likely inflated with unmarked stray hatchery-origin fish that were indistinguishable from wild fish (French and Pribyl 2003). Population estimates of wild and hatchery summer steelhead passing Sherars Falls in the lower Deschutes River reflect data collected annually since 1977 using Peterson mark-recapture estimation techniques. These estimates are made by tagging wild summer steelhead captured at the Sherars Falls adult salmon and steelhead trap (located in the fish ladder at Sherars Falls) and making later recovery of both tagged and untagged fish at Warms Springs Hatchery and at the Pelton Fish Trap. This technique yields an estimated number of wild and hatchery steelhead passing Sherars Falls (French and Pribyl 2002).

Capacity

The NOAA Fisheries interim spawner escapement objective for the subbasin is 6,300 wild steelhead. The ODFW Lower Deschutes Fish Management Plan (1997) concluded that a spawning escapement of 6,575 wild steelhead upstream from Sherars Falls would be adequate to sustain maximum natural production potential during years of good juvenile and adult survival conditions. During years of outstanding fresh water and ocean rearing conditions and high smolt-to-adult survival, spawning escapement could be considerably larger (ODFW 1997).

Table 13. Estimated number of steelhead migrating above Sherars Falls, by run year (French and Pribyl 2004).

Run Year	Wild	Round Butte Hatchery	Stray Hatchery	Total
1977-78	6,600	6,100	900	13,600
1978-79	2,800	3,200	300	6,300
1979-80	4,200	5,400	600	10,200
1980-81	4,100	5,500	500 a/	10,100
1981-82	6,900	3,800	1,200 a/	11,900
1982-83	6,567	3,524	1,249 a/	11,340
1983-84	8,228 b/	7,250	7,684 a/	23,162
1984-85	7,721 b/	7,563	3,824 a/	19,108
1985-86	9,624 b/	7,382	5,056 c/	22,062
1986-87	6,207 b/	9,064	9,803 c/	25,074
1987-88	5,367 b/	9,209	8,367	23,943
1988-89	3,546	3,849	2,909	10,304
1989-90	4,278	2,758	3,659	10,695
1990-91	3,653	1,990	2,852	8,495
1991-92	4,826	3,778	8,409	17,049
1992-93	904	2,539	4,261	7,704
1993-94	1,487	1,159	4,293	6,936
1994-95	482	1,781	4,391	6,654
1995-96	1,662	2,708	11,855	16,225
1996-97	3,458	5,932	23,618	33,008
1997-98	1,820	5,042	17,703	24,465
1998-99	3,800	3,527	11,110	18,437
1999-2000	4,790	2,628	13,785	21,203
2000-2001	8,985	4,380	15,072	28,437
2001-2002	8,749	9,373	25,263	31,784
2002-2003	9,363	8,880	15,203	23,004

a/ May include some AD CWT marked steelhead that originated from Warm Springs NFH although few of these ever returned to that facility.

b/ May include some unmarked hatchery steelhead out-planted as fry into the Warm spring River from Warm Springs NFH.

c/ May include adults from a release of 13,000 smolts from Round Butte Hatchery that were accidentally marked with the same fin clip as steelhead released from other Columbia basin hatcheries.

The Ecosystem Diagnosis and Treatment Model projected that the habitat capacity for summer steelhead in the three NOAA Fisheries designated population areas could produce up to 13,800 adult steelhead returning annually to the subbasin. This estimate was based on the assumption that fish passage was successfully restored at Pelton Round Butte and at small dams on lower Crooked River and Squaw Creek. This estimate included potential adult returns numbering up to 3,100, 5,200 and 5,500 for the Deschutes River Westside Tributaries, Deschutes River Eastside Tributaries and the

Middle Deschutes River Tributaries population areas, respectively. However, steelhead production in the Warm Springs River and Shitike Creek does not appear to have been as important historically as the Deschutes River Eastside Tributaries or the Crooked River system. It is also anticipated that these two prominent Westside tributaries will continue to produce low numbers of steelhead.

Portland General Electric has explored summer steelhead production potential upstream of the Pelton Round Butte Complex as part of the FERC relicensing process. During these investigations a PGE consultant, S.P. Cramer and Associates, Inc., developed a model that evaluated the relative importance of different mortality and habitat factors that could affect re-introduced anadromous fish species (Ratliff 2003). Cramer and Associates, Inc. modeled hypothetical asymptotic parr capacity in the accessible habitat upstream of the hydro project and estimated a capacity range between 40,000 and 160,000 fish, based on assumed stock-recruitment relationships and expected survival rates. When it was assumed there was no project-related juvenile or adult passage mortality or increased competition with resident trout, the estimated equilibrium spawner numbers ranged from 500 to 4,000 spawners per year (depending on the productivity of the re-introduced population (Cramer and Beamesderfer 2001).

Productivity

The summer steelhead population has the capability to respond to favorable management and environmental factors. However, the effects of thousands of stray steelhead spawning with the indigenous stock may ultimately have a negative impact on the population's productivity. Specific information on habitat carrying capacity for wild summer steelhead is not available for the lower Deschutes River subbasin. Specific information on wild juvenile summer steelhead populations in the mainstem lower Deschutes River or tributaries is also not available. It appears that steelhead productivity in several lower subbasin tributaries, including Trout, Buck Hollow, and Bakeoven may be increasing as a result of stream and watershed restoration measures implemented in recent years.

The EDT Model projected that the productivity of the Deschutes River Westside steelhead population to be 6.4. With moderate habitat restoration this productivity could increase to 9.0. The projected productivity of the Deschutes River Eastside Population was 1.6. With moderate habitat restoration this population's productivity could increase to 2.9. The potential productivity of the Middle Deschutes population could be 5.7, if fish were present. With restored fish passage and moderate habitat restoration population productivity could reach 8.2.

Life History Diversity

Adult summer steelhead generally return to the Deschutes River from June through October. Steelhead pass Sherars Falls from June through March with peak movement in September or early October. Wild female steelhead consistently out-number males in a run year (Table 14). Information on sex ratio by age at return, and length-weight ratio of wild summer steelhead is not available. Average fish length data for 1 and 2-salt adults is summarized in Table 15. Fecundity of wild summer steelhead, sampled in 1970 and 1971, ranged from 3,093 to 10,480 eggs per female with a mean of 5,341 eggs per female (Olsen et al. 1991). Average fecundity is 4,680 eggs per female for fish that have spent one year in the ocean (1-salt) and 5,930 eggs per female for fish that have spent two years in the ocean (2-salt) (ODFW 1997).

Wild summer steelhead spawn in the lower Deschutes River, Warm Springs River system, White River, Shitike Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and a lack of barriers to fish migration. Spawning in White River is limited to the river below the impassable barrier at White River Falls (RM 2). A natural barrier also limits spawning opportunities in Nena Creek. The relative proportion of mainstem and tributary steelhead spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30 to 60% of the natural production (ODFW 1997).

Spawning in the lower Deschutes River and west side tributaries usually begins in March and continues through May (Zimmerman and Reeves, 1999). Steelhead begin their spawning migration into the Warm Springs River in mid-February. The peak migration past Warm Springs Hatchery typically is in mid-April and is completed by late May. Spawning in the Warm Springs system generally occurs in the river upstream of the hatchery and in the tributaries, including Mill, Beaver, and Badger creeks. The life history characteristics of the Shitike Creek summer steelhead are believed to be similar to the Warm Springs fish. Summer steelhead appear to spawn and rear throughout the lower 40 km of the creek (USFWS 2003).

Spawning in east side tributaries occurs from January through mid-April. Spawning in east side tributaries may have evolved to an earlier time than west side tributaries or the mainstem Deschutes River because stream flow tends to decrease earlier in the more arid eastside watersheds (Olsen et al. 1991).

Table 14. Sex ratio of wild summer steelhead captured at Warm Springs Hatchery, 1977-94 run years (ODFW 1997).

Run Year	% Males	% Females
1977	35	65
1978	23	77
1979	38	62
1980	32	68
1981	34	66
1982	22	78
1983	40	60
1984	35	65
1985	36	64
1986	35	65
1987	25	75
1988	32	68
1989	38	62
1990	31	69
1991	45	55
1992	32	68
1993	47	53
1994	48	52

Table 15. Mean fork length (inches) of Round Butte Hatchery summer steelhead adults sampled at Sherars Falls, 1975-86 broods (ODFW 1997).

Brood Year	N	1-Salt Length	Range	N	2-Salt Length	Range
1975	426	23.6	17-29	473	27.4	20-31
1976	213	23.1	20-30	178	27.1	20-31
1977	859	23.5	20-29	530	26.2	20-31
1978	462	22.8	20-28	326	26.9	20-33
1979	255	22.7	19-28	182	26.5	22-31
1980	27	23.6	20-33	33	26.4	22-31
1981	332	23.5	19-28	187	27.3	22-31
1982	93	23.2	20-28	192	27.3	22-32
1983	280	23.4	20-31	457	27.7	20-32
1984	349	23.2	20-31	299	26.4	21-32
1985	119	22.8	20-34	465	27.2	21-31
1986	200	23.6	21-34	277	26.4	21-31

Steelhead fry emerge in spring or early summer depending on time of spawning and water temperature during egg incubation. Zimmer and Reeves (1999) documented summer steelhead emergence in late May through June. Juvenile summer steelhead emigrate from the tributaries in spring from age-0 to age-3. Steelhead fry from small or intermittent tributary streams experience greater growth then those in the mainstem Deschutes River and may experience a competitive advantage as they move from the tributary environments to the river (Zimmerman and Reeves, 1999). Many juveniles that migrate from the tributaries continue to rear in the mainstem lower Deschutes River before smolting. Scale patterns from wild adult steelhead indicate that smolts enter the ocean at age-1 to age-4 (Olsen et al. 1991). Specific information on time of emigration through the Columbia River is not available, but researchers believe that smolts leave the lower Deschutes River from March through June.

Lower Deschutes River origin wild summer steelhead typically return to the Deschutes after one or two years in the Pacific Ocean (termed 1-salt or 2-salt steelhead). Typical of other summer steelhead stocks, very few steelhead return to spawn a second time in the lower Deschutes River. Information on survival rates from egg-to-smolt and smolt-to-adult is not available for wild summer steelhead in the lower Deschutes River.

Zimmerman and Reeves (1999) concluded that summer steelhead and resident redband trout are reproductively isolated in the Deschutes River by a combination of spatial and temporal mechanisms. Although there was an overlap in the timing of spawning, only 9 to 15 percent of the total redband trout spawning occurred during while steelhead were spawning. Fifty percent of the steelhead spawning occurred 9 to 10 weeks earlier than the time when fifty percent of the redband spawning had occurred. Steelhead also selected spawning sites in deeper water with larger substrate than those selected by the redband trout.

The EDT Model projected the current and potential life history diversity of the three NOAA Fisheries designated steelhead populations. The model estimated that the current productivity of the Deschutes River Westside Tributaries population to be 89%. With moderate habitat restoration this population's diversity could reach 99%. The Deschutes River Eastside Tributaries population was estimated to have a life history diversity of 26%. With moderate habitat restoration this population's diversity could reach 57%. The life history diversity of the potential Middle Deschutes River population above Pelton Dam could reach 74%, if efficient fish passage is established at the Pelton Round Butte Complex.

Carrying Capacity

Specific information on habitat carrying capacity for wild summer steelhead is not available for the lower Deschutes River subbasin. Based on present habitat, an average fecundity of 5,130 eggs per female, and an assumed egg-to-smolt survival of 0.75%, the maximum steelhead production capacity of the lower Deschutes River subbasin is estimated to be 147,659 smolts, with an adult spawning population of 6,575 fish (ODFW 1997). These production estimates were developed during the preparation of the Columbia River Management Plan as directed by terms of the *U.S. v Oregon* court case. The data used to develop these estimates reflect the best information available at that time and are believed to be currently accurate. Both estimates of production capacity (smolts and adults) are based on the assumption that current habitat will sustain past escapement levels and juvenile rearing habitat will sustain the densities predicted from maximum escapement levels. The estimated adult return from a spawner escapement of 6,575 is 9,089 fish, assuming a 6% wild smolt-to-adult survival rate (ODFW 1997). The estimated return of 9,089 adults to the mouth of the Deschutes River would, theoretically, produce some level of harvestable wild summer steelhead.

Population Trend and Risk Assessment

Deschutes River summer steelhead within the Mid-Columbia ESU have been designated as a threatened species under the federal Endangered Species Act. Rationale for this listing includes the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead. The incorporation of genetic material from large numbers of stray steelhead could have a long term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-basin strays also pose a threat to steelhead population health. About 5% of the hatchery stray steelhead have tested positive for whirling disease (Engleking 2002).

Summer steelhead escapement estimates have been made for fish passing upstream of Sherars Falls since the 1977-78 run year (Table 13) (French and Pribyl 2004). The average annual escapement of wild steelhead upstream from Sherars Falls for this period was 5,005 fish, with a range of 482 to 9,624 fish. However, these wild steelhead estimates could be inflated for some years when unmarked stray hatchery fish were unknowingly included in the wild fish escapement calculations. The estimated number of wild steelhead passing Sherars Falls during the last five run years has averaged 7,137 fish, with a range of 3,800 to 9,363 fish. These numbers may also be inflated by unmarked, stray hatchery included in the run size calculations (French and Pribyl 2004).

Only about 3% of the steelhead/redband spawning in the Deschutes occurs below the confluence of White River. Most spawning below Sherars is likely associated with several small tributaries and Buck Hollow Creek. Juvenile rearing occurs in the mainstem below Sherars Falls and may be more important because of the general upward trend in the condition of the riparian community.

The component of the Deschutes steelhead population spawning in the Warm Springs River system upstream of Warm Springs Hatchery may be at less genetic risk. The Warm Springs system is of particular value as a refuge for wild summer steelhead since hatchery marked or suspected hatchery origin summer steelhead are not allowed to pass the barrier dam at the hatchery (WSNFH Operational Plan 1992-1996). This effectively excludes all non-Deschutes River origin summer steelhead except stray wild summer steelhead or stray, unmarked, hatchery origin fish. The numbers of stray hatchery and wild summer steelhead arriving at the Warm Springs Hatchery are summarized in Table 14. Wild steelhead are passed upstream to spawn, while stray hatchery steelhead are donated to the Tribes. Table 15 shows redd counts from areas within Warm Springs River and tributaries since 1994.

Table 14. Summer steelhead adults arriving at Warm Springs Hatchery, 1977 to 2001 (Gauvin 2003).

Year	Wild*	Hatchery**	Total Steelhead
1977	136		136
1978	417		417
1979	378	16	394
1980	311	42	353
1981	397	46	443
1982	569	39	608
1983	255	35	290
1984	431	129	560
1985	577	89	666
1986	373	56	429
1987	822	692	1514
1988	522	699	1221
1989	385	204	589
1990	339	182	521
1991	165	129	294
1992	280	403	683
1993	79	109	188
1994	135	147	282
1995	95	101	196
1996	85	173	258
1997	243	349	592
1998	214	380	594
1999	96	80	176
2000	319	417	736
2001	503	319	822

* Fish are passed upstream to spawn naturally. ** Fish are donated to the Confederated Tribes.

Unique Population Units

Schreck et al. (1986) compared biochemical, morphological, meristic, and life history characteristics among steelhead stocks in the Columbia basin. Lower Deschutes River wild summer steelhead were found to be a component of one of three subgroups of stocks found east of the Cascade mountains; specifically, the group formed by stocks found in the Columbia Basin from Fifteenmile Creek in Oregon to the Entiat River in Washington.

Life History Characteristics of Unique Populations

Scale patterns from wild adult steelhead indicate a variety of life history patterns exemplified by smolts migrating to the ocean from age-1 to age-4 (Olsen et al. 1991). A total of eight life history patterns were identified on scales collected from a sample of lower Deschutes River origin wild adult summer steelhead (Olsen et al. 1991). Typical of other summer steelhead stocks, very few steelhead return to spawn a second time in the lower Deschutes River.

Table 15. Summer steelhead redd counts from index areas within the Warm Springs River system, 1994 – 2003 (Gauvin 2003).

INDEX AREAS	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BEAVER CREEK:										
Reach D to Robinson Park	1	1	0	0	1	1	2	2	2	4
Robinson Park to Dahl Pine	0	6	0	3	23	4	5	6	0	17
Dahl Pine to Canyon	3	0	5	4	21	2	17	32	16	6
Old Bridge to Power line	1	0	0	0	0	3	1	3	0	0
Island Area	4	2	1	2	13	0	6	14	8	15
MILL CREEK:										
B-241 Road Bridge Area	-	-	-	-	-	-	5	-		
Old Mill to Strawberry Falls	2	0	0	0	2	3	1	2	1	4
Strawberry Falls to Potter's Pond	5	0	1	2	3	2	2	2	6	10
Potter's Pond to Boulder Creek	7	1	1	11	5	2	0	9	15	3
WARM SPRINGS RIVER:										
Bunchgrass to Schoolie	-	-	-	-	-	-	-	-		
Schoolie to He-He	-	-	-	-	-	-	-	-		
He-He to McKinley Arthur	-	-	-	-	6	3	-	-		
WSNFH to Culpus Bridge	-	-	-	-	-	-	-	-	-	
Total Redds	23	10	8	22	74	20	39	70	48	59

Estimate of Desired Future Condition for Long-term Sustainability

A spawning escapement of 6,575 wild adult summer steelhead is believed to be adequate to sustain maximum natural production potential with existing habitat conditions during years of good juvenile and adult survival conditions. During years of outstanding survival conditions and high smolt-to-adult survival, the spawning escapement could be even larger (ODFW 1997). A larger escapement capable of supporting some in-subbasin harvest would be desirable.

Distribution

Current Distribution

NOAA Fisheries Technical Recovery Team identified three subbasin steelhead populations, including the 1) Deschutes River Eastside Tributaries - this population encompasses the mainstem Deschutes River from its mouth to the confluence of Trout Creek, and the tributaries entering the Deschutes from the east: Buck Hollow, Bakeoven, and Trout Creeks, 2) Deschutes River Westside Tributaries - The Westside Deschutes River tributaries are separated from the eastside tributary population on the basis of habitat and life history characteristics. Included in this population are mainstem spawners from the mouth of Trout Creek upstream to Pelton Dam (current upstream barrier to anadromous fish), and the Warm Springs River and Shitike Creek, and 3) Middle Deschutes River Tributaries – this extirpated population utilized historic habitat upstream of the Pelton Round Butte Project (RM 100).
Summer steelhead occur throughout the mainstem lower Deschutes River and most tributaries below Pelton Reregulating Dam. Wild summer steelhead spawn in the lower Deschutes River, Warm Springs River system, White River, Shitike Creek, Skookum Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and a lack of barriers to fish migration. Spawning in White River is limited to the lower two miles below White River Falls, an impassable barrier. Spawning opportunities in Nena Creek are also limited by a natural barrier.

The relative proportion of mainstem and tributary spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30-60% of the natural production (ODFW 1987). The Warm Springs River system includes the mainstem and a number of moderate-sized tributaries, but does not appear to contribute a large portion of the tributary-spawned wild summer steelhead in the lower Deschutes River. Estimates of spawning activity suggest that Trout Creek may support 20-30% of the returning wild Deschutes summer steelhead. However, to have increased confidence in this percentage there needs to be an increased effort to better identify and understand the hatchery component in the basin (Haarberg and Nelson 2002).

Differences in Distribution due to Human Disturbance

Summer steelhead distribution was truncated first by the construction of Ochoco Dam on Ochoco Creek and then by the construction of the Pelton Round Butte Complex. Anadromous fish passage was not incorporated into the design of Ochoco Dam and failed at Pelton and Round Butte dams. Stream habitat deterioration associated with water withdrawals and stream channel alterations may have further reduced steelhead distribution in some tributary streams located downstream of the Pelton Round Butte Complex.

Artificial Production

A variety of brood stocks were used historically to augment natural steelhead production in the Deschutes River Subbasin. Willamette River and Big Creek stock winter steelhead were used for brood stock in 1958 and 1959, respectively. Skamania River and Siletz River summer steelhead were used as brood stock in 1965 and in 1965-66, respectively (Olsen et al. 1991). The Big Creek and Siletz River stocks were both susceptible to *Ceratomyxa shasta*. These fish likely did not survive and return as adults to have any genetic influence on the naturally reproducing population. Both the Willamette River and Skamania River stocks exhibit a higher degree of resistance to *C. shasta* and it is possible some adults could have survived from these releases to return to the lower Deschutes River. Potential effects of genetic exchange from these stocks to wild summer steelhead in the subbasin is unknown. Local brood stock for hatchery production before 1957 was collected from Squaw Creek, which lies above the Pelton Round Butte Complex. All brood stock from 1967 to present have been collected only from the lower Deschutes River.

Current Hatchery Production

Round Butte Hatchery, completed in 1972 to mitigate the effects of the Pelton Round Butte Complex, is the only hatchery releasing summer steelhead in the lower Deschutes River subbasin. The project operator is required, as a condition of the project's Federal Energy Regulatory Commission power license, to annually return 1,800 summer steelhead adults to the Pelton Fish Trap from Round Butte Hatchery smolt releases. Portland General Electric funded construction of the hatchery and continues to finance operation and maintenance. ODFW operates the hatchery. No non-indigenous summer steelhead stocks are being released into the subbasin.

Round Butte Hatchery annually releases approximately 162,000 age 1+ summer steelhead smolts. This level of smolt production is designed to meet the FERC License requirement to return 1,800 hatchery origin adults to the Pelton Fish Trap annually.

Brood stock for the summer steelhead program at Round Butte Hatchery were initially collected from hatchery origin and wild fish returning to the Pelton Fish Trap or from wild fish captured at the Sherars Falls adult trap (RM 44). Both wild and Round Butte Hatchery stock summer steelhead were held for brood stock prior to the 1984 brood year. Brood stock for the 1984 through 1987 brood years were selected only from Round Butte Hatchery origin steelhead because of concerns about unmarked, out-of-basin, stray fish introducing foreign strains of the *Infectious Hematopoietic Necrosis* virus (IHNV) into the hatchery steelhead program. From 1988 through 1992, managers collected wild steelhead for brood stock in addition to Round Butte Hatchery origin steelhead (ODFW 1997).

Wild brood stock used from 1988 to 1992 was incorporated into production through wild-by-wild pairing as opposed to a wild by hatchery pairing. Wild-by-wild offspring accounted for 27% to 34% of releases during those years. Wild brood stock collected in 1993, 1994, and 1995 was used in a wild by hatchery matrix pairing and resulted in wild genetic material being incorporated into the resulting egg take at a 32%, 61%, and 16%

rate, respectively (ODFW 1997). Only known Round Butte Hatchery origin adult steelhead have been used as hatchery brood stock since 1993.

Historic Hatchery Production

Squaw Creek was first stocked in 1952 with 27,817 steelhead, four to six inches in length. Hatchery records do not state the origin of the fish, but Nehlsen (1995) found the Oregon State Game Commission operated a trap at Camp Polk annually through 1956 for obtaining eggs from Squaw Creek steelhead. These fish were reared at Wizard Falls Fish Hatchery. Steelhead were also stocked in 1953, 1954, and 1955. Numbers ranged from 26,162 to 32,432 fish. They were released as 4-8 inch or 6-8 inch fish. Stocking was terminated after 1955 (Fies et al. 1998).

Before the 1972 opening of Round Butte Hatchery, Cedar Creek, Gnat Creek, Oak Springs, and Wizard Falls hatcheries reared Deschutes River origin summer steelhead for release into the lower Deschutes River (ODFW 1997). Warm Springs Hatchery reared and released summer steelhead in the subbasin in 1979 and 1981 (Table 18) (ODFW 1997). Steelhead production at the hatchery was discontinued in 1981 due to disease problems, as well as water temperature and physical facility limitations associated with the rearing of 2-year smolts. Future steelhead production at that facility is not planned (WSNFH Operation Plan 1992-1996).

Natural summer steelhead production was supplemented with fry and fingerlings from Round Butte and Warm Springs hatcheries periodically from 1974 to 1984. Fry and fingerling releases were intended to augment natural production rather than provide harvest opportunity. Shitike Creek and tributaries of the Warm Springs River were supplemented with summer steelhead fry or fingerlings from Warm Springs Hatchery, while fingerlings from Round Butte Hatchery were released in the lower Deschutes River (Table 19). The steelhead released off station in the Warm Springs River tributaries were not differentially marked to distinguish them from the production lot released directly from the hatchery. Generally, this supplementation did not appear to be successful since no large increase in unmarked returns was noted from these releases. No future supplementation of natural summer steelhead production is anticipated in the lower Deschutes River.

Table 18. Summer steelhead production releases from Warm Springs Hatchery, 1978 and 1980 broods (ODFW 1997).

Brood Year	Release Date	Number of Smolts	Location	Mark
1978	05/79	89,380	Warm Springs R.	AD+CWT
1980	04/81	4,486	Warm Springs R.	AD+CWT

Table 19. Releases of hatchery summer steelhead in the lower Deschutes River subbasin for supplementation of natural production, 1974 –1984 (ODFW 1997).

Release Year	Hatchery	Number	Size (fish/lb)	Location	Mark
1974	RBH	116,106	142	Deschutes mouth	--
1976	RBH	138,650	96.0	Deschutes mouth	--
1981	WSNFH	35,000	54.4	Warm Springs R.	AD+CWT
	WSNFH	20,000	54.4	Beaver Creek	AD+CWT
	WSNFH	28,000	54.4	Mill Creek	AD+CWT
	WSNFH	15,000	54.4	Badger Creek	AD+CWT
	WSNFH	27,332	781	Shitike Creek	--
1982	WSNFH	16,668	981	Beaver Creek	--
	WSNFH	15,000	981	Mill Creek	--
	WSNFH	35,000	981	Badger Creek	--
	WSNFH	3,000	981	Wilson Creek	--
	WSNFH	79,748	753	Shitike Creek	--
1983	WSNFH	5,000	440	Beaver Creek	--
	WSNFH	54,400	440	Badger Creek	--
	WSNFH	5,000	440	Wilson Creek	--
	WSNFH	5,000	440	Swamp Creek	--
	WSNFH	31,718	413	Shitike Creek	--
	RBH	150,006	26.6	Deschutes R.[a/]	ADRM
1984	WSNFH	80,481	993	Shitike Creek	--
	RBH	150,015	51.2	Deschutes R.[b/]	ADLM

[a/] Released at Pine Tree (RM 39).

[b/] Released at Macks Canyon (RM 25), Beavertail Campground (RM 31) and Pine Tree.

Effect of Straying/Ecological Consequences

While the percentage of stray hatchery summer steelhead passing Sherars Falls has increased over time (Table 20), the percentage of Round Butte Hatchery origin summer steelhead in the population has generally decreased (Table 21). The influx of out-of-basin stray steelhead started in the early 1980's and appears to be related to an increase in the number of hatchery origin steelhead smolts released in the upper Columbia basin and an increase in the number of steelhead smolts transported from upper Columbia River collection points for release below Bonneville Dam.

The annual estimated number of stray steelhead passing upstream from Sherars Falls to the Pelton Fish Trap averaged 7,841 (44%) fish for the 26-year period from 1978 to 2003, with a range of 300 (5%) to 25,263 (58%) fish (Table 22). For the first five years of this data string (1978 to 1983), the average number of stray steelhead passing Sherars Falls annually was 360 fish. From 1997/98 to 2002/03, an average of 16,087 stray steelhead passed Sherars Falls annually (French and Pribyl 2004).

The percentage of Round Butte Hatchery summer steelhead captured in the Pelton Fish Trap has decreased since 1983 (Table 22). The proportion of Round Butte Hatchery summer steelhead returning to the Pelton Fish Trap annually has ranged from a high of 96% in both 1973 and 1974 to a low of 35% in 1993. Conversely, returns of stray hatchery origin summer steelhead to the Pelton Fish Trap has ranged from a low of less than 1% in both 1971 and 1974 to a high of 53% in 1994 and 1995, generally increasing through time since 1983 (French and Pribyl 2004).

The large influx of out-of-subbasin stray summer steelhead may be contributing significant amounts of maladapted genetic material to the wild summer steelhead population in the lower Deschutes River subbasin. While Round Butte Hatchery origin summer steelhead contribute to this problem, their impact is much less numerically and genetically than the large number of out-of-subbasin stray hatchery steelhead also present in the spawning population. The cumulative effect of this genetic introgression may contribute to lowered productive capacity of the wild population as evidenced by low run strength of wild summer steelhead through time.

Table 20. Estimated number of steelhead that migrated past Sherars Falls, by run year (French and Pribyl 2004).

Run Year	Wild	Round Butte Hatchery	Stray Hatchery	Total Hatchery
1977-78	6,600	6,100	900	7,000
1978-79	2,800	3,200	300	3,500
1979-80	4,200	5,400	600	6,000
1980-81	4,100	5,500	500 a/	6,000
1981-82	6,900	3,800	1,200 a/	5,000
1982-83	6,567	3,524	1,249 a/	4,773
1983-84	8,228 b/	7,250	7,684 a/	15,443
1984-85	7,721 b/	7,563	3,824 a/	11,770
1985-86	9,624 b/	7,382	5,056 c/	12,106
1986-87	6,207 b/	9,064	9,803 c/	18,358
1987-88	5,367 b/	9,209	8,367	17,623
1988-89	3,546	3,849	2,909	6,336
1989-90	4,278	2,758	3,659	6,504
1990-91	3,653	1,990	2,852	4,786
1991-92	4,826	3,778	8,409	11,859
1992-93	904	2,539	4,261	6,008
1993-94	1,487	1,159	4,293	5,476
1994-95	482	1,781	4,391	6,126
1995-96	1,662	2,708	11,855	12,828
1996-97	3,458	5,932	23,618	28,416
1997-98	1,820	5,042	17,703	22,511
1998-99	3,800	3,527	11,110	15,120
1999-2000	4,790	2,628	13,785	15,219
2000-2001	8,985	4,380	15,072	19,310
2001-2002	8,749	9,373	25,263	31,784
2002-2003	9,363	8,880	15,203	23,004

Table 21. Estimated percent of Round Butte Fish Hatchery summer steelhead passing Sherars Falls (RM 43) (Data from French and Pribyl 2004).

Run Year	Round Butte Hatchery Steelhead	Total Steelhead	Percent
1977-78	6,100	13,600	45%
1978-79	3,200	6,300	51%
1979-80	5,400	10,200	53%
1980-81	5,500	10,100	54%
1981-82	3,800	11,900	32%
1982-83	3,524	11,340	31%
1983-84	7,250	23,162	31%
1984-85	7,563	19,108	40%
1985-86	7,382	22,062	33%
1986-87	9,064	25,074	36%
1987-88	9,209	23,943	38%
1988-89	3,849	10,304	37%
1989-90	2,758	10,695	26%
1990-91	1,990	8,495	23%
1991-92	3,778	17,049	22%
1992-93	2,539	7,704	33%
1993-94	1,159	6,936	17%
1994-95	1,781	6,654	27%
1995-96	2,708	16,225	17%
1996-97	5,932	33,008	18%
1997-98	5,042	24,465	21%
1998-99	3,527	18,437	19%
1999-2000	2,628	21,203	12%
2000-2001	4,380	28,437	15%
2001-2002	9,373	31,784	23%
2002-2003	8,880	23,004	39%

Table 22. Number and percent of wild, stray, and Round Butte Hatchery origin summer steelhead returning to the Pelton Fish Trap, by run year (French and Pribyl 2004).

	Wild Origin		Stray Hatchery		Round Butte Hatchery	
Run Year	Number	%	Number	percent	Number	percent
81-82	245	11.3	156	7.4	1,760	81.3
82-83	344	16.7	167	8.8	1,547	74.6
83-84	814	17.3	1,452	33.0	2,439	49.7
84-85	603	12.9	795	17.0	3,278	71.1
85-86	686	14.4	943	19.7	3,153	65.9
86-87	467	10.7	1,538	33.4	2,640	57.6
87-88	160	6.6	796	32.1	1,484	61.3
88-89	123	7.4	300	17.7	1,247	74.9
89-90	136	9.1	524	35.2	829	55.7
90-91	82	7.4	428	35.8	606	56.8
91-92	101	4.4	849	36.7	1,365	58.9
92-93	59	3.6	427	26.0	1,157	70.4
93-94	65	12.0	288	53.0	190	35.0
94-95	27	2.0	642	53.0	753	45.0
95-96	32	1.6	976	48.6	1,000	49.8
96-97	126	2.2	2,001	34.9	3,605	62.9
97-98	194	3.8	2,459	48.3	2,440	47.9
98-99	155	6.0	1,284	49.9	1,135	44.1
99-00	83	4.4	768	40.4	1,050	55.2
00-01	114	4.1	1,103	39.2	1,593	56.7
01-02	282	3.2	3,674	41.3	4,942	55.5
02-03	207	3.3	1,787	28.5	4,284	68.2

Relationship between Natural and Artificially Produced Populations

Most steelhead spawning in the subbasin occurs in the Deschutes River and tributaries upstream from Sherars Falls. If numbers of hatchery origin summer steelhead captured at the Pelton Fish Trap, Warm Springs Hatchery trap, and estimated in angler harvest upstream from Sherars Falls are subtracted from the estimated number of hatchery summer steelhead passing Sherars Falls, many hatchery fish, both Round Butte Hatchery origin and stray hatchery origin, remain unaccounted for. Steelhead spawning surveys on Buck Hollow and Bakeoven creeks indicate that many of these fish remain in the wild each year, potentially spawning with wild steelhead (Table 23). From 1984 to 1991, estimated hatchery origin summer steelhead adults migrating upstream from Sherars Falls exceeded estimated numbers of wild summer steelhead adults six of those ten years. From 1992 to 2003, the estimated number of hatchery origin summer steelhead adults escaping upstream from Sherars Falls exceeded the number of wild steelhead every year (see Table 13).

Table 23. Summer steelhead and redd counts, Bakeoven Creek and Buck Hollow Creek, by year (French and Pribyl 2002).

Year	Bakeoven Creek Steelhead				Buck Hollow Creek Steelhead			
	Redds	Wild	Hatch	Unkn	Redds	Wild	Hatch	Unkn
1990	24	2	1	0	85	3	0	0
1991	8	5	0	4	72	1	1	0
1992	9	0	0	0	34	0	0	0
1993	21	2	3	10	48	0	1	0
1994	13	0	0	0	8	0	0	0
1995	20	1	3	1	69	2	1	0
1996	35	2	8	6	65	0	0	0
1997	57	4	9	5	136	2	0	0
1998	68	3	2	4	179	0	0	2
1999	89	13	6	7	152	0	0	0
2000	83	14	17	11	110	0	0	1
2001	480	167	29	113	445	17	9	9
2002	214	55	10	170	221	42	20	41
2003	117	19	4	27	222	43	17	47

Subbasin Harvest

Tribal fishers have been harvesting summer steelhead in the Deschutes Subbasin for hundreds, if not, thousands of years. Non-tribal fishers have been harvesting these fish for decades. The only systematic monitoring of the steelhead harvest has occurred within the past thirty years. This monitoring has been done by personnel with ODFW and the Warm Springs Tribes and is generally associated with the lower 44 miles of river from the mouth to Sherars Falls.

Current Harvest

During the past ten years (1993 to 2002) the average catch of wild steelhead in the recreational fishery from the mouth upstream to, but not including the Sherars Falls area, averaged 3,268 fish, with a range of 1,192 to 6,525 fish. Recreational angling regulations stipulated that all wild fish had to be released unharmed. During the same period the catch of hatchery origin steelhead for the same river reach averaged 2,665 fish, with a range from 779 to 5,120 fish.

Most tribal summer steelhead harvest occurs in the dipnet/set net subsistence fishery concentrated at Sherars Falls. During the ten-year period from 1993 to 2003, tribal fishers at Sherars Falls had tribal regulations restricting the harvest of wild steelhead. The annual harvest of wild steelhead in this subsistence fishery averaged 31 fish, with a range from 0 to 135 per year (French and Pribyl 2004). Some limited hook and line harvest of wild summer steelhead by Tribal members does occur in areas upstream of Sherars Falls, primarily during the winter months. The number of wild summer steelhead harvested by tribal fishers in this fishery is not known.

Historic Harvest

Harvest or catch of the different components of summer steelhead runs in the lower Deschutes River has been estimated by statistical harvest estimation procedures since 1970. Both recreational anglers and tribal fishers catch wild summer steelhead. Only tribal fishers have been able to legally retain them since 1978. Tribal harvest of wild summer steelhead during the 1980s, years of unrestricted tribal dipnet effort, ranged from a low of 339 in 1988 to a high of 1,600 in 1984, and averaged 925 for the ten-year period. The recreational catch of summer steelhead in the Deschutes River July 1 to October 31 from the mouth to Sherars Falls, in years when all harvest samples were completed, is summarized in Table 24. Table 25 shows hatchery steelhead harvest data from upstream of Sherars Falls to the Pelton Reregulating Dam from 1984 to 1994.

Table 24. Estimated recreational catch of summer steelhead in the Deschutes River July 1 to October 31 from the mouth to Sherars Falls in years when all harvest samples were completed, 1973-95[c/].

Run	Wild [a/]		Round Butte Hatchery		Stray Hatchery		Total
Year	Number	Percent	Number	Percent	Number	Percent	Number
1973	5,080	69	1,974	27	315	4	7,369
1974	4,623	56	3,287	40	289	4	8,199
1975	4,226	75	1,156	20	279	5	5,671
1977	4,674	75	1,063	17	471	7	6,208
1980	5,674	71	1,610	20	723	9	8,007
1981	7,157	80	1,146	13	622	7	8,925
1982	5,929	78	973	13	713	9	7,645
1983	8,377	72	1,132	10	2,142	18	11,650
1987	11,662	81	765	5	1,913	14	14,340
1989	5,155	66	607	7	2,088	27	7,850
1990	2,037	57	220	5	1,319	38	3,576
1992b/	2,007	55	251	6	1,369	39	3,627
1993b/	2,139	59	180	4	1,303	37	3,622
1994b/	1,192	49	159	7	1,085	44	2,436
1995b/	1,641	44	259	7	1,833	49	3,733

a/ Includes fish caught and released under a regulation adopted in 1979.

b/ Recreational angling closed at Sherars Falls June 15 to October 31.

c/ Does not include estimated east bank mouth catch after 1979. Does include estimated catch at Kloan 1970, 1972-1975, 1977, and 1980.

Table 25. Estimated harvest of hatchery origin adult steelhead and spawning escapement above Sherars Falls, 1977 – 1994 (ODFW 1997).

	Estimated harvest of Hatchery steelhead		Estimated hatchery-origin spawners		Estimated Wild Spawners
Run Year	**Stray**	**RBH**	**Stray**	**RBH**	**Spawners**
1977	---	---	---	---	6600
1978	---	---	---	---	2800
1979	---	---	---	---	4200
1980	---	---	---	---	4100
1981	---	---	---	---	6900
1982	---	---	---	---	6600
1983	---	---	---	---	8200
1984	311	631	2628	3673	7700
1985	609	876	3532	3356	9600
1986	629	580	7088	5920	6200
1987	407	442	6681	7262	5400
1988	367	486	2067	2039	3500
1989	507	382	2506	1579	4300
1990	479	320	1898	1072	3700
1991	856	385	6792	2036	4900
1992	557	314	3216	1024	900
1993	693	195	3132	811	1500
1994	535	219	3205	823	500

Resident Redband Trout

Redband trout are a large group of inland native rainbow trout endemic to basins of the Pacific Northwest east of the Cascade Mountains. Their range includes the upper Columbia and Fraser Rivers, and the Klamath River southward to the McCloud River of northern California (Behnke 1992). Unlike rainbow trout, redband trout demonstrate a greater tolerance of high water temperatures, low dissolved oxygen levels, and extremes in stream flows that frequently occur in desert climates.

Redband trout were historically found in large numbers throughout suitable habitat areas in the Deschutes River and tributaries, including the entire Crooked River drainage. Today, redband trout are still found in many traditional habitat areas, but in some areas are much diminished in abundance, and fragmented and isolated into separate populations by habitat limitations, including low stream flow, high water temperatures, competition from other fish species and numerous manmade barriers.

Importance

Redband trout are indigenous to the Deschutes River subbasin. They are a valuable resource and are important to the tribal and non-tribal citizens. Anglers from throughout the country, as well as various foreign countries come to the subbasin to angle for the redband trout. Redband trout were selected as a focal species based on an evaluation of their special ecological, cultural and legal status.

- ***Species designation:*** The redband trout was proposed for ESA listing throughout its range, but a listing was determined not warranted at that time.

- ***Species recognition:*** Currens et al. (1990) examined the genetic characteristics of 22 populations of redband trout in the lower Deschutes River subbasin and found three distinct groups based on biochemical similarity. One group consisted of two introduced hatchery populations, the second group consisted of nine populations sampled in White River, and the third group consisted of wild populations in the lower Deschutes River and tributaries other than White River (including indigenous hatchery strains). Redband trout isolated above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin, in both genetic and morphological characteristics, than they are to lower Deschutes River redband trout. These characteristics include fewer pyloric caeca, finer scales, and little or no variation at two specific alleles (Currens et al. 1990). A possible explanation is that the Fort Rock Basin was drained by the Deschutes River until lava flows separated the drainages in the late Pleistocene epoch (Allison 1979). Ancestral redband trout probably invaded White River and the Fort Rock Basin when they were connected to the Deschutes River. Subsequent isolation of White River and Fort Rock basins prevented these populations from acquiring genetic traits that evolved in the Deschutes River population during the last glacial period. Today, some populations in the White River system may represent remnants of the ancestral population and an evolutionary line originating from a primitive race of redband trout.

  Currens (1994) also found that redband trout from some tributaries of the North Fork Crooked River are in a group that is distinct from the remainder of the redband populations within the subbasin.

- ***Special ecological importance to subbasin:*** Redband trout were historically distributed throughout the Deschutes River subbasin. The population provided an important food source for the subbasin's first inhabitants, as well as a variety of wildlife species, including birds and mammals. These fish supplied an important source of nutrients for the aquatic, as well as the terrestrial ecosystem.

- ***Tribal recognition:*** Redband trout have long been an important food source for the Native Americans.

Population Data and Status

Abundance in the Lower Deschutes Subbasin

ODFW recognizes 46 wild populations of resident/fluvial redband trout in the basin up to Big Falls, with the strongest populations located in the lower mainstem. The lower mainstem, in fact, has the strongest population of resident redband trout in Oregon (Kostow 1995).

Surveys indicate that redband trout in the lower Deschutes River are most abundant in the 50-mile stretch of river between Maupin and the Pelton Reregulating Dam, and less abundant in the subbasin below Sherars Falls (Table 26) (ODFW 1997). There is little mainstem spawning habitat below Sherars Falls, so the population in this part of the river may rely on recruits from the river upstream (Aney et al.).

Abundance of lower Deschutes River redband trout, larger than 8 inches, was estimated in specific areas of the lower Deschutes River during the 1970's, 1980's and 1990's. Density of redband trout in the lower Deschutes River above Sherars Falls during this time ranged from 640 to 2,560 fish/mile (Tables 27 to 28). Densities in the 1980's, the time period with the most data, averaged 1,630 fish/mile in the North Junction area (RM 69.8 to 72.8) (Table 27) and 1,830 fish/mile in the Nena Creek area (RM 56.5 to 59.5) (Table 28) (Schroeder and Smith 1989).

Redband trout are abundant in the White River system, where all habitat above RM 2 is inaccessible to anadromous fish because of a series of impassable waterfalls. The abundance of redband trout age-1 and older in the White River system upstream from White River Falls was estimated in 1984 to range from 56 to 2,897 fish/mile (ODFW et al. 1985). In White River tributaries the density of redband trout greater than 6 inches ranged from 56 fish/mile (Little Badger Creek) to 445 fish/mile (Threemile Creek), whereas density of redband trout less than 6 inches ranged from 316 fish/mile (Clear and Frog creeks) to 2,897 fish/mile (Jordan Creek) (Table 29).

Redband trout are also known to be abundant in other lower Deschutes subbasin tributaries, such as Buck Hollow and Bakeoven creeks, however few studies have been completed to determine the extent of this production. Resident redband trout numbers are believed to be low in Trout Creek.

Table 26. Redband trout density (fish/mile) in four areas of the Deschutes River (ODFW 1997).

Location/	Size Group			
Year	8-10"	10-12"	> 12"	Total
Deschutes River Above Sherars Falls				
Warm Springs Bridge-Trout Creek (RM 88 – 97)				
1972	375	456	742	1,573
1973	a/	684	733	1,417b/
1974	739	261	530	1,530
1975	741	478	367	1,586
Above Warm Springs River (RM 84 –87)				
1978	407	720	1,050	2,177
1979	536	374	784	1,694
1996	275	519	323	1,117
Whiskey Dick (RM 80.0 – 84.0)				
1971	200	712	911	1,823
1972	401	733	1,040	2,174
1973	a/	741	686	1,427b/
1974	786	377	559	1,722
1978	412	473	1,240	2,125
1979	377	345	572	1,294
Deschutes River Below Sherars Falls				
Beavertail-Macks Canyon (RM 24- 31)				
1971	--	--	--	31
Pine Tree-Macks Canyon (RM 24 – 39)				
1972	--	--	--	55
Jones Canyon-Rattlesnake Canyon (RM 30.5 – 33.5)				
1986	140	163	217	520
1996	378	592	145	1,115

a/ No estimate because of insufficient recaptures.
b/ Total estimate for trout > 10" only.

Table 27. Redband trout density (fish/mile) in the Deschutes River at the North Junction study section (RM 69.8 – 72.8), by year (ODFW 1997).

	Size Group			
Year	8-10"	10-12"	> 12"	Total
1972	295	354	282	931
1973	164	1,138	462	1,764
1974	555	481	568	1,604
1975	1,179	723	533	2,435
1981	423	393	333	1,149
1983	343	857	853	2,053
1984	253	507	683	1,443
1985	a/	303	462	765[b/]
1986	559	357	1,224	2,140
1987	211	541	638	1,390
1988	a/	757	962	1,719
1995	335	822	497	1,654

a/ No estimate because of insufficient recaptures.
b/ Total estimate for trout > 10" only.

Table 28. Redband trout density (fish/mile) in the Deschutes River at the Nena Creek study section (RM 56.5 – 59.5), by year (ODFW 1997).

	Size Group			
Year	**8-10"**	**10-12"**	**> 12"**	**Total**
1973	a/	184	a/	--
1974	858	267	89	1,214
1975	1,311	167	56	1,534
1979	267	201	171	639
1981	911	596	338	1,845
1982	971	997	592	2,560
1983	927	1,005	486	2,418
1984	755	721	172	1,648
1985	a/	782	130	912b/
1986	409	555	489	1,453
1987	261	472	312	1,045
1988	567	651	491	1,709
1995	465	457	212	1,134

a/ No estimate because of insufficient recaptures.

b/ Total estimate for trout > 10" only.

Table 29. Redband trout population estimates and density (fish/mile) in the White River system 1984[a/] (ODFW et al. 1985).

Stream	Length (mile)	≤6 inches	Density (fish/mi)	<6 inches	Density (fish/mi)	%>6 inches
White River	41.0	11,413	278	27,979	682	29
Tygh Creek						
below falls	12.6	2,055	163	30,421	2,414	6
Above falls	5.4 b/	396 b/	73	7,261 b/	1,344	5
Jordan Creek						
below falls	0.9	300	333	2,607	2,897	10
Above falls	12.8	3,237	253	24,773	1,935	12
Badger Creek						
below falls	18.9	5,320	281	42,374	2,242	11
Above falls	3.1	1,289	416	2,807	905	31
Little Badger Cr.	5.7 b/	320 b/	56	11,645 b/	2,043	3
Threemile Creek	10.0 b/	4,447 b/	445	25,510 b/	2,551	15
Rock Creek						
below reservoir	3.3 b/	381 b/	115	5,997 b/	1,811	6
Above reservoir	6.0	763	127	14,487	2,414	5
Gate-South Fork	10.2 b/	584 b/	57	4,210 b/	397	12
Boulder-Forest c/	12.6	1,827	145	10,966	870	14
Clear-Frog c/,d/	16.4	1,145	70	5,183	316	18
Barlow Creek c/	6.4	68	108	5,599	875	11
Mineral c/-Iron-Bonney c/ -Buck c/	8.7	498 e/	57	3,901	448	11
Total						
Below barriers	146.7	28,979	196	176,372	1,202	
Above barriers	27.3	5,685	208	49,328	1,807	

a/ Population estimates expanded for stream by site-specific measurements of abundance.

b/ Adjusted stream length and abundance to account for stream sections with no summer flow or without resident populations.

c/ Brook trout present in the stream.

d/ Frog Creek had no redband trout above 4.6 miles.

e/ All in Iron Creek. Redband trout population estimates and density (fish/mile) in the White River system 1984 (from ODFW et al. 1985).

Abundance in the Crooked River Subbasin

Land and water management practices over the last 120 years have resulted in a decline in riparian condition, river channel morphology, water quality and quantity, and subsequent declines or extirpation of native fish populations. Most streams in the Crooked River basin are degraded, and fish habitat and production is substantially diminished from historical times. Redband trout occupy an estimated 75% of their historic range and are at a mere fraction of their historical abundance. Many streams, particularly in the southeast portion of the basin may have lost native redband trout due to habitat degradation, reduced flows and high water temperatures (Stuart, et al. 1996).

Currently, redband trout productivity in the Crooked River subbasin is severely limited by habitat degradation. The basin contains as many as 28 isolated redband trout populations (Stuart and Thiesfeld 1994). Many of these isolated populations are considered depressed (Figure 2). Generally, where habitat is in relatively good condition, with cool water temperatures, good riparian and instream conditions, redband populations in the Crooked River system exhibit a mixture of age classes and comprise the bulk of the fish populations. For example, headwater reaches of North Fork Crooked River tributaries such as Brush, Lookout, Peterson, Allen, and Porter creeks are primarily or exclusively redband trout. Tributaries with poorer riparian and instream conditions have a higher proportion of non-game fish, particularly dace and Bridgelip sucker (Stuart, et al. 1996).

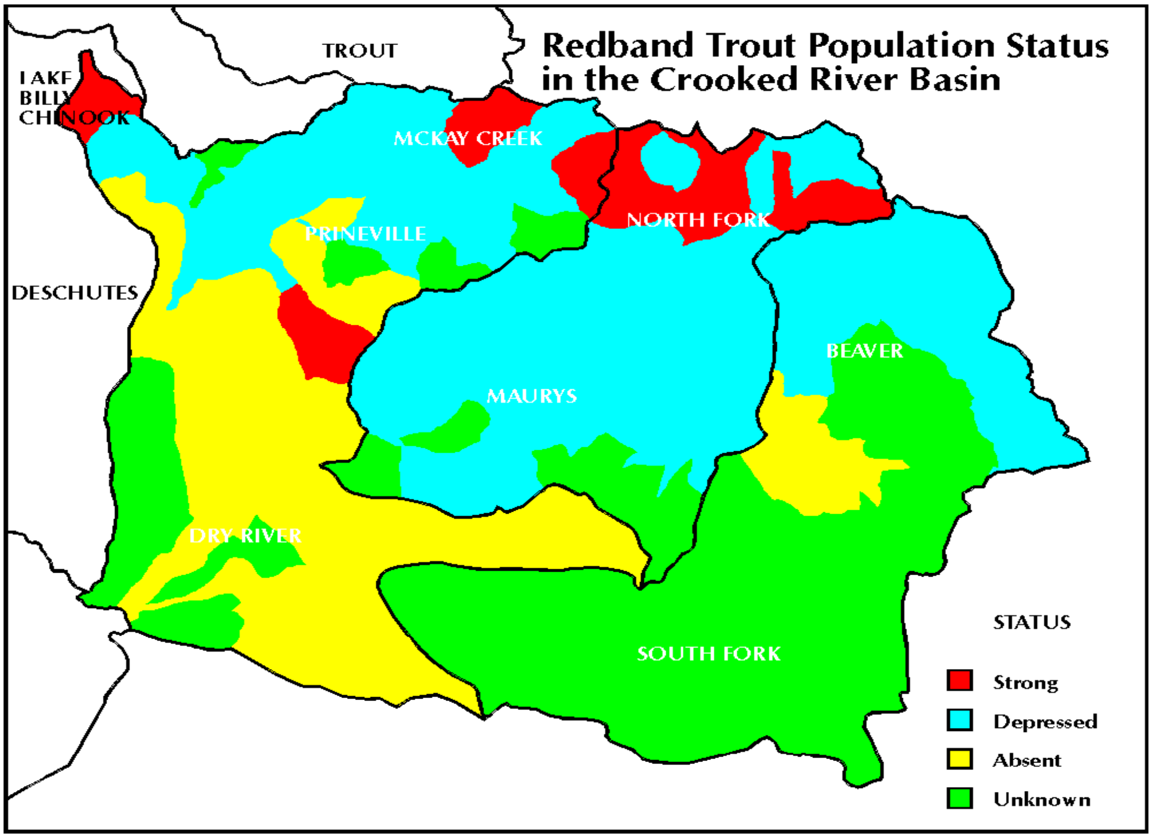


Figure 2. Status of redband trout populations in the Crooked River basin (Stuart et al. 1996).

Redband trout are the only native game fish remaining in the upper Crooked River subbasin, and reside primarily in the headwaters of smaller tributaries located on the USFS lands, including the following streams or stream segments: East Fork Mill Creek, Canyon Creek, Wolf Creek, Sugar Creek and Deep Creek and tributaries (Rife 2003). Headwater tributaries of Beaver, Ochoco, and McKay creeks, and the mainstem Crooked and North Fork Crooked River and Beaver Creek support low to moderately abundant populations of redband trout. Where habitat is in good condition, (i.e. cooler water, lower temperatures, and good riparian and instream conditions), populations exhibited diverse age classes with young of the year, juveniles, and mature fish up to 6 years old. Tributaries with degraded riparian conditions had lower densities of redband trout.

Most of the redband populations in the Crooked River system have been fragmented and isolated due to physical and water temperature barriers. Considerable effort has been expended studying populations of redband trout in the North Fork Crooked River. Streams in this basin vary in habitat quality from excellent to poor. Those streams with good habitat exhibit redband trout densities greater than 1/yd^2, whereas those with poor habitat have redband trout densities less than 0.50/yd^2. Electrofishing surveys in the upper Crooked River system found that redband trout comprise approximately 20% of the fish population in the Williams Prairie area, with dace accounting for the remainder (Ferry et al. 1979). Sampling downstream, the percentage of redband trout dropped and the percentage of non-game fish species increased. In the lower North Fork Crooked River, below the confluence with Deep Creek, redband trout comprise less than 1% of the population.

Redband trout were also found during physical and biological stream surveys in several South Fork Crooked River tributaries in 1979 (Carter 1979a; Carter 1979b), and in a fish presence survey on the South Fork Beaver, Grindstone, Trout, Camp, Freeman, Swamp and Dobson creeks in 1995 and on Swamp Creek in 1996. However, Stuart (1996) found that the South Fork Crooked River, and Beaver, Grindstone and Camp creeks, were either largely devoid of fish or were populated primarily with non-game fish species, such as dace and suckers, which are more tolerant to high summer water temperatures. Some of the tributaries in the Camp Creek drainage that arise in the Maury Mountains still have isolated redband trout populations, although at extremely low levels of abundance. Most of the west, south, and middle forks of Camp Creek appear to have no resident redband trout Stuart, et al. 1996).

The mainstem Crooked River redband population is also depressed, except for the tail water area downstream from Bowman Dam. In the Chimney Rock reach of the mainstem, fish surveys found high densities of trout ranging from 826 to 8,228 trout/mile (Table 30) in 1989 and 1994, respectively (Lichatowich 1998). Environmental conditions in this reach are influenced by the higher flows and lower temperatures of water released from Prineville Reservoir.

Table 30. Redband trout abundance (fish greater than 180 mm) in the lower Crooked River below Bowman Dam (Stuart et al. 1996).

Year	Reach	Fish/km
1989	RK 104-112	516
1993	RK 109-112	1431
1994	RK 109-112	5143
1995	RK 109-112	3811

Redband trout populations in Ochoco Creek and tributaries are also low. During redband trout density surveys conducted in 1991 and 1992, surveyors found 2.64 fish/m^2 in Canyon Creek, 2.66 fish/m^2 in Ochoco Creek, 0.31-0.77 fish/m^2 in Marks Creek and 0.34-0.69 fish/m^2 in Mill Creek (Stuart et al. 1996). Table 31 summarizes redband trout densities from a number of streams in the Crooked River drainage.

Table 31. Relative densities of redband trout, all age classes, in tributary stream of the Crooked River on Ochoco National Forest lands (Stuart et al. 1996).

Subbasin	Stream	Date	Fish/m^2
Ochoco	Canyon	8/92	2.64
	Ochoco	8/92	2.66
	Marks	8/92	0.31-0.77
	Mill	7/91	0.04-.069
North Fork Crooked River	Gray	7/94	0.068
	Lookout	8/91	0.81
	Brush	8/91	1.42
	E Fork Howard	7/91	0.54-0.68
	W Fork Howard	7/91	0.96
	Howard	7/91	0.77
	Porter	8/92	0.44
	North Fork CR.	7/90	0.01
Beaver	Dippingvat	8/92	1.01
	Roba	8/92	0.2

Abundance in the Upper Deschutes Subbasin

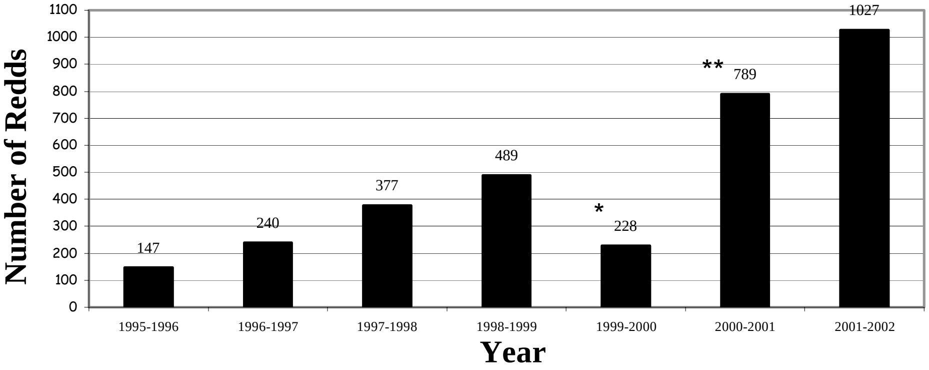
Principal redband trout production areas above Lake Billy Chinook include the mainstem Deschutes up to Steelhead Falls, Squaw Creek, Crooked River and Metolius River. The amount of genetic interchange between these areas has not been studied, but historically there were no physical barriers to stop movement of fish (Fies et al. 1996). For instance, redband trout in the Metolius River were likely once a part of the Deschutes River redband trout complex of populations (Fies et al. 1996).

The most productive redband trout habitat in the Deschutes mainstem between Bend and Lake Billy Chinook lies below Big Falls. During snorkeling and raft electrofishing surveys conducted from 1989 to 1991, biologists counted 1,261 redband trout in 0.42 miles surveyed between Big Falls and Lake Billy Chinook. In comparison, they counted only 68 redband trout in 0.88 miles surveyed between Big Falls and Bend. Redband trout population data gathered from 1989 to 1991 in the Deschutes River between Bend and Lake Billy Chinook is shown in more detail in Table 30. A general consensus is that fish populations have declined in this section of river in recent years, primarily due to low summer stream flow. By the early 1990s, redband trout essentially disappeared from near Tumalo (RM 158) to below Lower Bridge (RM 134.5) where spring flow begins to moderate temperature and river flow. Trout production is believed to have improved during the good water years of the late 1990s when sufficient river flows were maintained in this reach to sustain the population through the summer, though there is no actual inventory to support these assumptions. Currently, however, the redband trout population between Tumalo and Lower Bridge is believed to be at, or close to, zero as a result of low flows during the recent dry weather cycle (Marx 2003).

Table 30. Redband trout inventory from Bend to Lake Billy Chinook by snorkeling and electrofishing, 1989-91 (Fies et al. 1998).

River section	River mile	Method	Survey miles	Number of fish	Fish per mile	Size range
Bend to Big Falls	167-132	Snorkeling and electrofishing	0.88	68	77.3	3-13"
Big Falls to Lake Billy Chinook	132-120	Snorkel	0.42	1261	3002.0	2-16"

Redband trout production in the Metolius River system has increased in recent years. However, during the early 1990s, fish managers became concerned about the status of redband trout in the river. Surveys conducted during this time in several sections of the Metolius River suggested that the abundance of potential redband trout spawners was less than 500 fish. While it is not clear how these numbers compare to historical numbers or to the current habitat potential, densities of fish were very low — especially in the areas open to angling. This combination of factors suggested that wild Metolius redband trout were likely at significant risk and in a potential conservation crisis (Fies et al. 1996). This downward trend has been reversed in recent years, with a notable increase in the number of redband trout redds counted annually. Recent redband trout spawning surveys in the Metolius River system recorded a high of 1,027 redds, which is a record for the period of record (Figure 2). A slight dip in the numbers of redds observed in 1999 – 2000 may be attributable to less frequent sampling effort, as well as the effect of the 1996 Flood on juvenile redband that would have reached spawning age in 2000 (Marx 2003). The upward trend is believed to reflect the termination of hatchery rainbow trout releases and the implementation of more restrictive angling regulations.



* Redd counts are made every two weeks from mid-November through early May.

Figure 2. Redband Trout redd counts in Metolius River, 1994-95 to 2001-02* (Marx, 2003).

Above Bend, redband trout production in the Deschutes River varies by reach and is directly associated with winter flow conditions. An ODFW electrofishing inventory (1990-91) between Bend (RM 167) and Benham Falls (RM 180.9) found an apparent small redband population in the upper end of this section, and a larger population in the lower end. At the upper end of the section, only 30 trout were captured per mile with none exceeding 9 inches and most under 6 inches. At the lower end (RM 172), a partial (relatively low percent of population caught) ODFW inventory recorded between 235 and 310 redband trout per mile. Approximately 50% of the trout were larger than 6 inches and 11% were between 10 and 12 inches (Fies et al. 1998).

Redband trout numbers have increased dramatically in the subbasin upstream of Crane Prairie Reservoir since 1990. Record numbers of redband trout redds were observed during spawning surveys on Crane Prairie Reservoir tributaries in 2001 (Figure 3).

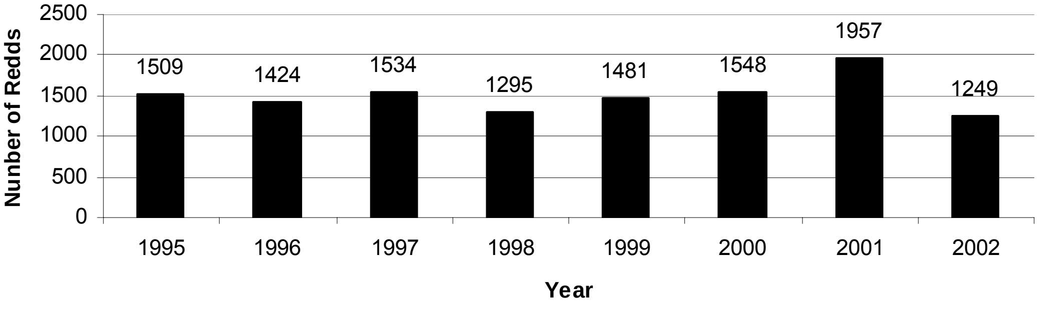


Figure 3. Redband trout redd counts in Crane Prairie Reservoir tributaries, 1995 – 2002 (Marx 2003).

A similar upward trend in redband redds has been seen on Odell Creek upstream of Davis Lake. Spawning surveys in 2001 recorded a record high 883 redds (Figure 4) (Marx 2003).

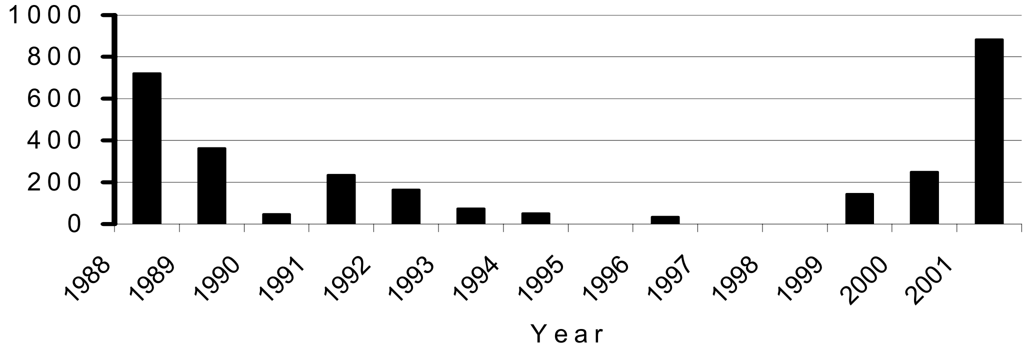


Figure 4. Redband Trout redd counts in Odell Creek, 1988 – 2001 (Marx 2003).

Fish inventories conducted throughout the Little Deschutes River basin using backpack electrofishers and snorkeling techniques show that, overall, the redband population is fair upstream of Gilchrist, but poor downstream. Redband trout were the dominant species historically, but habitat conditions have allowed brown and brook trout to out compete indigenous populations. During fish inventories in 1990 and 1992 at seven sites on the Little Deschutes River, only 10 redband trout were captured, with only 1 fish found above the town of La Pine. The redband ranged from 3 to 9 inches in length. Counts in 1992, however, were probably below normal as it was an extreme low water year and redband trout were less abundant than in more average water years (Fies et al. 1998).

Results from fish surveys conducted in 1992 along three reaches of Crescent Creek, all below Highway 58, show that the creek supports a small redband population. Redband trout were the most abundant trout species captured in Crescent Creek during the surveys. In the canyon reach below Highway 58, surveyors captured 9 redband and no brown trout in about 980 feet of stream. In the reach below Forest Road 61, they identified 26 redband, 94 whitefish, more than 50 sculpins, and 10 Tui chub in approximately one-half mile of stream. The reach furthest downstream, approximately 2.5 miles in length, was surveyed with a drift boat electrofisher. Through the entire reach, surveyors captured only 5 redband trout, 4 brown trout, and 41 whitefish (Fies et al. 1998).

Capacity

The lower Deschutes River Subbasin is capable of producing large populations of wild redband trout. Densities of redband trout greater than 8 inches in the 1980's averaged 1,630 fish/mile in the North Junction area and 1,830 fish/mile in the Nena Creek area of the lower Deschutes River. The capacity of most other subbasin streams is depressed by degraded habitat and competition.

While the Crooked River system once supported large numbers of redband trout, production potential is currently limited because of habitat conditions. Production potential will remain low until habitat deficiencies are improved.

The Deschutes River upstream of Crane Prairie Reservoir and the Metolius River systems appear capable of producing larger populations, as indicated by the previously discussed population trends. Below Crane Prairie, redband trout production is limited by available spawning habitat (i.e. limited gravel and limited free-flowing stream distance). Following extensive placement of spawning gravel (approximately 1,500 cubic yards) in the early 1990s, there was a notable rebound in the redband population. However, spawning habitat still limits these redband. There may also be adverse effects on this population from non-indigenous fish species in these waters, including brown bullhead catfish, largemouth bass and three-spine stickleback.

Productivity

Depressed redband trout populations are capable of rapid recovery if habitat conditions are favorable and other limiting factors are not oppressive. For example, the redband population in the Nena Creek reach of the lower Deschutes was depressed in 1979, with an estimated 639 fish per river mile greater than 8 inches in length. The low numbers of redband trout were the result of high harvest rates associated with an annual catchable-size hatchery rainbow trout stocking program. Redband trout production increased after rainbow trout stocking in the reach ended in 1979 and more restrictive bag limit and gear restrictions were implemented. In 1981, the population in this same reach had increased to an estimated 1,845 fish greater than 8 inches in length per mile (ODFW 1997). Similar results were seen in the Metolius River system. As discussed earlier, the population has rebounded in recent years, with a record number of redband trout redds observed during the most recent spawning surveys. This apparent rebound in redband numbers appears to be associated with changes in fish management practices.

Most reaches of the North Fork and mainstem Crooked River are in a degraded condition with low flows and high summer temperatures. They support densities of redband trout of less than 300 fish/km. The tailrace reach below Bowman Dam, however, supports very high densities of redband trout, indicating a tremendous capacity to produce native salmonids where flow conditions are sufficient throughout the year and water temperatures stay relatively cool, below 150C. Since 1989, abundance of redband trout in the 19 km of the lower Crooked River below Bowman Dam has shown a 10-fold increase from approximately 520 to 5200 fish/km. This population increase is likely attributable to increases in winter time flow from unallocated storage in Prineville Reservoir. Prior to 1989, flows during the drought cycle were frequently as low as 10 cfs to store water during the non irrigation season. Since 1989, the Bureau of Reclamation has released from 30 to 75 cfs through the winter storage season (Stuart, et al. 1996).

Surveys in the North Fork Crooked River and tributaries indicate that redband trout utilize intermittent streams when there is water, and that they readily re-colonize those habitats when water re-occurs. During drought years, an entire year’s juvenile production may be lost in some streams (ODFW 1996).

Life History Diversity

In the lower Deschutes River, redband trout spawn during spring and early summer, with most spawning occurring from April to July. Zimmerman and Reeves (1999) observed redband spawning from mid-March through August. Most suitable trout spawning gravel in the lower Deschutes River is in the area from White River to Pelton Reregulating Dam (Huntington 1985).

Mean age and length of lower Deschutes River redband trout at first spawning is 3 or 4 years and 12 to 13 inches. Some males mature at age 2, and at about 8-10 inches in length. Average fecundity of redband trout in the lower Deschutes River is 1,300 to 1,500 eggs/female. Spawning redband trout compose about half of the population of fish over 10 inches. Approximately 60% of the spawning fish have spawned previously. Some redband trout skip one or more years between spawning (Schroeder and Smith 1989).

Growth of redband trout in the lower Deschutes River is dependent on the stage of maturity and size of the individual. Immature fish grow faster than mature fish. Growth slows after a fish matures as energy is used for development of gonads and regaining body condition following spawning. Growth slows as fish size increases. Average annual growth of redband trout at ages 1-6 is 4.4 inches, 4.3 inches, 3.1 inches, 1.7 inches, 1.4 inches, and 0.8 inch, respectively. Data from tagged fish showed that, of the redband trout greater than 2 years in age, many were 5 to 7 years old, with a few fish living as long as 10 years (Schroeder and Smith 1989).

Analysis of scales from redband trout in the White River system indicated a predominance of age-1 and age-2 fish in the watershed. Analysis of scales of redband trout over 12 inches from lower White River indicated first spawning at age-3 and age-4. Scale analysis suggested that growth continues after maturation, somewhat contrary to what is observed in the lower Deschutes River. Growth rate of redband trout in the lower mainstem White River was significantly greater than for redband trout elsewhere in White River. Redband trout that migrate out of tributary streams into the lower mainstem of White River from July to October showed an increase in growth for that period (Schroeder and Smith 1989).

Redband trout spawn in the Crooked River system from late April through early June. Fry emergence has been observed in early July to mid August. By September, most 0+ age fish range in length from 60 to 100 mm and averaged 76 mm in length. A few 0+ age fish were recorded as small as 41 mm. Mean lengths of 1+ age fish average 74-98 mm, and 2+ age fish average 124-147 mm in Crooked River tributaries. The oldest fish observed by scale analysis was 6 years old (280 mm); however, larger fish up to 355 to 455 mm have been observed in other sampling activities, and suggests fish may live occasionally older than 6 years of age (Stuart, et al. 1996).

In the Crooked River below Bowman Dam, size of redband trout by age class was determined by back calculating lengths from scale analysis. Age at annulus formation of redband trout scales collected in June 1994 were 119, 206, 237, and 300 mm, respectively, for age 1 to 4 trout (Borgerson 1994). Scale collections from April 1989, when trout densities were approximately 10% of 1994 densities, had back calculated lengths at annulus formation of 116, 193, 299, 379, 413, and 426 mm, respectively for age 1 to 6 trout. Both samples included larger fish with regenerated scales that made age determination impossible. Anglers have reported landing fish from Crooked River downstream of Bowman Dam up to 610 mm in length (Stuart et al. 1996). Figure 7 illustrates the average lengths of redband trout by age class sampled in Crooked River downstream from Bowman Dam.

Age composition of fish collected after an August, 1996 McKay Creek fish kill was 75%, 12%, 11%, and 2% of age 0+, 1+, 2+, and 3+ and older fish, respectively. However, in the two-day interval from the time of the kill to the survey, predators may have removed fish from the sample sites (Stuart, et al. 1996).

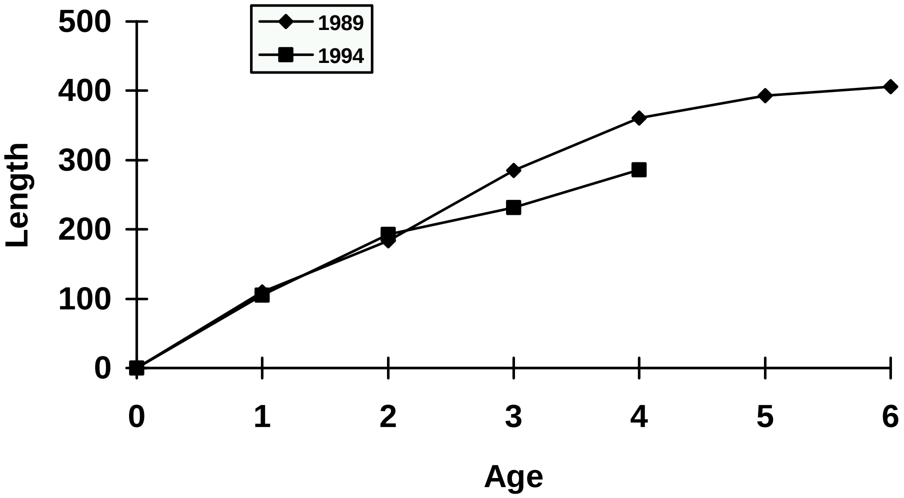


Figure 7. Back calculated length at annulus formation for rainbow trout captured in the Crooked River (RK 104-112) (Stuart, et al. 1996).

Carrying Capacity

There have been no estimates of potential redband trout carrying capacity in the Deschutes subbasin.

Population Trends and Risk Assessment

The redband trout populations in the lower Deschutes River and White River are robust. The biggest risk to these populations is a catastrophic environmental incident. The lower Deschutes population may be vulnerable to the effects of a hazardous substance spill that could result from a train derailment on the rail line closely bordering the lower 87 miles of the river. The White River population could be particularly vulnerable to catastrophic flooding associated with volcanic activity on Mount Hood. Historically this system has experienced pyroclastic flows and mud flows that originated on the slopes of Mount Hood and extended downstream to the river's confluence with the Deschutes River. Habitat deficiencies in some small tributaries, including low flow, temperature extremes and the lack of cover put trout populations at risk.

Natural mortality of trout in the lower Deschutes River, particularly associated with spawning, is high (45% to 69%) for fish greater than 31 centimeters (about 12.2 inches). This high natural mortality, and not harvest, is likely the limiting factor controlling recruitment of trout into size ranges over 41 centimeters (about 16.1 inches) (Schroeder and Smith 1989).

Lower Deschutes River redband trout are resistant to *Ceratomyxosis*, a fatal gut infection caused by *Ceratomyxa shasta,* a myxosporidian parasite. This disease was first detected in the lower Deschutes River immediately below the Pelton Reregulating Dam (river mile 100) in 1965. Its presence has been detected every time tests have been conducted since 1965 (ODFW 1997). Studies done by ODFW in 1984 indicate that redband trout in the White River system are also susceptible to infection by *C. shasta*.

Redband trout in the Crooked River basin are consistent with the metapopulation concept. Small fragmented and isolated populations reside in tributary streams, while vast reaches of the mainstem Crooked River, with the exception of the 19 km reach below Bowman Dam, are severely reduced in abundance. Historically the mainstem Crooked River was likely a “source” population. However, with severe habitat degradation and numerous partial and complete barriers on the mainstem and tributaries, many populations are fragmented and completely isolated from each other (Stuart et al. 1996). Fragmentation and isolation of populations may eliminate life history forms and reduce survival, growth and resilience. Populations with extremely low abundance, in streams with marginal habitats, and with little or no exchange of genetic material, have a high risk of extinction (Rieman and McIntyre 1993).

Today, only seven percent of the Crooked River Basin supports strong populations of redband trout. Little information on fish populations is available in the southern and eastern parts of the basin. However, based on current habitat conditions it can generally be assumed that fish populations in this part of the watershed are either depressed or absent. Of the known habitat occupied by redband trout, only 15 percent was identified as containing strong populations. Production appears to be strongly tied to environmental conditions. Surveys in the North Fork Crooked River and tributaries indicate that redband trout utilize intermittent streams when there is water, and that they readily re-colonize those habitats when water re-occurs. During drought years, an entire year’s juvenile production may be lost in some streams (ODFW 1995).

Redband populations in the upper Deschutes subbasin are smaller than those in the lower subbasin and often fragmented. These populations may have been genetically impacted by past stocking of hatchery rainbow trout or are at genetic risk because of the small remaining population size. Environmental conditions associated with diminishing stream flows and degraded stream habitat have placed a number of populations at risk.

Metolius River redband trout have been examined to determine if there has been genetic introgression as a result of the past stocking of non-native hatchery rainbow trout. Study findings showed that Metolius redband trout had genetic and meristic characteristics of coastal or non-native hatchery rainbow trout populations. In addition, disease challenges revealed that Metolius redband trout were much more susceptible to *Ceratomyxa shasta* than redband trout from the Deschutes River, which have genetic resistance to the lethal disease. Based on these data it was concluded that genetic introgression has occurred with non-native hatchery rainbow trout. This introgression has made the Metolius River redband more susceptible to *Ceratomyxosis* when conditions for infection occur (Currens, et al. 1997).

Redband trout production is increasing in some areas because of changes in fish management and habitat enhancement. Redband trout populations in the Metolius River and Crane Prairie Reservoir tributaries both have shown indications from annual redd counts that these populations are on the increase. Record high redd numbers were observed in the Crane Prairie Reservoir tributaries in 2001 and in the Metolius River in 2001-2002.

Unique Population Units

Redband trout isolated above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin of south-central Oregon, in both genetic and morphological characteristics, than they are to lower Deschutes River redband trout. These characteristics include fewer pyloric caeca, finer scales, and little or no variation at two specific alleles (Currens et al. 1990). A possible explanation is that the Deschutes River drained the Fort Rock Basin until lava flows separated the drainages in the late Pleistocene epoch (Allison 1979). Ancestral redband trout probably invaded White River and the Fort Rock Basin when they were connected to the Deschutes River. Subsequent isolation of White River and Fort Rock basins prevented these populations from acquiring genetic traits that evolved in the Deschutes River population during the last glacial period. Therefore, some populations in the White River system may represent remnants of the ancestral population and an evolutionary line originating from a primitive race of redband trout.

Preliminary information suggests that redband trout from tributaries of the North Fork Crooked River including Fox Canyon, Howard, and Lookout creeks have diverged from other inland redband trout groups and exhibit little introgression from non-native hatchery fish. However, populations in the lower Crooked River basin including the reach below Bowman Dam, Ochoco, Marks, and Canyon creeks, have the highest rate of hatchery introgression, ranging from 10 to 30% (Currens 1994). This percentage of introgression seems plausible due to the long term hatchery stocking and the multiple rotenone projects, particularly in the Ochoco Creek subbasin (Stuart, et al. 1996).

Estimate of Desired Future Condition for Long-term Sustainability

Recovery of depressed and fragmented redband trout populations to sustainable levels through habitat restoration would help insure the continued existence of the fish throughout the subbasin.

Distribution

Differences in Distribution due to Human Disturbance

Redband trout are still distributed throughout the Deschutes River subbasin. Some populations are now fragmented and isolated in headwater areas where habitat conditions are still conducive to trout survival. In the upper Crooked River drainage, redband trout have apparently been extirpated from a number of streams or stream reaches because of the cumulative effects of water withdrawal, riparian habitat degradation and/or elevated water temperatures. Habitat conditions in the mid and lower reaches of a number of streams effectively preclude trout survival and isolate remnant headwater populations. The presence of major and small impoundments in the subbasin without functional fish passage facilities have further fragmented redband populations.

With increasing settlement and development, redband trout populations have declined in distribution and abundance within the Crooked River basin. Presently, strong populations are found in 7% of the basin. This includes only two reaches of the mainstem Crooked River: the Wild and Scenic River section below Bowman Dam and the lower Crooked River upstream of Lake Billy Chinook. The remaining strong populations are located in headwater systems on the Ochoco National Forest. All strong populations are found on federally managed land. Many of the most productive fishery habitats were historically located in low gradient reaches of the mainstem of the Crooked River and its major tributaries. These areas were also the first places settled and developed in the basin and currently represent some of the most degraded habitats (Stuart et al. 1996).

Numerous chemical treatment projects using rotenone were conducted from the 1950's to the late 1980's to rid some flowing and standing water bodies of large populations of non-game fish species such as bridgelip and largescale sucker, and northern pike minnow. These species were thought to compete with trout for food and space, and in some cases prey on eggs or juvenile trout. Eradication of the non-game fish also resulted in the eradication of the remnant redband populations in some of these streams. Figure 8 illustrates the location of streams and stream reaches impacted by this management practice in the Crooked River Basin (Stuart, et al. 1996).

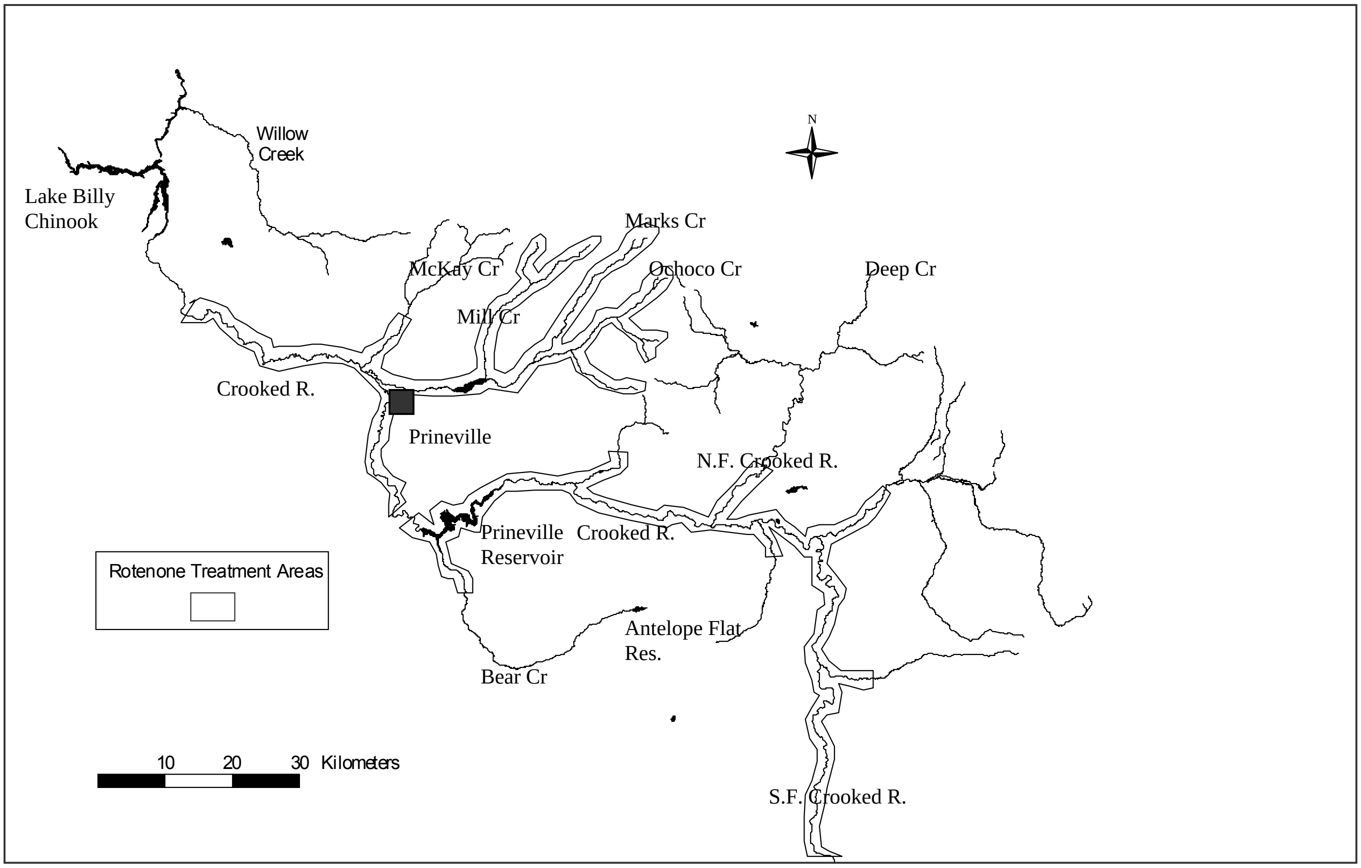


Figure 8. Map of past chemical treatment projects in the Crooked River Basin (Stuart et al. 1996).

Brown trout were introduced into Oregon in the early 1900's (ODFW 1969). The brown trout population in the upper Deschutes River and tributaries appears to be amazingly resilient in view of the adverse environmental conditions. The habitat in this portion of the Deschutes River, under its current condition, is more suited for brown trout than redband trout. It has a low gradient and few riffle areas. Competition from brown trout and whitefish may be holding the redband population in check and there is also a lack of winter holding habitat (Fies et al. 1998).

Artificial Production

Artificial propagation of rainbow in the subbasin began in 1916, with initial releases of hatchery trout into the Deschutes River near the City of Bend starting as early as 1911. Since that early beginning, hatchery rainbow trout from a number of fish hatcheries have been released in many subbasin waters. In recent years the release sites for hatchery trout in the subbasin have been essentially limited to lakes and reservoirs.

Current Hatchery Production

The release of hatchery rainbow trout into subbasin streams has been nearly halted within the past 25 years. Table 31 summarizes the status of hatchery rainbow trout stocking in subbasin streams.

A small Deschutes River redband trout brood stock (Stock 66) has been maintained at ODFW's Oak Springs Fish Hatchery for about 20 years. The original fish for this brood stock were collected from the lower Deschutes River. This stock's resistance to *Ceratomyxosis* was one of the primary rationales for developing the hatchery brood stock. Progeny of this stock have been used in a number of waters within the subbasin where *Ceratomyxosis* resistance was important for fish survival and contribution to recreational fisheries. Most recently, waters receiving Stock 66 Deschutes Redband Trout have included Haystack Reservoir, Crescent Lake, South Fork Crooked River and Fall River. Recent contributions of these fish to the sport fishery has been disappointing. ODFW plans to phase out this hatchery stock by 2006 or 2007 (Curtis 2003).

Table 31. Status of hatchery rainbow trout stocking in subbasin streams.

Stream	Currently being stocked with hatchery rainbow trout	Last year Hatchery rainbow trout were stocked
Lower Deschutes River		1978*
White River		1993
Badger Creek		1993
Warm Springs River		1997
Metolius River		1995
Middle Deschutes River – Lake Billy Chinook to Bend		1977
Upper Deschutes River – Bend to Benham Falls		1978
Upper Deschutes River – Benham Falls to Wickiup Dam	10,000 to 44,000 annually	
Fall River	7,500 annually	
Spring River		1954
Little Deschutes River		1978

Tumalo Creek	No stocking

* Occasional May release of 500 *C. shasta* susceptible rainbow trout in Maupin area for handicap anglers.

ODFW began to develop a Crooked River redband trout hatchery brood stock (Stock 153) at Oak Springs Fish Hatchery in 2003. The agency hopes this stock, which is also *Ceratomyxosis* resistant, will out-perform the Stock 66 fish in a number of upper subbasin waters. The first eggs for this new hatchery brood stock were collected from fish in Ochoco Creek (Crooked River tributary) upstream from Ochoco Reservoir. The brood stock will receive an annual infusion of 25% wild fish into each egg-take to help insure genetic diversity (Curtis 2003).

Historic Hatchery Production

There is a long history of trout production and stockings in the Deschutes River. This record is summarized below by subbasin.

Upper Deschutes Subbasin

- Concerns were raised in 1919 about fish populations in the upper Deschutes River being depleted. Citizens petitioned for a fish hatchery to be built and fish stocked in the river (reasons: stage of water seldom varies by 12 inches, a site can be obtained adjacent to the city, stock is depleted because Deschutes is a popular river and attracts many visitors, money collected from licenses has never been applied locally).

- Fish stocking in the Deschutes River may have begun as early as 1911, but records are not clear. The earliest records confirming fish stocking were found for 1916 (Oregon Sportsmen, January 1916). Fish were stocked above Benham Falls (RM 180.9), at Cline Falls (RM 144.7), and Bend. They were brook trout, rainbow trout, and steelhead. The brook trout were of East Coast origin, but the source of the rainbow and steelhead is unknown.

- Mathisen (1992) compiled early stocking history in the Deschutes River. He stated rainbow trout were planted in 1913 at several locations in the Deschutes River: 67,000 two miles above Bend (RM 169.6), 27,000 at Robinson Bridge (RM 179.6) and 33,000 at Spring River Bridge (or Harper Bridge, RM 191.6), 22 miles above town. They were brought in by the Game Commission rail car (called "Rainbow") probably from the Bonneville Hatchery.

- In 1915, Master Fish Warden announced plans to build a hatchery about three miles south of Bend on the John Sizemore meadows with an initial capacity of 500,000 eggs. By 1916 the hatchery building was supplemented by three outdoor ponds and 300,000 young trout were being raised for release in Deschutes, Jefferson, Crook, and Klamath counties.

- In 1919, the Old Bend Hatchery was replaced by the Tumalo Hatchery, which in turn was replaced by Fall River Hatchery in the mid-1920s.

- A few notes were found in the Oregon Sportsman and old hatchery records report about fish being stocked "at Bend" from 1929-1935, probably in the area above North Canal Dam. These fish were rainbow and brook trout. Hatchery records revealed 20,000 rainbow were stocked at Tetherow Bridge (RM 140.9) and 40,000 at Tumalo (RM 158.1) from 1931-1935. The origin of the fish is unknown. Fish stocking from 1931-35 also included 10,000 steelhead in the Deschutes River (Fies et al. 1998).

- Rainbow were stocked between Sheep Bridge (RM 236.5) and Twin Bridges in 1936, numbers and origin unknown (Fies et al. 1998).
- Hatchery fish stocking records for the Little Deschutes River date back to the 1930s when 60,000 rainbow were stocked at river mile 3.
- An unknown number of hatchery rainbow trout were released into Fall River in 1946. Rainbow were stocked in Spring River in 1947 and 1948 as fry or legal-size fish numbering from 9,900 to 20,043 fish (Fies et al. 1998). In 1945, about 52,000 fingerling rainbow, of unknown stock, were planted in the Little Deschutes River. Legal-size rainbow were first stocked in the Little Deschutes in 1948, origin unknown.
- Legal-size rainbow were stocked in 1950 in the Deschutes River between Wickiup Dam (RM 227) and Benham Falls. Stocking records show Crescent Creek was stocked only once, in 1950, with 4-6 inch rainbow trout, stock unknown (Fies et al. 1998).
- Stocking of hatchery-reared rainbow trout in the Deschutes from Benham Falls to Bend began in 1954 with the release of 11,000 to 58,000 legal-size rainbow trout from Oak Springs, Wizard Falls, and Klamath hatcheries. Rainbow were first stocked as legal-sized fish in Fall River beginning in 1957 and continue to the present. From 1957-1965, approximately 7,000 - 8,500 legal rainbow were stocked annually into Fall River. Numbers stocked over the years have ranged from 7,000 to 15,000 annually (Fies et al. 1998; Marx 2003). Legal-size rainbow trout were stocked in the Little Deschutes annually from 1954-1975 and 1977-1978, and ranged from 800-14,000 rainbow trout each year (Fies et al. 1998).
- Brown trout were tried with little success from 1965-1968. Rainbow trout releases did not resume until after 1968 when 2,000 - 41,000 fish were being released annually. The rainbow trout came from Klamath, Wizard Falls, Fall River, and Oak Springs hatcheries. This stocking ended in 1978 (Fies et al. 1998).
- From 1985-1993, conservation groups made annual releases of Deschutes River stock (Lot 66) rainbow fry at RM 190 and RM 205. Numbers released ranged from 369 in 1993 to 113,039 in 1989. Oak Springs Fish Hatchery provided eggs through the ODFW Salmon Trout Enhancement Program. The eggs were incubated in hatch boxes placed by the conservation groups in Spring and Fall rivers. Deschutes stock redband trout were selected for the egg incubation experiment because they are resistant to *Ceratomyxosis*, a lethal disease found throughout the Deschutes River below Wickiup Reservoir (Fies et al. 1998).
- In 1994, approximately 25,000 legal-size (3 per pound) rainbow trout (Fall River, lot 72) were stocked in the Deschutes from Wickiup Dam to Sunriver.

- Big Marsh Creek was stocked in 1968-69 with 4-500 legal-size rainbow trout, reared at Klamath hatchery (Fies et al. 1998).

- Tumalo Creek was first stocked in 1948 with 1,800 rainbow trout. The origin of the rainbow is unknown. This stream was stocked annually from 1949 through 1972. All of the rainbow trout releases were legal-size fish (Fies et al. 1998).

- Rainbow trout, steelhead, and brown trout have been released in the Deschutes River from Bend to Lake Billy Chinook. These have all been legal-size fish except for one release of fingerling rainbow in 1955. Numbers released ranged from 7 fish (16" brown trout in 1956) to 43,042 rainbow trout in 1960. Records of hatchery rainbow trout releases in the middle and lower Deschutes River were originally combined, so it is impossible to distinguish hatchery rainbow releases in this river reach prior to 1954 (Fies et al. 1998).

- Beginning in the 1920's hatchery rainbow trout were used to supplement the sport fishing demand on the Metolius River. Starting initially with fingerling releases, the program expanded with the construction of Wizard Falls Hatchery in 1947 (Fies. et al. 1998).

Crooked River Subbasin

- Very little fish stocking has occurred in the upper portion of the Crooked River basin. Fry and fingerling hatchery rainbow trout were planted in the mainstem Crooked River and in Tom Vaughn, Sherwood, Poison, Newsome, Maury, Lodgepole, Indian, Little Horse Heaven, Drake, Camp, Cottonwood, and Double Cabin creeks, and in Reams, Miller, and Double Cabin ponds. Most plantings occurred from 1947 to 1957 and were generally a single event in each stream although some streams received a total of 2-4 plantings in that time period (ODFW 1996).

- Both legal and fingerling hatchery rainbow trout have been released into the South Fork Crooked River since 1947, with legal releases of up to 10,000 catchable and 100,000 fingerling fish. Most fish have come from Oak Springs hatchery with a few releases from Wizard Falls, Fall River, or Klamath hatcheries (ODFW 1996).

Lower Deschutes Subbasin

- Approximately 60,000 Roaring River stock legal-sized, rainbow trout from Oak Springs and Wizard Falls hatcheries were released annually in the lower Deschutes River from the late 1940's to 1978. Trout were released near Warm Springs (RM 97 – 98.5), from Nena Creek to Wapinitia Creek (RM 55 – 59.5), and from Maupin to Oak Springs (RM 48 – 51.5). This stock was susceptible to *Ceratomyxosis* and likely did not survive to spawn in the lower Deschutes River. The Oregon Fish and Wildlife Commission discontinued stocking in 1978 after deciding to manage the lower 100 miles of the Deschutes River exclusively for wild trout.

- Indigenous White River redband trout populations were supplemented with hatchery rainbow trout from 1934 to 1993. Roaring River stock of hatchery rainbow trout was released into White River, Badger Creek, and the lakes and reservoirs of the White River system. These hatchery trout were reared at Oak Springs, Hood River, Wizard Falls, Fall River, Klamath, and Bonneville hatcheries. Deschutes River stock redband trout from Oak Springs Hatchery were released into the White River system from 1983 until 1991. Former stocking locations in the White River system were White River at Farmers Road (RM 17.5); Tygh Valley Bridge (RM 6.5); below the Highway 197 bridge (RM 5.0); and Badger Creek at Bonney Crossing (RM 7.0). These programs were discontinued in 1993 due to concerns for potential genetic impacts to the unique indigenous White River redband trout (ODFW 1997).

- Historic releases of rainbow trout made throughout the subbasin were generally comprised of non-indigenous stocks. These exotic fish stocks included rainbow trout that originated from Cape Cod, Massachusetts.

- In the past, Warm Springs River and Shitike Creek were stocked with Cape Cod (Roaring River Hatchery) domestic rainbow trout that were reared at Warm Springs Hatchery from eggs obtained from Roaring River Hatchery (ODFW 1997).

Effect of straying/ecological consequences

There is no indication that redband trout from other subbasins stray into the Deschutes subbasin. The past use of various domestic rainbow trout stocks in hatchery fish releases throughout the subbasin could have potentially posed similar or greater genetic risks to the indigenous redband populations as the straying of non-indigenous trout into the subbasin. These hatchery trout releases often encouraged elevated angling pressure and harvest of redband trout. Hatchery trout often competed with redband trout for food and habitat, which may have reduced redband numbers in some streams. Aside from competition, there are a number of confirmed examples where hatchery rainbow trout spawning with redband trout has resulted in some genetic intergression.

The fish disease, *Ceratomyxosis*, likely acted as a natural control that limited the potential adverse effects of the hatchery rainbow trout releases on some of the indigenous redband trout populations. In subbasin streams where *Ceratomyxosis* was prevalent, non-resistant hatchery rainbow trout were either harvested by anglers or predators, or died within weeks of being released. This natural population control of these hatchery rainbow trout meant these fish did not survive to compete with redband trout during the winter pinch period. It also meant that these hatchery trout did not survive to spawn with the redband trout. In streams where *Ceratomyxosis* is not found, such as White River above White River Falls, there has been documented genetic introgression from the hatchery trout. When hatchery trout survived to spawn with the redband trout in these streams, they also remained for months or years to compete with the redband trout.

Relationship between Natural and Artificially Produced Populations

Observed differences between populations in the White and lower Deschutes rivers are probably not attributable to the influence of hatchery rainbow trout that have been previously stocked in the White River system. However, there is evidence that genetic introgression between indigenous redband trout and hatchery populations may have occurred in the lower White River, lower Tygh Creek, Jordan Creek, and Rock Creek (Currens et al. 1990). Redband trout in Deep Creek (North Fork Crooked River tributary) also exhibited a moderate level of hatchery introgression from legal rainbow trout released from 1963 to 1990 (ODFW 1995).

Subbasin Harvest

Subbasin streams support a variety of redband trout fisheries, although most trout angling occurs in the numerous lakes and reservoirs. There have not been regular statistical sampling programs to document trout harvest from subbasin waters for approximately 30 years.

Current Harvest

The lower Deschutes River supports a popular redband trout fishery. The character of this fishery has changed over the years as angling regulations have become more restrictive and the stocking of hatchery rainbow trout has been discontinued. Angling regulations and management strategies have changed to protect juvenile steelhead and to potentially increase certain size groups of wild redband trout (ODFW 1997). The trout season on the lower Deschutes River is currently open year around from the river mouth up to the northern boundary of the Warm Springs Tribes reservation (RM 69). From river mile 69 upstream to Pelton Reregulating Dam, the trout season is open from the fourth Saturday in April until the end of October (no angling from Pelton Reregulating Dam downstream about 600 feet to the ODFW markers) (ODFW 1997).

Harvest data for trout are available for the lower Deschutes River downstream from Sherars Falls for 1989, 1990, and 1992 through 2002 for the period July through October. These data show that under the current regulations the majority of angler caught trout are subsequently released alive. The estimated percent of trout kept downstream from Sherars Falls during this period ranged from 2 to 7% and averaged 2.5% for the period of record. These low harvest rates indicate that most anglers currently do not fish for trout in the lower Deschutes River for consumption, but rather choose to release their catch regardless of existing regulations (ODFW 1997). There is no comprehensive creel census data available for the Deschutes River from Bend to Lake Billy Chinook (Fies et al. 1998).

While data specific to the lower Deschutes River does not exist, hooking mortality very likely equals or exceeds angler harvest under the existing regulations. Taylor and White (1992), in an analysis of 31 hooking mortality studies, report a mean hooking mortality of 7% for rainbow trout caught on flies and artificial lures.

It is believed that much of the past rainbow trout fishery in the White River system was supported by the stocking of hatchery fish in White River at Tygh Valley and Farmers Crossing and in Badger Creek at Bonney Crossing. Total harvest of hatchery or wild trout in the White River system has not been estimated (ODFW 1997).

There are no recent comprehensive catch estimates or angler-use estimates for the upper Deschutes River between Bend and Wickiup Dam. An extensive 1967 ODFW creel survey recorded 783 anglers catching 252 wild brown trout or about 0.32 fish per angler, but does not mention the redband catch. The survey covered the Deschutes

River from Wickiup to its confluence with Fall River. Random creel census collected in the Wickiup to Benham Falls section during the years 1970 - 1994 showed mean catch rates of 0.38 fish per hour and 0.84 fish per angler. Similar data collected for the Benham Falls to Bend section showed mean catch rates of 0.35 fish per hour and 0.63 fish per angler. However, the fish per angler catch rate has been declining since 1970 for both sections of the Deschutes (Table 32) (Fies et al. 1998).

Table 32. A comparison of fish per angler catch rates on two sections of the Deschutes River from Wickiup Dam to Bend (North Canal Dam) for the years 1970-94 (Fies et al. 1998).

	Fish Per Angler	
Years	**Wickiup Dam to Bend**	**Benham Falls to Bend**
1970-1980	1.24	0.78
1981-1990	0.61	0.54
1991-1994	0.47	0.39

Historic Harvest

Harvest of trout in the lower Deschutes River was estimated from random and statistical creel surveys in the 1950's, 60's, and 70's when the regulations were liberal and hatchery trout were stocked in the main stem. Historically, most of the trout angling in the lower Deschutes River occurred above Sherars Falls. Estimated harvest of trout from Sherars Falls to Pelton Reregulating Dam ranged from about 22,000 to 133,000 fish during years of creel surveys in the 1950's to the 1970's (ODFW 1997). Hatchery fish contributed significantly to the trout catch. Anglers harvested approximately 62% of the 61,000 hatchery fish stocked annually (Schroeder and Smith 1989).

Historical accounts also describe large trout harvests in the Deschutes River near Bend. In 1906, about 3,125 trout were caught in the Deschutes River near Bend on hook and line from four days of fishing by four anglers for a fish fry. In August 1915, about 2,000 people were fed with fish caught by six fishermen using hook and line (Mathisen 1985).

Bull Trout

Bull Trout are a resident species indigenous to the subbasin. Deschutes basin bull trout exhibit resident, fluvial (lower Deschutes) and adfluvial (upper Deschutes) life histories. Fluvial bull trout migrate from their smaller natal streams to a larger river to rear, and then back to their natal stream to spawn. Adfluvial bull trout migrate from their smaller natal stream eventually entering a lake or reservoir to rear. After several years of growth, and with the onset of maturity, adfluvial bull trout retrace their earlier migration back to their natal stream to spawn (USFWS 2002).

Historically the Deschutes Basin supported a number of bull trout populations that included the lower Deschutes River population in the river and tributaries upstream to Big Falls, the upper Deschutes River population above Big Falls and tributaries, and the Odell Lake – Davis Lake population. Today, these populations are listed as threatened under the Endangered Species Act. The Odell Lake subpopulation contains the last extant native lake migratory (adfluvial) bull trout in Oregon (Ratliff and Howell 1992; Buchanan et al. 1997).

Bull trout in the basin are part of the Deschutes Recovery Unit, which encompasses the Deschutes River and its tributaries and contains two core bull trout habitat areas. The lower Deschutes Core Area and upper Deschutes Core Area are separated by Big Falls on the mainstem Deschutes River at RM 132. The lower Deschutes Core Area is generally described as the mainstem Deschutes River and its tributaries from Big Falls downstream to the Columbia River. The upper Deschutes core habitat is generally described as the upper Deschutes River, Little Deschutes River, and other tributaries upstream from Big Falls at about River Kilometer 212 (River Mile 132). The upper Deschutes core habitat does not currently support bull trout populations, but had bull trout historically (USFWS 2002).

Importance

Bull trout were selected as a focal species based on an evaluation of the legal, cultural and ecological status. They are federally listed as a threatened species under the Endangered Species Act and hold ecological value and local significance in the Deschutes basin.

- ***Species designation:*** The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout (*Salvelinus confluentus*), including the Deschutes subbasin populations, as a threatened species under the Endangered Species Act on June 10, 1998 (63 FR 31647) (USFWS 2002). Bull trout are currently listed on the Oregon Sensitive Species List (OAR 635-100-040) as Critical.

- ***Species recognition:*** Historically the species was not highly regarded by tribal or non-tribal fishers or fishery managers. Until about 1960, bull trout were trapped and removed [killed] from the Metolius River at a salmon weir, because of perceived predation on spring Chinook eggs and juveniles. Bull trout captured at the Warm Springs Hatchery barrier dam were not counted before 1990, but were killed rather than passed upstream (ODFW 1997). Today, bull trout are recognized as indicators of high quality fish habitat and cold water. Their presence is associated with an intact aquatic ecosystem (Brun 2003).

- ***Special ecological importance to subbasin:*** Historically bull trout were an important component of the subbasin's aggregate fish population. The fish were an important predator that co-existed with other fish species and helped to keep the ecosystem in balance. Today bull trout are recognized as indicators of high quality fish habitat and cold water. Their presence is associated with an intact aquatic ecosystem (Brun 2003).

- ***Tribal recognition:*** Historically, the tribes utilized bull trout as food fish. Bull trout were generally perceived to be a predatory fish that adversely affected more desirable resident and anadromous fish species. This tribal image of the fish was fostered by the negative image they were given by ODFW and the USFWS. Today, the tribes view bull trout as being an important part of healthy, functioning ecosystems, which is consistent with their traditional beliefs (Brun 2003).

Population Data and Status

Abundance

The Metolius River system supports some of the largest bull trout populations in the Deschutes Basin. The system contains both resident and adfluvial bull trout populations. The populations have apparently responded to angling restrictions enacted to restore population numbers. Record high numbers of bull trout redds were recorded during the 2001 spawning survey (Figure 6), indicating an apparent upward population trend. A total of 643 redds was observed during the 2002 surveys (Table 33). This is 117 less redds than in 2001 (Figure 6), or a decrease of 15.4%. It is, however, still the second highest count on record. Based on a figure of 2.3 adult fish per redd this equates to 1,479 bull trout moving into the basin streams to spawn during the 2002 year. Those reaches surveyed in 2002 averaged 42.6 redds per mile compared to the 2001 average of 57.2 redds per mile and the 1986 average of 1.4 redds per mile (Wise 2003).

Several tributaries to the lower Deschutes River also support bull trout populations. The draft bull trout recovery plan estimates there are 1,500 to 3,000 adult bull trout in the recovery unit, which are distributed in the lower Deschutes Core Area (USFWS 2002). The lower Deschutes resident/fluvial bull trout populations reproduce in Shitike Creek and the Warm Springs River, though some adults spend a portion of the year in the Deschutes River. In 2001 Brun (2001) estimated there were approximately 260 and 470 bull trout spawners in the Warm Springs River and Shitike Creek, respectively. The Shitike Creek population may be comparable to the Metolius River populations in bull trout densities, but the Warm Springs River population is much smaller. Juvenile bull trout densities observed in Shitike Creek in 1999 were similar to juvenile densities in Metolius River tributaries. Metolius River tributary juvenile bull trout densities in 1999 were 1.34 fish/100m2 compared to 2.4 fish/100m2 in Shitike Creek (Brun 2003). In 1997, ODFW estimated bull trout numbers in a lower Deschutes River study reach at North Junction (RM 68.5 to 71.5). The number of bull trout greater than 25 cm in length was estimated to be 7 fish per mile (Newton and Nelson 1997). This estimate was made as part of redband trout population study that utilized the Petersen mark/recapture population estimate methodology.

Anecdotal information suggests that bull trout in the lower Deschutes River subbasin were more abundant historically than at present. A fish trap was used to pass upstream migrating salmonids over Pelton Reregulating Dam before 1968. Workers at that facility recalled annually passing up to several hundred large bull trout upstream for a number of years, indicating that bull trout were much more abundant historically (Ratliff et al. 1996).

Bull trout have not been reported from Odell Creek in recent years. The last official documentation was from a USFS survey in 1979 that recorded bull trout from 14 to 18 inches at a density of 0-5 fish per 100 feet of stream. Surveys were done by snorkeling.

USFS personnel conducted a spawning ground survey downstream of Odell Lake with the objective to document bull trout use, in 1994. Two surveys were completed in October but no redds or fish were found (Fies et al. 1998).

Capacity

There is potential to expand population abundance of all five populations within the Lower Deschutes Core Area (USFWS 2002), but there are no estimates available on the population potential. There are also no estimates of the population potential for the Odell Lake or Upper Deschutes Core Habitats.

Productivity

Recent upward trends in bull trout redd counts in both the Metolius populations and the lower Deschutes populations indicate that bull trout numbers are increasing in apparent response to restrictive angling regulations, habitat protection, and a more abundant forage base. Kokanee salmon populations in Lake Billy Chinook and the Metolius River provide a good prey species. Recent increases in salmon and steelhead numbers in the lower Deschutes River system would also increase prey availability.

Life History Diversity

In the Metolius River system, most bull trout spawning occurs between August 15 and October 1. However, spawning has been observed as early as July 13 and as late as mid-October (Ratliff et al. 1996). In Shitike Creek, spawning was observed from August 20 through early November, when water temperature averaged 6.2°C (43°F) between RM 18 to 27; this was the mean 7-day average from thermographs. In the Warm Springs River, temperatures averaged 6.6°C (44°F) between RM 31 to 35 during the late-August to early November spawning period (Brun 1999).

Juvenile bull trout typically rear in the parent stream for two years and then migrate in the spring to larger waters for rearing to adulthood. Deschutes basin bull trout exhibit resident, fluvial and adfluvial life histories. At age-5, fluvial and adfluvial fish migrate back to their natal tributary to spawn (USFWS 2002). Bull trout are very piscivorous allowing them to reach up to 20 lbs in size depending on food availability.

Carrying Capacity

There is no estimate of the subbasin’s bull trout carrying capacity.

Population Trend and Risk Assessment

Bull trout core areas with fewer than five local populations are at increased risk, core areas with between five and ten local populations are at intermediate risk, and core areas with more than ten interconnected local populations are at diminished risk. For the lower Deschutes Core Area, there are currently five known local populations. Based on the above guidance, bull trout in the Deschutes Recovery Unit is at an intermediate threat category (USFWS 2002).

Hybridization with brook trout is a concern for the Warm Springs River and Shitike Creek populations. Hybridization has not been documented in the lower Deschutes River subbasin but brook trout are present in high lakes in both systems and the potential does exist. Competition between juvenile brook trout and bull trout for available resources may exist where both are present even if hybridization does not occur (Brun and Dodson 2000).

Small populations risk extinction through excessive rates of inbreeding and chronic or catastrophic natural processes. It is unknown if lower Deschutes River subbasin bull trout populations are large enough to escape these risks (ODFW 1997). The limited quantitative measures of bull trout numbers in the lower Deschutes suggest there are several small populations. Tribal fishery managers have been closely monitoring bull trout populations in recent years at the weirs in Shitike Creek and the Warm Springs River, so any unusually population characteristics should be promptly noted.

The bull trout populations in the Metolius River system appear to have rebounded from extremely low levels as recently as the 1980s (Fies et al. 1996). The recent trend in Metolius River system bull trout redd counts also appears to indicate an upward population trend (Figure 6).

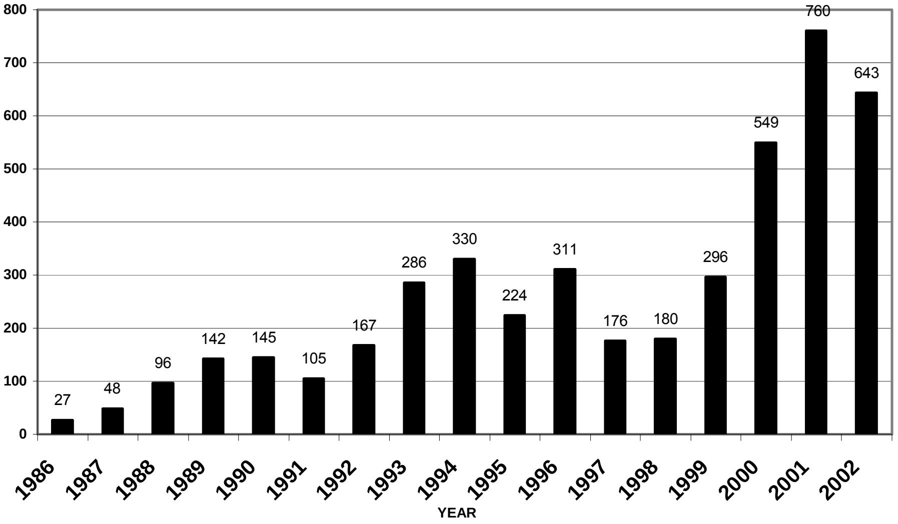


Figure 6. Bull Trout redd counts, Metolius River system, 1986 – 2002 (Wise 2003).

Bull trout spawning surveys in Shitike Creek and the Warm Springs River (Figure 7) indicate that the annual numbers of spawners appears to be stable in the Warm Springs River system and on an upward trend in Shitike Creek.

Table 33. Bull trout redd counts, Metolius River and tributaries spawning surveys, 1986– 2002 (Wise 2003).

Year	Jefferson	Candle	Canyon	Roaring	Jack	Heising	Metolius	Total
1986	6	6	8	4	3	0	0	27
1987	9	8	16	4	11	0	0	48
1988	27	8	9	22	30	0	0	96
1989	36	17	22	17	50	0	0	142
1990	29	16	35	13	49	3	0	145
1991	25	8	14	30	23	5	0	105
1992	28	13	40	28	53	5	0	167
1993	121	28	36	19	61	18	3	286
1994	81	30	104	17	50	31	17	330
1995	32	42	29	12	70	34	5	224
1996	75	71	56	14	55	35	5	311
1997	14	33	44	24	40	16	5	176
1998	29	48	33	9	39	15	7	180
1999	29	70	70	44	44	22	17	296
2000	116	85	92	90	87	57	22	549
2001	117	174	156	82	207	8	16	760
2002	134	91	130	104	164	13	7	643

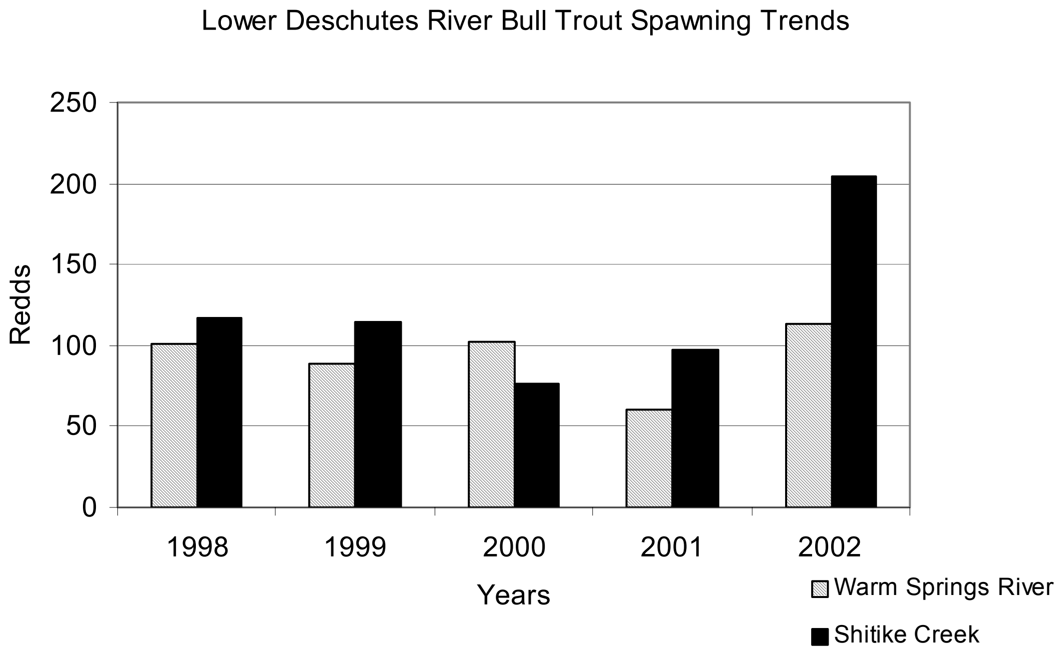


Figure 7. Bull trout redd counts from the Warm Springs River and Shitike Creek, 1998 – 2002 (Brun 2003).

Unique Population Units

Research conducted on the genetics of bull trout in Oregon established the genetic baseline for bull trout and confirmed Oregon Department of Fish and Wildlife's designation of Deschutes bull trout as a separate gene conservation group (Spruell and Allendorf 1997). Fluvial subpopulations in Shitike Creek and the Warm Springs River contribute bull trout into the lower Deschutes River. The Metolius River system populations were historically a component of the lower Deschutes populations. The Pelton Round Butte Complex isolated some of these populations. The Odell Lake population has been isolated from other subbasin populations for approximately 6,000 years.

Life history Characteristics of Unique Populations

The Warm Springs River and Shitike Creek bull trout populations are thought to be fluvial, but contain a resident component as well. The fluvial life history pattern is dominant in the lower Deschutes River habitat. The fluvial components of these populations spawn and rear in headwater reaches of the Warm Springs River and Shitike Creek. At age-2 and age-3, some juveniles migrate to the mainstem lower Deschutes River to rear. Brun (1999) found that the average size of juvenile bull trout migrants from Shitike Creek to be 131 mm and 183.9 mm in the spring and fall respectively. Some juveniles rear two to three years in the headwater stream reaches before emigrating to the Deschutes River.

Adults begin returning to the headwater spawning areas as age–4 fish (Brun and Dodson 2000). Adults migrate from the Deschutes into Shitike Creek and the Warm Springs River from April to June. Fish are generally in the habitat suitable for spawning by September. Spawning is generally complete by the end of October. The only known suitable spawning sites in the lower Deschutes subbasin are contained in the Warm Springs River system and Shitike Creek.

The Metolius River complex populations have a life history similar to the Shitike Creek and Warm Springs River populations. However, the Metolius populations contain at least an adfluvial component that spends a portion of its life rearing in Lake Billy Chinook.

Estimate of Desired Future Condition for Long-term Sustainability

The recovered abundance levels in the Deschutes Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows the recovery team to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift. For the purpose of recovery planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes (USFWS 2002).

Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the loss of genetic variation due to genetic drift and to maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 19) (USFWS 2002). In a recovered condition, the lower Deschutes Core Area would have spawning and rearing populations in the Whitewater River, Jefferson/Candle/Abbot river complex, Canyon/Jack/Heising/mainstem Metolius river complex, Warm Springs River, and Shitike Creek. Core habitat in the upper Deschutes core habitat would also contain one or more local populations as yet to be identified (USFWS 2002). The Odell Lake habitat complex population should be increased to a minimum of 500 fish to avoid long term genetic risks.

There will be intact migratory corridors among all local populations in core areas providing opportunity for genetic exchange and diversity within the lower Deschutes Core Area. This will mean upstream and downstream passage must be addressed at the three dams associated with the Pelton Round Butte Complex and passage barriers at Opal Springs Dam, Link Creek, and upper Squaw Creek. Additional barriers may also be identified. If re-establishment is undertaken in the upper Deschutes core habitat, upstream and downstream passage at Wickiup, Crane Prairie, and several privately owned-hydropower and irrigation diversion dams must be addressed (USFWS 2002).

Distribution

Current Distribution

Bull trout in the Deschutes subbasin have been reduced to six populations. These are located in Odell Lake and tributary and outlet streams, Shitike Creek, Warm Springs River, Whitewater River, Jefferson/Candle/Abbot river complex, and Canyon/Jack/Heising/mainstem Metolius river complex (USFWS 2002). With the exception of the remnant Odell Lake population, the current bull trout distribution is limited to the lower Deschutes Core Area, which covers the lower Deschutes Basin below Big Falls and includes five local populations: one in Shitike Creek, one in the Warm Springs River, and three population complexes in the Metolius River (USFWS 2002).

Historic Distribution

Historically the Deschutes Basin supported a number of bull trout populations that included the lower Deschutes River population in the river and tributaries downstream from Big Falls, the upper Deschutes River population above Big Falls and tributaries, and the Odell Lake – Davis Lake population. Odell Lake was isolated from other bull trout populations in the upper Deschutes by a lava flow that dammed Odell Creek about 5,000 to 6,000 years ago (USFWS 2002). Deschutes River bull trout populations in Shitike and Squaw creeks, and middle Deschutes, Warm Springs, Crooked and Metolius rivers likely were once part of a much larger fluvial metapopulation, which included fish that migrated to and from the Columbia River (USFWS 2002). These populations quite possibly exchanged genetic material with bull trout from the nearby Hood and Klickitat rivers.

Differences in Distribution due to Human Disturbance

Bull trout were extirpated from most of the basin above Steelhead Falls by the 1950’s (Ratliff et al. 1994). A variety of factors including construction of Crane Prairie (1922) and Wickiup (1947) dams, water withdrawal from irrigation developments, excessive harvest and introduction of brook trout likely contributed to the extinction of upriver subpopulations in the 1950's. Dam construction and water withdrawals in the Crooked River system eventually limited bull trout distribution to the river downstream from Opal Springs Dam. Construction of Pelton (1956) and Round Butte (1964) dams and termination of fish passage around these structures in 1968 greatly restricted or eliminated natural movement of upriver groups of bull trout into the lower Deschutes River.

Artificial Production

Bull trout have not been artificially produced in the subbasin and there are no records of any artificially produced bull trout being released anywhere in the subbasin.

Effect of Straying/Ecological Consequences

There are no documented instances of bull trout from other subbasins straying into the Deschutes subbasin. However, releases of other hatchery-reared salmonids within the subbasin may mimic or potentially be more harmful than the potential effects of straying. Brook trout inhabit Squaw Creek, the Warm Springs River, and Shitike Creek. Brook trout are a major threat to bull trout in the Warm Springs River due to competition for limited rearing habitat. In Mill Creek, a Warm Springs River tributary, brook trout have displaced bull trout. Brook trout do not appear to be limiting bull trout abundance in Shitike Creek (Brun 2002).

Introduced brook and brown trout may be limiting for some bull trout populations in the Metolius River basin due to their potential for interaction. Brook trout are found in Abbot, Brush, and Canyon creeks. Brown trout occur in Suttle Lake and may have been partially responsible for the demise of that bull trout population. Over-harvest may be a factor in a mixed fishery with brown trout (Ratliff et al*.* 1996).

Subbasin Harvest

Current Harvest

In the past 20 years, size and bag limit regulations on the lower Deschutes River have likely precluded a target bull trout fishery and limited exploitation rates to very low levels. The taking of bull trout was banned by rule in the lower Deschutes River starting in 1994 (ODFW 1997).

Today, the only legal harvest of bull trout within the Deschutes Basin occurs in a very restrictive fishery within Lake Billy Chinook. Anglers are allowed to keep one bull trout over 24 inches in length per day. Protective bull trout angling regulations in the Metolius

River have been implemented since 1980, which culminated in the closure of the tributaries below Lake Creek to angling in 1994 (USFWS 2002).

The Warm Springs River and Shitike Creek are closed to tribal angling to protect spring Chinook salmon. The only exception is the occasional opening of the Warm Springs River from the mouth to the hatchery for spring Chinook when the salmon are abundant. Tribal angling is generally very light during these special seasons. Some tribal harvest of bull trout probably occurs from the lower Deschutes River, bordering the reservation, but numbers are believed to be minimal (Brun 2003).

Historic Harvest

There is little quantitative data available on in-basin bull trout harvest. A major Native American and pioneer fishery occurred on the Upper Deschutes River at Pringle Falls (Ratliff and Fies 1989). There are many historical photos of large bull trout or "Dolly Varden", as they were called, from both the Upper Deschutes River near Bend and from the Metolius River basin. The Deschutes River had excellent populations of bull trout and native redband trout. Pringle Falls created a natural fish trap, and bull trout migrating toward upstream spawning grounds in July and August (1903) were taken by spear or clubs at night while they were delayed and concentrated at falls. The bull trout weighed between 5 and 20 lbs, and ranged from 24-37 inches in length. Fish were salted and packed in barrels or smoked and packed for winter use. Bull trout were still being caught during spawning migrations at Pringle Falls in 1923 (Fies et al. 1998).

Historically, liberal bag limits and a lack of terminal tackle restrictions likely resulted in greater harvest and higher exploitation rates on bull trout in the mainstem lower Deschutes River than in recent times. It is possible that small target fisheries for bull trout existed and that harvest affected population levels (ODFW 1997).

Until about 1960, bull trout were trapped and removed from the Metolius River in conjunction with operation of a weir to collect salmon for hatchery brood, because of predation on spring Chinook eggs and juveniles (Fies et al. 1996).

Pacific Lamprey

Importance

Pacific Lamprey is an indigenous, anadromous species found in the Deschutes River subbasin. Historically, lampreys were widely distributed throughout the subbasin. This historic distribution may have surpassed the historic salmon and steelhead distribution since lampreys are adept at passing some natural barriers (i.e. Sherars Falls and Willamette Falls). Anecdotal historic observations indicate that lamprey were very abundant, at least periodically (Kostow 2002). Historical accounts also describe lamprey collections from the Crooked River (Kostow 2002). Masses of adult lampreys could typically be seen stuck to the windows of the Bonneville Dam fish ladder as recently as the 1980’s. Today, Pacific lampreys have been extirpated above the Pelton Round Butte Complex.

- ***Species designation:*** Pacific lamprey were listed as a state sensitive species in 1993, and in 1997 they were given further legal protected status by the state of Oregon. They are not included on the federal threatened or endangered species lists. However, because of apparent declines in lamprey populations conservation groups in Oregon, Washington and California prepared a petition to give lamprey federal protection under the Endangered Species Act in January 2003. Budget limitations have forced the U. S. Fish and Wildlife Service to defer formal consideration of the lamprey petition until at least October 2003.

- ***Species recognition:*** There are a number of different lamprey species, including parasitic and non-parasitic species, anadromous species and those that live their complete lifecycle in fresh water. People have commonly viewed lampreys as a threat even where they are native and live in harmony with their ecosystem. Some people seem to find their parasitic behavior repulsive, a view that is perhaps also sustained by their sliminess and snake-like appearance (Kostow 2002). Historically lampreys have provided an important, local fishery, for subsistence, ceremonial and medicinal purposes, by the members of the Confederated Tribes of Warm Springs.

- ***Special ecological importance to subbasin:*** Historically this species likely had the widest distribution of any of the anadromous species within the subbasin. Barriers that effectively interrupted the migration of other fish can often be negotiated by this species. Historically pristine stream conditions throughout the subbasin likely supported lampreys. Some mammalian and avian predators may target lampreys during their migrations to and from the ocean. Most adult lampreys die shortly after spawning, feeding various scavenger species and contributing rich nutrients throughout their freshwater habitat (Kostow 2002).

- ***Tribal recognition:*** The species is culturally significant for Native Americans, including members of the Confederated Tribes. The lampreys have religious and ceremonial importance to tribal members. Lampreys are also an important component of the tribal subsistence fishery that occurs annually in the subbasin. Lampreys are fatty and highly nutritious. They are valued as a traditional source of food by some Native Americans (Kostow 2002). A Tribal subsistence fishery for adult lampreys has occurred in the Deschutes River at Sherars Falls for generations. Lampreys have also been used for medicinal purposes. The oils of the “eels” have been used as hair oil and were traditionally mixed with salmon and used as a cure for tuberculosis.

Population Data and Status

Pacific lamprey abundance in the Deschutes subbasin has not been estimated, but appears to be low. Pacific lamprey abundance throughout the Columbia River Basin has decreased significantly in recent years (ODFW 1997). In part, this reflects lamprey counts at Bonneville and The Dalles dams, which were lower in the 1990’s than pre-1970 counts (Kostow 2002). Counts at Columbia River dam fish ladders are one of the few indicators of lamprey numbers in the Mid-Columbia ESU. However, even these counts are suspect because of certain lamprey characteristics. Lampreys typically migrate at night, while most fish ladder counting occurs during daylight hours. Fish counting stations typically were designed for counting salmon and steelhead, and lampreys can often times pass without being seen. Their erratic swimming in the faster current of the fish ladders could also result in multiple counts of an individual lamprey that may become dislodged and drift back down stream (Kostow 2002).

Tribal biologists will begin to estimate adult lamprey escapement above Sherars Falls this year as part of a Bonneville Power Administration funded project (BPA Project 200201600).

Capacity

There is no information or estimates available that would indicate the potential lamprey capacity in the Deschutes Basin.

Productivity

Historic lamprey counts at Bonneville and The Dalles dams show the order of magnitude variations that can occur as lamprey numbers swung between tens of thousands and hundreds of thousands in just a few years (Kostow 2002). Because of their high fecundity rate, lamprey populations may be able to quickly rebound if freshwater and ocean survival conditions are favorable.

Carrying Capacity

The Deschutes River subbasin Pacific lamprey carrying capacity is unknown.

Population Trend and Risk Assessment

Abundance of Pacific lampreys in the subbasin appears to be low. Risks to the lamprey populations include the degradation of stream habitat including erratic or intermittent flow, decreased flows, increased water temperatures and poor riparian areas, predation in all life stages, artificial barriers and the lack of appropriate screening for lampreys. They are particularly vulnerable to pollution and erratic stream flows during their juvenile or ammocoete life stage because of the length of time they reside in the stream substrate. Migrating ammocoetes are especially vulnerable to predation during their in-river and ocean migration. Most movement appears to occur at night, but their size (up to 10cm) and the number of predators, especially in the Columbia River and impoundments, pose a serious risk.

Unique Population Units

There have been no unique populations of Pacific lampreys identified in the subbasin. Little is known about Pacific lampreys because taxonomy and field identification of the various species is so difficult. Generally species differentiation is based on adult characteristics, but lampreys are adults for a rather short period of their total lives (Kostow 2002). Until species identification and genetic characteristics of the species is better understood it will be difficult to determine if any unique populations exist.

Life History Characteristics of Unique Populations

Life history information for the Deschutes River subbasin lamprey population is generally lacking. Much of the information contained in this assessment is based on observations and data from other Columbia River Basin or Pacific Northwest lamprey populations.

Pacific lampreys are an anadromous, parasitic species. They are parasitic during that portion of their life cycle that occurs in the ocean. Adult lampreys return to the Deschutes River during the summer months. It is assumed that they over-winter in subbasin streams prior to spawning the following spring or early summer. Willamette River subbasin lampreys spawn from February through May (Kostow 2002). Colder water temperatures in the westside Deschutes River tributaries may result in a slightly later spawning time in the Deschutes River subbasin.

Lampreys do not feed once they enter freshwater. Adult lampreys may be attracted to pheromones (chemical stimuli) produced by juveniles (ammocoetes) living in the stream substrate, rather than relying on some homing instinct. During the over-winter period individuals survive on stored body fats, losing up to 20% of their weight and shrink in length. The size of adult Pacific lampreys can be highly variable depending when the measurements are taken. Measurements of adults reported in literature include 39.3 to 62.0 cm for migrating adults and 33.2 to 54.2 for spawning adults (Kostow 2002).

Spawning generally occurs just upstream of stream riffles and often near silty pools and banks. Lampreys' fecundity is thought to be highly variable, which might suggest a variety of life history patterns or age classes in a single spawning population. It has been estimated that the fecundity rate may vary from 15,500 to 240,000 eggs/female (Kostow 2002). Lampreys spawn in low gradient stream sections. They construct gravel nests in the stream substrate at the tail-outs of pools or in riffles. Most authorities believe that all lampreys die after spawning. However, there have been several reported observations of robust lamprey kelts migrating downstream and an indication of repeat spawning in one Olympic Peninsula population (Kostow 2002).

Lamprey eggs hatch within 2-3 weeks, depending upon water temperature. The juveniles emerge from the spawning gravel at approximately 1 cm in length. The ammocoetes burrow into the soft substrate downstream from the nest and may spend up to six or seven years in the substrate. They are filter feeders that feed on algae and diatoms. The ammocoetes will move gradually downstream, moving primarily at night, seeking coarser sand/silt substrates and deeper water as they grow. They appear to concentrate in the lower parts of basins before undergoing their metamorphism. When body transformation, or metamorphism, from the juvenile to adult stage is complete, they migrate to the ocean from November through June (Kostow 2002). In the Umatilla River this out-migration was observed to occur in the winter to early spring (Kostow 2002).

Pacific lampreys enter saltwater and become parasitic. They feed on a wide variety of fishes and whales. They appear to move quickly offshore into waters up to 70 meters deep. Some individuals have been caught in high seas fisheries. The length of their ocean stay is unknown, but some have speculated that it could range from 6 to 40 months (Kostow 2002).

Estimate of Desired Future Condition for Long-term Sustainability

It would be desirable to have a population of sufficient size to provide for subbasin harvest while insuring adequate spawner escapement to perpetuate the population.

Distribution

Current Distribution

Pacific lamprey distribution in the Deschutes subbasin is confined to the Deschutes River and select tributaries downstream of the Pelton Round Butte Complex. ODFW personnel have conducted numerous steelhead surveys on the tributaries entering the lower Deschutes River from the east. No adult or juvenile lampreys have been observed during these surveys. It is assumed that most, if not all, spawning occurs within the boundaries of the Warm Springs Reservation. This spawning is likely occurring only in the Shitike Creek and Warm Springs River systems. Tribal biologists are currently mapping the known larval distribution of lamprey within reservation waters (BPA Project 200201600) (Brun 2003).

Differences in Distribution due to Human Disturbance

Lamprey distribution within the subbasin has been greatly reduced as a result of the construction of impassable barriers, including the Pelton and Round Butte dams. Marked flow fluctuations and degraded stream habitat have further reduced the lamprey distribution. Subbasin harvest may have also contributed to the reduction in lamprey numbers and distribution.

Artificial Production

There have been no artificial lamprey production programs anywhere within the subbasin.

Effect of Straying/Ecological Consequences

Little is known about straying of lamprey in the Deschutes River subbasin, including the straying of lamprey from other subbasins into the Deschutes. Studies of the sea lamprey (*Petromyzon marinus*) in the Great Lakes have indicated that some lampreys have essentially no homing behavior. Instead, the adults may be attracted to streams with concentrations of ammocoetes, which were detected by some chemical stimuli (Kostow 2002). If these observations apply to Pacific lampreys, straying may be common if the chemical stimuli are an indiscriminate attractant for all lampreys.

Subbasin Harvest

Current Harvest

All lamprey harvest in the subbasin is associated with the Tribal salmonid subsistence fishery located at Sherars Falls. Tribal harvest of adult lampreys in recent years has been low, but there are no estimates of the numbers of lampreys harvested. The first sampling program designed to monitor tribal harvest of adult lamprey from the Deschutes River is scheduled to begin this year at Sherars Falls (BPA Project 200201600) (Brun 2003).

Historic harvest

There is no data to quantify past lamprey harvest in the subbasin. Anecdotal observations by ODFW workers in the Sherars Falls area have indicated that when lamprey were more numerous, Tribal fishers at times were able to fill several burlap sacks with adult lampreys after a few hours of fishing. During years when lampreys were abundant it is possible that several hundred lampreys could have been harvested daily at Sherars Falls.

Sockeye Salmon

This assessment considers both anadromous sockeye salmon, which were extirpated from the subbasin about 1940, and the landlocked sockeye or kokanee salmon, which is an important subbasin fish species today. Sockeye salmon were selected as a focal species because of their historic ecological value, tribal significance and potential for re-introduction if remedial fish passage issues at the Pelton Round Butte Complex are successful.

Importance

Sockeye salmon historically were an important anadromous fish species that occupied a portion of the Deschutes River subbasin. Spawning and early life history stages were confined to the Metolius River/Suttle Lake/Blue Lake habitat complex. Sockeye salmon in Suttle Lake were an indigenous species (Fies and Robart 1988; Fulton 1970; NOAA No. 618). Sockeye used Link Creek for spawning and Suttle Lake for rearing. The historic sockeye run was suppressed by the 1930's and apparently extirpated by 1940, due to passage problems on Lake Creek near the outlet of Suttle Lake (Fies et al. 1996). The sockeye population may have been comprised of several thousand spawners annually, if any comparisons can be drawn between the original sockeye salmon population and the current kokanee salmon population in Lake Billy Chinook/Metolius River habitat complex. Kokanee, the resident form of the species, provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex.

- ***Species designation:*** *S*ockeye/kokanee salmon within the Mid-Columbia ESU are not listed on the state or federal sensitive species lists.

- ***Species recognition****:* Since sockeye salmon were indigenous to Suttle Lake and Link Creek, it is reasonable to believe a residual sockeye (kokanee) population existed as well. The 1940 lake survey of Suttle Lake (Newcomb 1941) reported that land-locked Blueback salmon were abundant. It is unknown if the indigenous form of kokanee are still present in Suttle Lake (Fies et al. 1996).

- ***Special ecological importance to subbasin:*** Historically the sockeye salmon were an important anadromous species in the subbasin, even though their distribution was limited to the Deschutes River and the Metolius River and tributaries. A variety of predators targeted these fish during their migrations to and from the ocean. Adult sockeye die shortly after spawning. Their carcasses were utilized by various scavenger species and they contributed rich nutrients throughout their freshwater and associated riparian habitat. Large spawning populations of kokanee salmon are now making similar contributions to the ecosystems in the upper portion of the subbasin. Kokanee migrating upstream from Lake Billy Chinook are utilizing former sockeye spawning habitat in the Metolius River system. Another large kokanee spawning migration occurs in the Deschutes River upstream of Wickiup Reservoir.

- ***Tribal recognition:*** Sockeye are highly regarded by members of the Confederated Tribes of the Warm Springs Reservation. The adult sockeye salmon were a high quality fish that was an important Tribal food source. They were captured as adults on the Deschutes River at Sherars Falls and in the Metolius River system on their spawning grounds.

Population Data and Status

Abundance

Counts of adult sockeye at the Pelton Fish Trap from 1955 to 1962 varied from 30 to 332 adults. However, most of these adults likely were hatchery returns from the Oregon Fish Commission's Metolius Hatchery on Spring Creek (Nehlsen 1994). The Metolius River hatchery program for sockeye salmon was discontinued and the return of native fish ranged from 7 to 35 from 1957-59 (Nehlsen 1995; Fies et al. 1996). The last sizable run of sockeye in the Metolius River was 227 adults reported in 1955 (Fies et al. 1996). Today, a few sockeye salmon are captured each year at the trap, but these fish are either out-of-basin strays or fish that have successfully out-migrated through the hydroelectric complex.

Capacity

The potential for re-introduction of sockeye salmon into historic habitat above the Pelton Round Butte Complex precipitated a 1996 through 2000 study designed to determine the dynamics of the current kokanee salmon population in Lake Billy Chinook. It was estimated that the number of spawning adult kokanee in the Metolius River basin ranged from 83,471 adults in 1996 to 569,201 adults in 2000. This study determined that kokanee eggs hatch in the Metolius River basin from early December through early February, with emergence occurring from January through April. Most fry migrate downstream in late March and early April. Estimated fry recruitment ranged from 1.9 million in 1999 to 2.5 million in 1998. Potential kokanee egg deposition in the Metolius River basin ranged from 39.75 million for brood year 1998 to 67.23 million for brood year 1997. Redd superimposition occurred at several monitored sites (regardless of adult run size) and may account for substantial egg mortality. Minimum egg to fry survival ranged from approximately 3.8 to 4.8 percent during this study (Thiede et al. 2002).

Portland General Electric had a consultant investigate the potential sockeye salmon production potential upstream of the Pelton Round Butte Complex as part of the FERC re-licensing process. The primary task of the model used to develop the potential run size estimates was to evaluate the relative importance of different mortality and habitat factors that could affect re-introduced sockeye salmon (Ratliff 2003). The estimated annual number of adult sockeye that would be available to spawn upstream of the hydro project was very speculative because there were so many assumptions required to make PasRAS model simulations. When the model parameter settings were assumed to be more consistent with the risks sockeye populations would face in the Deschutes River (i.e. downstream migrant collection efficacies of 0.6, with an initial population of 1,000 to 3,000 spawners) over 60% of the replications of scenarios involving collection mortalities ended in extinction within 50 years (Oosterhout 1999).

Productivity

Sockeye salmon and kokanee salmon populations can reproduce very successfully. Naturally reproducing populations in lakes and reservoirs have a propensity for over-populating if there is good spawning habitat available. Over-population often results in a population of small or stunted fish. An example of this problem is the Suttle Lake kokanee population. In the past anglers complained about the lake's small-size kokanee. A weir on Link Creek (Suttle Lake tributary) originally used to monitor fish migration and collect eggs for hatchery programs was used in the 1980's to block spawning runs of kokanee to reduce the kokanee recruitment into Suttle Lake and thereby increase the average fish size. Those efforts increased the average size (fork length in inches) of mature kokanee from 9.8 inches in 1984 to 14.3 inches in 1990 (Fies et al. 1996).

Life History Diversity

Sockeye salmon populations often exhibit a number of different life history patterns from each brood year's production. Most sockeye juveniles smolt and migrate to the ocean after 12 to 15 months rearing in a freshwater lake environment. A small percentage smolt and migrate after two years of lake rearing. Adult sockeye return to spawn after 1 to 3 years of ocean life (Wydoski and Whitney 1979).

Kokanee generally reach sexual maturity at three years of age, and then die in the fall after spawning (Fies et al. 1998). Large numbers of kokanee migrate from Lake Billy Chinook into the Metolius River for spawning. A similar migration of Wickiup Reservoir Kokanee occurs annually in the short segment of the Deschutes River below Crane Prairie Dam.

Carrying Capacity

There is no estimate of the subbasin's potential sockeye salmon population. The future of this population is strictly dependent upon solving adult and juvenile fish passage problems associated with the Pelton Round Butte Complex. The composite subbasin kokanee carrying capacity has not been estimated.

Population Trend and Risk Assessment

The indigenous Deschutes River subbasin sockeye salmon population was extirpated by 1940. Currently, the only adult sockeye salmon found in the subbasin are the few fish observed at the Pelton Reregulating Dam fish trap each year. However, these fish are assumed to be out-of-basin strays or adults returning from kokanee that successfully migrated downstream through the Pelton Round Butte Complex.

Unique Population Units

The Metolius River/Suttle Lake complex sockeye salmon population, extirpated by 1940, was historically the unique sockeye salmon population within the subbasin. This population was apparently extirpated by 1940.

Life History Characteristics of Unique Populations

Historically, sockeye salmon migrated up the Metolius River and into the Lake Creek-Suttle Lake habitat complex to spawn. Spawning was likely concentrated in Link Creek (connecting Suttle and Blue lakes), however some fish may have either spawned downstream from Suttle Lake or along the shores of Suttle Lake if there was suitable habitat with upwelling spring flow through the substrate. The fecundity of sockeye females ranges up to 4,000 eggs. Eggs generally hatch in 6 to 9 weeks, depending on water temperature. The young will remain in the substrate for another 2 to 3 weeks before emerging and moving into the lake environment (Wydoski and Whitney 1979).

Some juvenile sockeye likely moved upstream to rear in Blue Lake, while others dropped downstream into Suttle Lake to rear. After the juveniles underwent the physiological transformation into smolts they began their ocean migration. Adult salmon were probably predominantly age-3 when they returned to spawn. Sockeye, like other species of Pacific Salmon, die shortly after spawning.

Estimate of Desired Future Condition for Long-term Sustainability

Re-establishment of a self-sustaining sockeye salmon population in the Metolius River/Suttle Lake habitat complex habitat is the preferred management scenario. The population would be able to withstand annual in-river harvest and still maintain adequate spawner escapement to perpetuate the population.

Distribution

Current Distribution

Today, kokanee migrate from Lake Billy Chinook each fall to spawn in the Deschutes River above Lake Billy Chinook and in the first two miles of Squaw Creek (Fies et al. 1998). Kokanee from Lake Billy Chinook also spawn in the Metolius River and tributaries.

It is also not uncommon to see kokanee salmon in the Deschutes River downstream from Wickiup Dam. The outlet of Wickiup Reservoir is unscreened and allows fish to escape when water levels are drawn down. The outlet's depth is approximately 70 feet, which rules out the use of conventional fish screening. When the reservoir drops below 40,000 acre-feet of storage and fish become concentrated in the Deschutes River channel of the reservoir, the loss of fish through the outlet increases. These are primarily kokanee and coho, fish with strong emigrational tendencies (Fies et al. 1998).

Thousands of kokanee and coho salmon, and lesser numbers of brown trout, can be lost from Wickiup Reservoir annually. Evidence of kokanee loss from the reservoir to the river has been demonstrated by trapping the fish bypass at the Central Oregon Irrigation District canal near Bend. The trap was operated during the irrigation season in 1984, 1989, and 1990. The numbers of kokanee captured in the trap were 17,367, 58,625, and 38,665 respectively (Craven 1991). Kokanee comprised 92.5% of the fish trapped during the three years, (Fies et al. 1998).

There have occasionally been large numbers of juvenile kokanee that sound and pass through the hydroelectric turbines at Round Butte Dam. Some of these fish survive and are successful in negotiating the Pelton and Pelton Reregulating Dam turbines. It appears that a few of these fish survive to migrate to the ocean and eventually return to the Pelton Fish Trap as adult sockeye salmon.

Differences in Distribution due to Human Disturbance

The historic Deschutes River subbasin sockeye salmon population was extirpated by 1940. The loss of this population was directly attributed to manmade dams on Lake Creek near the outlet of Suttle Lake (Fies et al. 1996).

Artificial Production

Current Hatchery Production

The only releases of hatchery-reared sockeye salmon within the subbasin are the annual releases of kokanee salmon into several lakes and reservoirs (Table 34). Hatchery-reared kokanee salmon are released annually into East and Paulina lakes and Crane Prairie Reservoir. Other kokanee populations associated with subbasin lakes and reservoirs are self-sustaining.

Table 34. Deschutes River Subbasin lakes and reservoirs with Kokanee Salmon populations (Data from Fies et al. 1996 and 1998).

Water Body	Population Status	First Hatchery Release	Management Program
Lake Billy Chinook	Natural	Hatchery releases into Suttle Lake	Self-sustaining
Lake Simtustus	Fall-out from Lake Billy Chinook	Fish escape from Lake Billy Chinook	
Suttle Lake	Natural	Sockeye releases in 1940's and 50's	Self-sustaining since 1973
Wickiup Reservoir	Natural	Kokanee releases from 1958 - 86	Self-sustaining since 1987
Crane Prairie Reservoir	Hatchery Stocks	First Kokanee release in 1957.	Annual stocking since 1981.
Davis Lake	Low numbers from Odell Lake	No hatchery releases	Fish drop out of Odell Lake and Odell Creek
Odell Lake	Natural	First stocking 1950	Self-sustaining since 1983
Paulina Lake	Hatchery Stocks	First stocking 1973	Annual stocking
East Lake	Hatchery Stocks	First stocking 1993	Annual stocking
Elk Lake	Natural		Self-sustaining

The Paulina Lake kokanee program has provided an annual source of high quality eggs for the Oregon kokanee program since 1978. Other states such as Idaho and Washington have also used eggs from Paulina Lake kokanee. Table 35 summarizes the kokanee egg collections at Paulina Lake for the years 1991-95 (Fies et al. 1998).

Table 35. A summary of kokanee egg collections at Paulina Lake for the years 1991-95 (Fies et al. 1998).

Year	Number females	Number eggs	Eggs/female
1991	594	689,440	1,161
1992	1,333	1,423,000	1,068
1993	1,026	1,132,536	1,104
1994	1,045	1,295,000	1,239
1995	549	838,000	1,526

Historic Production

Wallis (1960) noted that blueback (sockeye - Washington and Bonneville stock) eggs were brought in for rearing at the Metolius River Fish Hatchery and released into the Metolius system as early as 1947 (Fies et al. 1996). Hatchery sockeye were planted in Suttle Lake in the late 1940's and 1950's in the hope of rebuilding the runs (Wallis 1960). The former Metolius Hatchery (opened in 1947) released sockeye into the Metolius River and Suttle Lake from 1948 to 1961. In the 1950's, a small artificial run of sockeye and kokanee utilized Suttle Lake and its tributaries. Marked sockeye salmon were released into Suttle Lake beginning with the 1953 brood. In 1958, approximately 10,000 blueback salmon (sockeye) eggs were placed in baskets in Link Creek to evaluate survival. Survival ranged from 62 to 91% (Fies et al. 1998). ODFW stocking records for Suttle Lake show kokanee were first released in 1954 and last released in 1973.

Hatchery releases of kokanee salmon into subbasin waters have originated from a number of in-subbasin and out-of-subbasin sources. For example, kokanee stocked in Wickiup Reservoir from 1958 to 1986 were the product of blending Montana, British Columbia, and Washington stocks (Fies et al. 1998). Current kokanee released into East and Paulina lakes are reared at the Wizard Falls Fish Hatchery from eggs collected annually at the outlet of Paulina Lake (Fies et al. 1998).

Effect of Straying/Ecological Consequences

The only known straying to have occurred in recent years has been out-of-basin stray sockeye captured in the Pelton Fish Trap. These fish have reached a dead-end and have no biological impact on the subbasin since the native sockeye salmon population was extirpated. There is no evidence that the small numbers of kokanee out-migrants leaving the subbasin are straying into other subbasins.

Relationship between Natural and Artificially Produced Populations

Introductions of sockeye and kokanee salmon into Suttle Lake in the 1940’s and 50 have established a landlocked kokanee salmon population in the Lake Billy Chinook/Metolius River habitat complex. This kokanee population has essentially occupied the historic sockeye salmon spawning and freshwater rearing habitat.

Subbasin Harvest

Current Harvest

The only sockeye salmon harvest occurring within the basin is minor incidental harvest of a few individuals annually in the subsistence tribal fishery at Sherars Falls.

Kokanee provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex. The harvest of kokanee salmon in the subbasin lakes and reservoirs attracts many recreational anglers annually. An annual comprehensive estimate of total subbasin kokanee harvest is not available.

Historic Harvest

There are no quantitative estimates of historic sockeye salmon harvest within the subbasin. Historically most of the sockeye salmon harvest likely occurred in the Tribal subsistence fishery at Sherars Falls. There may have been some minor incidental sport harvest associated with the lower Deschutes River redband trout, steelhead and Chinook salmon fishery. However, adult sockeye salmon are not readily caught on hook and line in freshwater.

References

Allison, I.S. 1979. Pluvial Fort Rock Lake, Lake County, Oregon. Oregon Department of Geology and Mineral Industries, Special Paper Number 7.

Beaty, R.E. 1992. Changes in size and age at maturity of Columbia River upriver bright fall Chinook (*Oncorhynchus tshawytscha)*: Implications for stock fitness, commercial value, and management. MS thesis, Oregon State University, Corvallis, Oregon.

Beaty, R.E. 1995. Evaluation of Deschutes River fall Chinook salmon. Review draft Technical Report 96-1. Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. Bethesda, Maryland.

Borgerson, L.A. 1991. Scale analysis. Annual Progress Report, Fish Research Project. Oregon Department of Fish and Wildlife, Portland, Oregon.

Brun, C.V. 1999. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation, 1998 Annual Report. Bonneville Power Administration, Portland, Oregon.

Brun, C.V. and R.D. Dodson. 2001. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation, 2000 Annual Report. Bonneville Power Administration, Portland, Oregon.

Brun, C.V. A mark-recapture experiment to improve the escapement estimate for fall Chinook salmon in the Deschutes River, Oregon – 2001 Progress Report. Department of Natural Resources, Confederated Tribes of Warm Springs Reservation of Oregon. Warm Springs, Oregon.

Brun, C.V. A mark-recapture experiment to improve the escapement estimate for fall Chinook salmon in the Deschutes River, Oregon – 2002 Progress Report. Department of Natural Resources Confederated Tribes of Warm Springs Reservation of Oregon. Warm Springs, Oregon. Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 119-126 *in* Mackay, W.C., M.K. Brewin, and M. Monita, editors. Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Buchanan, D.V., M.L. Hanson and R.M. Hooton. 1997. Status of Oregon's bull trout-distribution, life history, limiting factors, management considerations and status. Oregon Department of Fish and Wildlife, Portland, Oregon.

Close D.A., M. S. Fitzpatrick, and H. W. Li. 2002. The ecological and cultural importance of a species at risk of extinction, Pacific Lamprey. Fisheries 27:19-25.

Cramer, S.P. and Beamesderfer, R.C.P. 2001. Population Dynamics, Habitat Capacity, and a Life History Simulation Model for Steelhead in the Deschutes River, Oregon. Cramer and Associates, Inc. Sandy, Oregon.

Crow, J. F. and M. Kimura. 1970. An introduction to population genetics theory. Harper and Row, New York.

Currens, K.P. 1987. Genetic differentiation of resident and anadromous rainbow trout (*Salmo gairdneri)* in the Deschutes River basin, Oregon. MS thesis. Oregon State University, Corvallis, Oregon.

Currens, K.P., C.B. Schreck, and H.W. Li. 1990 Allozyme and morphological divergence of rainbow trout above and below waterfalls in the Deschutes River, Oregon. Copeia 1990: 730-746.

Currens, K.P., Hemmimgsen, A., French, R., Buchanan, D., Schreck, C. and Li, H. 1997. Introgression and Susceptibility to Disease in a Wild Population of Rainbow Trout. North American Journal of Fisheries Management 17:1065-1078.

Engelking, M. 2002. Potential for Introduction of Myxobolus cerebralis into the Deschutes River Watershed in Central Oregon form Adult Anadromous Salmonids. American Fisheries Society Symposium 29:25-31.

Ferry, B., E. Schwartz and R. Klumph. 1979. Physical and biological stream survey North Fork Crooked River and tributaries, excluding Committee Creek and Deep Creek watersheds. Administrative Report No. 79-1. Oregon Department of Fish and Wildlife, Prineville.

Fies, T., Lewis, B., Manion, M. and Marx, S. 1996. Metolius River Subbasin Fish Management Plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

Fies, T., Lewis, B., Manion, M. and Marx, S. 1998. Upper Deschutes River Subbasin Fish Management Plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

Franklin, I. R. 1980. Evolutionary changes in small populations. Pages 135-149 in M. E.

French, R. and Pribyl, S. 2002. 2001 Mid-Columbia Fish District Annual Report. Oregon Department of Fish and Wildlife. The Dalles, Oregon.

French and Pribyl 2003. Mid-Columbia Fish District Annual Report Tables. Unpublished. Oregon Department of Fish and Wildlife, The Dalles, Oregon.

French and Pribyl 2004. Mid-Columbia Fish District Annual Report Tables. Unpublished. Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Frey, 1942. Field notes summarized in the report by Nielson (1950)

Galbreath, J.L. 1966. Timing of tributary races of Chinook salmon through the lower Columbia River based on analysis of tag recoveries. Fish Commission of Oregon Research Briefs 12(1)58-80. Portland, Oregon.

Gavin, M. 2003. Natural Resources Department, Confederated Tribes of Warm Springs Reservation of Oregon. Personal communication.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. U.S. Department of Agriculture, Forest Service, Willamette National Forest, Eugene, Oregon.

Goetz, F. 1991. Bull trout life history and habitat study. U.S. Department of Agriculture, Forest Service, Deschutes National Forest, Bend, Oregon.

Howell, P.J. and D.V. Buchanan, editors. 1992. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Huntington, C.W. 1985. Deschutes River spawning gravel study. Buell and Associates, Contract DE-AC79-BP13102, Project 83-423, Final Report, Volume I. Prepared for Bonneville Power Administration, Portland, Oregon.

Jonasson, B.C. and R.L. Lindsay. 1988. Fall Chinook salmon in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife Information Reports (Fish) 88-6, Portland, Oregon.

Kostow, K. 2002. Oregon Lampreys: Natural History Status and Analysis of Management Issues. Oregon Department of Fish and Wildlife. Portland, Oregon. Lande, R. 1995. Breeding plans for small populations, based on the dynamics of quantitative genetic variance. In *Population Management For Survival and Recovery*, Eds. J.D. Ballou, M. Gilpin, and T.J. Foose, pp. 318-340. Columbia University Press, New York.

Lindsay, R.B., R.K. Schroeder, K.R. Kenaston. Undated. Annual Progress Report, 1994. Steelhead Production Factors. Project Number F-120-R-10. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Marx, S. 2003. Upper Deschutes River Subbasin Trout Update. Personal communication. Oregon Department of Fish and Wildlife. Bend, Oregon.

Marx, S. 2003. Metolius River Bull Trout Redd Surveys 2001. Unpublished. Oregon Department of Fish and Wildlife, Bend, Oregon.

Newton, J. and Nelson, L. 1997. Lower Deschutes River resident trout population inventory. Unpublished Report. Oregon Department of Fish and Wildlife, The Dalles.

NMFS (National Marine Fisheries Service). 1999. Endangered and threatened species; threatened status for two ESUs of steelhead in Washington and Oregon. Federal Register 64: 14517-14528.

NMFS (National Marine Fisheries Service). 1999a. Updated review of the status of the Upper Willamette River and Middle Columbia River ESUs of steelhead. Memorandum of W. Stelle and W. Hogarth from M. Schieve, NMFS, Northwest Fisheries Science Center, Seattle, Washington.

Mathisen, L. 1985

Mathisen, L. 1992

Nehlsen, W. 1995. Historical salmon and steelhead runs of the upper Deschutes River and their environments. Portland General Electric Company, Hydro Licensing Department, Portland, Oregon.

ODFW, USDA Mount Hood National Forest, Ott Water Engineers, Inc., and Buell and Associates, Inc. 1985. White River Falls fish passage project, Tygh Valley, Oregon. Final Technical Report, Volumes I-III. Contract DE-A179-84BP12910, Project 83-440/450. Prepared for Bonneville Power Administration, Portland, Oregon.

ODFW 1987. United States vs. Oregon subbasin production reports. Oregon Department of Fish and Wildlife, Portland, Oregon.

ODFW 1996. Crooked River Subbasin Fish Management Plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

ODFW 1997. Lower Deschutes River Subbasin Fish Management Plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

Oosterhout, G. 1999. PasRAS: A Stochastic Simulation of Chinook and Sockeye Life Histories – Pelton Round Butte Hydroelectric Project FERC No. 2030. Decision Matrix, Inc. Canby, Oregon.

Oregon Department of Fish and Wildlife. 1987. Oregon's trout plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

ODFW 1998. Metolius River Fish Management Plan. Oregon Department of Fish and Wildlife. Bend, Oregon.

Olsen, E.A., R.B. Lindsay, W.A. Burck. 1991. Summer steelhead in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife Information Report. Oregon Department of Fish and Wildlife, Corvallis, Oregon. Unpublished draft.

Oregon Sportsmen. January 1916.

Ratliff, D.E. 1981. *Ceratomyxa shasta:* epizootiology in Chinook salmon of central Oregon. Transactions of the American Fisheries Society 1100:507-513.

Ratliff, D.E. 1983. *Ceratomyxa shasta*: longevity, distribution, timing, and abundance of the infective stage in central Oregon. Can. J. Fish. Aquatic. Science. 40: 1622-1632.

Ratliff, D.E. 1992. Bull trout investigations in the Metolius River – Lake Billy Chinook system. Pages 37-44 *in* P.J. Howell and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain Bull Trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Ratliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 *in* P.J. Howell and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain Bull Trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Ratliff, D., M. Reihle, W. Weber, A. Stuart, D. Buchanan. 1994. Bull Trout Population Summary Deschutes River Basin, Oregon. Portland General Electric Co., Madras, U.S.F.S. Sisters Ranger District, Sisters, Oregon Department of Fish and Wildlife, Bend, Prineville, and Portland. January 1994.

Ratliff, D.E., M. Riehle, W. Weber, A. Stuart, S. Thiesfeld, and D. Buchanan. 1996. Bull trout population summary Deschutes River basin, Oregon. Metolius River, Lake Billy Chinook system. Oregon Department of Fish and Wildlife, Information Report, Portland, Oregon.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S.D.A., Forest Service, Intermountain Research Station, General Technical Report INT-302. Ogden, Utah.

Schreck, C.B., H.W. Li, R.C. Hjort, and C.S. Sharpe. 1986. Stock identification of Columbia River Chinook salmon and steelhead trout. Division of Fish and Wildlife, Bonneville Power Administration, Project 83-451, Final Report, Portland, Oregon.

Schroeder, R.K. and L.H. Smith. 1989. Life History of rainbow trout and effects of angling regulations Deschutes, River, Oregon. Oregon Department of Fish and Wildlife, Information Report (Fish 89-6), Portland, Oregon.

Soule, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pages 151-170 in M. E. Soule and B. A. Wilcox, editors. Conservation biology: An evolutionary-ecological perspective. Sinauer and Associates, Sunderland, Massachusetts.

Spruell, P. and F.W. Allendorf. 1997. Nuclear DNA analysis of Oregon bull trout. Final Report to Oregon Department of Fish and Wildlife. Division of Biological Sciences, University of Montana, Missoula.

Stuart, A., Grover, D. and Thiesfeld, S. 1996. Redband Trout Investigations in the Crooked River Basin. Oregon Department of Fish and Wildlife.

Thiede, G., Kern,J., Weldon, M., Dale, A., Thiesfeld, S, and Buckman, M. 2002. Lake Billy Chinook Sockeye Salmon and Kokanee Research Study 1996 – 2000. Project Completion Report. Portland General Electric Company, Portland, Oregon.

U.S. Fish and Wildlife Service. 2002. Chapter 7, Deschutes Recovery Unit, Oregon. 62 p. *In:* U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland. Oregon.

Wallis, J. 1960. An Evaluation of the Metolius River Hatchery. Oregon Fish Commission Research Laboratory, Clackamas, Oregon. December 1960.

Wydoski, R. and Whitney, R. 1979. Inland Fishes of Washington. University of Washington Press, Seattle, Washington.

WSNFH Operational Plan. 1992-1996. U.S. Fish and Wildlife Service

Wise, T. 2003. Metolius River Bull Trout Redd Surveys 2002. Unpublished. Oregon Department of Fish and Wildlife, Bend, Oregon.

Zimmerman, C.E. and Reeves, G.H. 1999. Steelhead and rainbow trout early life history and habitat use in Deschutes River, Oregon. Portland General Electric Company. Portland, Oregon.

Personal Communications

Brun, C. Confederated Tribes of the Warm Springs, The Dalles, Oregon. Personal communication, 2003.

Curtis, L. Oregon Department of Fish and Wildlife. Oak Springs Fish Hatchery, Maupin, Oregon. Personal communication. 2003.

French, R. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Personal communication, 2003.

Gauvin, M. Confederated Tribes of the Warm Springs Reservation of Oregon. Personal communication. 2003.

Ratliff, D. Portland General Electric Co. Madras, Oregon. 2003

Rife, Daniel. U.S. Forest Service. Bend, Oregon. 2003

Environmental Conditions
Appendix II

The unique geology, hydrology and climates of the Deschutes River Subbasin create a diverse mix of habitat conditions for fish and wildlife. These populations are linked to the ecosystems in which they live and their health, individual characteristics and abundance reflect the diversity — and quality — of their environments. Fish populations, for instance, developed complex life histories through time that responded to the subbasin's considerable variation in habitat conditions. Stream flows, water temperatures, substrate characteristics and other combined attributes affected anadromous fish distribution within the subbasin and timing of migration. Wildlife population abundance and distribution also developed in response to habitat conditions. Native grasslands once covered vast areas and supported species such as sage grouse, which once occurred exclusively in this habitat. Loss of grassland habitat greatly reduced such populations. Today subbasin habitat conditions continue to influence fish and wildlife production, distribution and survival. These habitats and their attributes — as well as the aquatic and terrestrial populations they support — are affected by both natural watershed processes and human activities that influence flow, water quality, upland and riparian conditions and instream habitat.

This chapter examines how environmental conditions in the Deschutes watershed affect the subbasin's fish and wildlife populations. Building on the more general review provided in the Overview, the discussion characterizes the environmental conditions within three watershed areas: the Lower Deschutes watershed (below RM 100), Crooked River watershed, and Upper Deschutes watershed (above RM 100). It characterizes the natural watershed environments, such as geology, climate and hydrology, and the focal fish species they support. It looks at historical conditions believed to exist in the watershed at the time of European settlement in the early and mid 1800s and the unique environmental conditions existing today in major drainages of each watershed. In addition, it identifies desired future (potential/optimal) conditions in the year 2050, and examines what future conditions might be expected if no additional future actions are taken.

1. Lower Deschutes River Watershed________________

The lower Deschutes River watershed encompasses the portion of the Deschutes Watershed draining into the 100-mile reach from the Pelton Round Butte Reregulating Dam to the confluence with the Columbia River. The watershed covers approximately 2,680 square miles (1,715,200 acres).

1.1. The Lower Watershed Natural Environment

Below the Reregulating Dam, the Deschutes River enters a narrow, picturesque desert canyon ranging from 700 to 2,000 feet deep. The river's elevation drops from 1,393 feet at the dam to 160 feet at the mouth. Gradient is relatively constant along the reach, with two major drops occurring at Sherars Falls (RM 44), a vertical drop of 15 feet, and Whitehorse Rapids (RM 75), a drop of 35 feet in one mile

The watershed includes approximately 760 miles of perennial streams and 1,440 miles of intermittent streams. Major tributaries entering the Deschutes from the west side include Shitike Creek, White River and Warm Springs River. These streams drain the eastern slopes of the Cascade Mountains. Major tributaries entering the lower Deschutes from the east include Trout, Bakeoven, and Buck Hollow creeks. These tributaries drain the Ochoco Mountains and high Columbia plateau. The lower watershed contains 28 high mountain lakes (including 10 lakes within the Warm Springs reservation), 6 lower elevation lakes and small reservoirs, and numerous man-made or natural small ponds.

1.1.1. Geology, Soils and Vegetation

Much of the lower Deschutes watershed is underlain by the Columbia River Basalt group, a series of layered basalt flows that erupted primarily between 17 and 14.5 million years ago (O’Connor et al. 2003). These basalt flows extend from northwestern Oregon, north into Washington and east into Idaho. The Columbia River Basalt has preserved major ridges in the watershed and is between 1,000 and 2,000 feet thick (LDLAC 2002). Younger formations, formed between 15 and 4 million years ago, include the Simtustus, Deschutes and Dalles formations. From Lake Billy Chinook north, the Deschutes River carves through these younger formations, bordered by wide, nearly level basalt ridge tops and cutting a deep V-shaped canyons up to 1,000 feet deep. Large tributaries from the west drain the Cascade Range, while tributaries from the east drain tablelands of the Columbia River Basalt Group and the softer John Day and Clarno Formations. The lower eastside area has the highest average slope and drainage density of the entire Deschutes River watershed (O’Connor et al. 2003). Elevations in the northern watershed range from 11,240 feet at the top of Mount Hood (headwaters of White River) to 160 feet at the river’s mouth.

Soils in the watershed were formed in residuum from the weathering of bedrock and in colluvium on sloping uplands and plateaus; material transported by water and deposited as unconsolidated deposits of clay, silt, and gravel; pumice and ash from volcanic activity (Newberry Crater and Mount Mazama); and loess that has been transported by wind from other areas. In some areas, these soils are highly erodible. Erosion potentials due to water or wind range from slight (less than 2.5 tons/acre/year) to severe (5 to 15 tons/acre/year) (LDLAC 2002).

Vegetation in the lower Deschutes watershed ranges from steppe and shrub-steppe in the canyon and plateau areas, to coniferous forests in the Cascade and Ochoco mountains. Indigenous vegetation includes bunch grass, sagebrush, bitterbrush, juniper and ponderosa pine in the lower elevation canyon and plateau areas. At increasing elevations in the western and southeastern portions of the watershed, the coniferous forests transition from pine into Douglas fir and grand fir. Western hemlock and lodgepole pine are common at upper elevations of the eastern Cascades, while western red cedar and Engelmann spruce are common along the stream margins at mid to upper elevations. In some areas, non-indigenous species such as cheatgrass, Kentucky bluegrass and medusa-head wild rye have been introduced through cultivation, livestock grazing and other human activities. Riparian vegetation along the lower Deschutes is dominated by perennial grasses, with communities of sedges, rushes, emergent aquatic plants, birch, hackberry, willow, cottonwood and alder. Low elevation perennial stream corridors are similar, with mixes of vine maple, alder, and cottonwood at higher elevations.

1.1.2. Climate

The climate in the lower Deschutes River watershed ranges from transitional in westside tributary headwaters to semiarid in the mainstem canyon and on eastside uplands. While the high slopes of the Cascades often collect more than 100 inches of precipitation each year, much of the watershed lies in the rain shadow of the Cascades and receives little precipitation. Precipitation levels drop significantly from west to east. Annual precipitation in the White River drainage, for instance, ranges from more than 100 inches in the headwaters to 11 inches or less near the river's mouth (Clark 2002). Most precipitation near the Deschutes falls as rain, but there is a substantial snowfall almost every winter at higher elevations.

Drainages on the east side of the Deschutes receive substantially less precipitation. The Bakeoven Creek watershed receives 10 to 12 inches of precipitation annually (Wasco County SWCD 1994). This low rainfall is characteristic of the Intermountain Region, which receives 70-80% of its precipitation between November and March. Two types of events that produce substantial and frequently damaging runoff events in this area are heavy precipitation or rapid snowmelt on frozen soils and violent summer cloudbursts.

Air temperatures within the lower Deschutes watershed range from –10°F in the winter to over 100°F in the summer. The Dalles, located near the mouth of the Deschutes River, experiences some of the highest temperatures in the state of Oregon.

1.2. Historic Environmental Conditions

Before 1855, the lower Deschutes River displayed many of the same conditions seen today. The river flowed within a constrained channel flanked by deep canyon walls. Few side channels were present. Alder, willow, birch and some cottonwood trees dominated riparian vegetation with shrubs, grasses, sedges, rushes, and other forbs skirting the water's edge. Streamflow in the lower mainstem was generally uniform throughout the year, due to a high contribution of spring fed waters from the Metolius, Crooked (Opal Springs) and Deschutes River (Alder Springs), as well as the Upper Deschutes system. High flow events and associated bedload redistribution occurred, but were infrequent (Hosman et al. 2003). Flows from more runoff-dominated watersheds in the Crooked River and lower basin tributaries were moderated by the larger capacity of fully-vegetated floodplains, which stored and released water throughout the drier summer months and during periods of prolonged winter cold. This stable flow pattern supported healthy riparian communities, and stable streambed and channel configurations. Water temperatures in many reaches also varied less than today due to the moderating effect of upstream springs and seeps associated with sub-irrigated meadows and wetlands (CTWS 1999a).

Westside tributaries to the lower Deschutes River such as the Warm Springs River and Shitike Creek displayed highly complex and favorable riparian and channel conditions for salmonid production (CTWS 1999a). Variable habitat characteristics within constrained and unconstrained stream reaches provided a mix of single channel and multiple channel areas. Beavers created off-channel habitat and wet meadows along unconstrained reaches. Well-developed riparian corridors consisted of deciduous and coniferous trees, shrubs and grasses. Groundwater recharge from wet meadows and beaver complexes stabilized summer and low winter flows and moderated water temperatures. Thus, summer water temperatures were within optimal range for salmonid growth and survival, while cold winter flows were moderated by springs and groundwater discharge from a well developed riparian system. Large woody debris and logjams were also abundant and provided high quality fish hiding and rearing habitat. The Warm Springs River, Shitike Creek and White River delivered abundant coarse sediment to the Deschutes River valley during high flows, perhaps exceeding the gravel volume delivered from upstream (O'Conner et al. 2003a). However, the stream systems may have been more hydrologically stable than today, with well vegetated riparian areas. As today, White River transported large volumes of fine glacial sand and silt from its source on Mount Hood to the Deschutes River.

The eastside tributaries — primarily Buck Hollow, Bakeoven and Trout creeks — flowed through more arid landscapes and contained salmonid habitat that was probably close to marginal under conditions of extended drought (Lichatowich et al. 1998). The drainages received much lower precipitation than the westside drainages and soils were susceptible to erosion (O'Connor et al. 2003a). As a result, they were substantially influenced by climatic conditions. Thunderstorms caused sudden, high flows promoting more dynamic stream channel behavior and characteristics than typically found in other Deschutes tributaries. In streams where natural flows dropped to low levels during summer months, late summer water temperatures became elevated, particularly during low precipitation years. The effects of such natural disturbances were buffered by conditions in the watersheds. Bunch grass plant communities on the uplands, more developed floodplains, and well-vegetated stream corridors slowed runoff and tempered flow and water temperature fluctuations. Beaver complexes and wet meadows promoted sustained groundwater recharge. Beaver complexes also created pools that provided cool water refuge for rearing salmonids and slowed the release of sediments into the stream systems. In-channel large wood and debris dams also provided adult and juvenile cover and rearing habitat. Variable habitat characteristics existed within constrained and unconstrained stream reaches, providing both single channel and multiple channel areas. In lower gradient reaches, stream channels were sinuous and bordered by deciduous vegetation and grasses (CTWS 1999a).

1.3. Current Environmental Conditions

1.3.1. Hydrology

The lower Deschutes River displays relatively uniform flows due to the upper system's ability to collect, store and slowly release runoff as groundwater (Gannett et al. 2003). Much of the system's groundwater re-enters the Deschutes River just above the lower Deschutes watershed, creating a substantial base flow in the lower river. During an average year, 91% of the water entering the lower Deschutes River through the Reregulating Dam is from groundwater sources (Gannett et al. 2003). Flows in the lower Deschutes River have exceeded 3,200 cfs 99% of the time, but have only exceeded 9,040 cfs 1% of the time since 1965 (Huntington 1985, O'Connor et al. 2003a). The average annual discharge for the Deschutes River Subbasin is 4.2 million-acre feet, with the lower watershed contributing about 1.2 million-acre feet to this runoff. During peak events, however, runoff from the lower subbasin adds substantially to Deschutes River flow. More than 70% of the peak discharges of both the December 1964 and February 1996 flood flows in the lower Deschutes entered the river downstream of the Pelton Round Butte Complex, an area that represents only 26% of the total Deschutes watershed area (O'Connor et al. 2003).

Streamflows in lower basin tributaries reflect conditions within individual drainages. Westside tributaries, such as the White River, Warm Springs River and Shitike Creek, receive more precipitation than eastside tributaries, including more snow. Flows in these systems peak in the spring and taper off to base flows in August or September. Flows in eastside tributaries Bakeoven, Trout and Buck Hollow creeks are more variable. These streams do not develop large snowpacks, have no glacial influence, and have shallow soils leading to flashier responses to climatic conditions. Streamflows in these systems rise quickly with winter rain or snowmelt and summer rainstorms, contributing to high runoff and flow events. Flows peak in winter and early spring and rapidly diminish to low levels in summer. Stream channel behavior and characteristics are more dynamic than in most other Deschutes tributaries.

Flows have been over appropriated on several streams in the lower Deschutes watershed. Flow conditions in the lower Deschutes and its major tributaries are discussed later in more detail.

1.3.2. Water Quality

The Oregon Department of Environmental Quality has listed several reaches within the Lower Deschutes River Watershed that do not meet state standards. This list, called the 303d list, and the water bodies on it are considered to be "water quality limited". Primary parameters of concern are temperature, pH, bacteria and total dissolved oxygen (Table X). Water quality problems may also exist in other areas. Data has been collected from few sites and the list may not accurately reflect the extent of water quality problems in the Deschutes Subbasin. Water quality concerns in each major tributary are addressed in more detail later in this section.

Table X. Water Quality Limited Streams in Lower Deschutes Subbasin and Trout Subbasin (DEQ 2002 303(d) List).

STREAM SEGMENT	RIVERMILE	PARAMETER	REASON for LISTING
Lower Deschutes Subbasin			
Buck Hollow Creek	0-37.7	Temperature (Summer)	Salmonid Rearing: >64ºF
Clear Creek	0-15.1	Temperature (Summer)	Salmonid Rearing: >64ºF
Deschutes River (mouth to White River)	0-46.4	Temperature (Summer)	Salmonid Rearing: >64ºF
		Temperature (Sept 1-June 30)	Salmonid Spawning: >55°F
		pH (Summer)	pH >8.5
Deschutes River (White R to Reregulating Dam)	46.4-99.8	Temperature (Year Around)	Oregon Bull Trout: >50ºF
		Temperature (Sept 1-June 30)	Salmonid Spawning: >55°F
		Dissolved Oxygen (Sept 1-June 30)	Salmonid Spawning: <11 mg/l or<95% saturation
		pH (Winter/Spring/Fall)	pH >8.5
Gate Creek	0-14.3	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	Excessive surface fines
Oak Canyon	0-6.3	Temperature (Summer)	Salmonid Rearing: >64ºF
Rock Creek (mouth to Rock Creek Reservoir)	0-8.1	Temperature (Summer)	Salmonid Rearing: >64ºF
Rock Creek (Reservoir to FS Road 4810)	8.8-14.1	Temperature (Summer)	Salmonid Rearing: >64ºF
Rock Creek (mouth to headwaters)	0-15.9	Sedimentation	Excessive surface fines
Sixteen Canyon	0-3.7	Temperature	Salmonid Rearing: >64ºF
Tenmile Creek		Temperature (Summer)	Salmonid Rearing: >64ºF
Threemile Creek (tributary to White River)	0-11.3	Temperature (Summer)	Salmonid Rearing: >64ºF
Wapinitia Creek	0-14.4	Temperature (Summer)	Salmonid Rearing: >64ºF
White River	0-12	Temperature (Summer)	Salmonid Rearing: >64ºF
Trout Subbasin			
Auger Creek	0-6.5	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Big Log Creek	0-5.5	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Bull Creek	0-1.8	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Cartwright Creek	0-4.3	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Dick Creek	0-2.2	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High cobble embeddedness
Dutchman Creek	0-4.8	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Potlid Creek	0-5.2	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness
Tenmile Creek	0-5.9	Temperature (Summer)	Salmonid Rearing: >64ºF
		Temperature (Oct 1-June 30)	Salmonid Spawning: >55°F
Trout Creek	0-50.7	Temperature (Summer)	Salmonid Rearing: >64ºF
		Sedimentation	High substrate embeddedness

1.3.3. Land Use and Management

The entire lower Deschutes River watershed is located within the boundary of lands ceded to the United States government by the seven bands of Wasco- and Sahaptin-speaking Indians whose representatives and head men were signatories to the Treaty with the Tribes of Middle Oregon of June 25, 1855. The Warm Springs Tribes are the legal successor to the Indian signatories to the treaty. Tribal reservation and off-reservation lands comprise approximately 21% of the land area of the lower Deschutes

River watershed. Tribal lands are managed primarily for timber production, livestock grazing, and residential uses.

The watershed contains several large parcels of public land. The Forest Service manages 235 square miles in the White River watershed, or 11% of the lower Deschutes River watershed. The Ochoco National Forest manages 27 square miles of land in the headwaters of the Trout Creek drainage. The Forest Service also manages about 23 square miles of the Crooked River National Grasslands in the Trout Creek drainage. The Bureau of Land Management manages about 4% of the watershed, mostly along the lower 20 miles of Deschutes River and along White River. Major land uses on federal lands are timber management, livestock grazing and recreation. The State of Oregon manages approximately 2% of the lower Deschutes River watershed. State lands are managed for recreation, fish and wildlife needs, and livestock grazing.

Private lands make up 62% of the lower watershed, mostly in the middle and lower drainage. These lands are generally managed for agricultural and range use.
Dry land grain production and pasture, principally wheat and barley, are common in the White River watershed. Irrigated farming is generally confined to the valley bottoms along Trout, Buck Hollow, Tygh, Shitike and Badger creeks, and along lower Warm Springs and White rivers. Large tracts of irrigated cropland occur in the Agency Plains area north of Madras and smaller, scattered tracts exist in the Juniper Flat and Wamic areas east of Maupin. Several small irrigated areas border the Deschutes River between North Junction and the Reregulating Dam. Livestock grazing is common in the lower Deschutes River canyon above RM 20 and in tributaries.

The lower Deschutes watershed includes several small communities. Warm Springs (population 3,800) is located along lower Shitike Creek. Maupin (population 500) borders the Deschutes at RM 51 and the mouth of Bakeoven Creek. Other communities in the lower watershed include Tygh Valley, Wamic, Antelope, Pine Hollow, Sidwalter, Simnasho and Pine Grove.

Wild and Scenic Rivers

The lower Deschutes River has been designated for protection and enhancement of its scenic, aesthetic, natural, recreation, and fish and wildlife values.

- In 1970, the lower 100 miles of the Deschutes River were designated a component of the Oregon State Scenic Waterways system.

- In 1988, U.S. Congress designated the lower 100 miles of the Deschutes River as a recreational component of the National Wild and Scenic Rivers System.

1.4. Focal Fish Species for the Lower Deschutes Watershed

The lower Deschutes watershed supports several fish species that are the focus of this plan. These focal species include Chinook salmon (spring and fall), rainbow trout (redband and steelhead), bull trout, sockeye and lamprey. This section describes focal species use and distribution in the lower Deschutes watershed, as the fish populations are linked to both natural watershed processes and to human activities that influence water quality, riparian conditions and instream fish habitat.

1.4.1. Chinook Salmon

Spring Chinook

Two separate naturally producing spring Chinook populations are recognized in the lower Deschutes River: one in the Warm Springs River and one in Shitike Creek. Both river systems are located on the Warm Springs Reservation. There is no evidence that wild spring Chinook spawn in either the mainstem lower Deschutes River or tributaries other than the Warm Springs River or Shitike Creek.

Summer/Fall Chinook

Fall Chinook spawning and rearing is concentrated in the lower Deschutes River. Their historical range may have been similar to that seen today. There are some indications that summer run of Chinook once returned to the lower river, but have since been extirpated. Today, fall Chinook return to the Deschutes River from July through November. They hold in deep pools and runs before spawning in the Deschutes mainstem from October and through December.

1.4.2. Redband Trout

Summer Steelhead

Wild summer steelhead spawn during late winter and early spring in the lower Deschutes River, Warm Springs River system, lower White River, Shitike Creek, Skookum Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and no barriers to fish migration.

Resident Redband Trout

Wild rainbow, or redband, trout are present throughout the lower Deschutes River and most tributaries with adequate flow. Redband trout are believed to be less abundant in the Deschutes below Sherars Falls than above (Newton and Nelson 1998), and are believed to be most abundant in the reach from the Reregulating Dam to Maupin (Schroeder and Smith 1989; Zimmerman and Reeves 2000).

1.4.3 Bull Trout

Fluvial and resident populations of bull trout reside in Shitike Creek and the Warm Springs River (Brun 2000; Brun and Dotson 2001,2002). Fluvial components of these populations spawn and rear in headwater reaches and sub-adults and adults drop downstream to the Deschutes River to rear before spawning. Headwater areas in Shitike Creek and the Warm Spring River contain cold springs and heavy cover necessary for bull trout spawning and rearing.

1.4.4. Pacific Lamprey

Pacific lamprey return to the lower Deschutes and migrate into the Warm Springs River, Beaver Creek and Shitike Creek where they are believed to reproduce naturally (Personal communication with CTWS staff). Most, if not all, lamprey spawning in the lower Deschutes River watershed is assumed to occur within the boundaries of the Warm Spring Reservation.

1.5. Focal Wildlife Species in the Lower Deschutes Watershed

Natural grasslands are a historically important wildlife habitat that has almost completely disappeared in the lower Deschutes watershed. Maps of historic habitat show a large area of grassland habitat in the eastern part of the lower basin in Wasco and Sherman counties. One species formerly existing in this habitat, the Columbian sharp-tailed grouse, is no longer present in the subbasin.

[Other information will be added after focal wildlife species/habitats are identified.]

1.6. Current Conditions in Major Drainages

This section describes current environmental conditions within the major drainages of the lower Deschutes River below Pelton Dam. These drainages are: the mainstem Deschutes, mouth to the Reregulating Dam (RM 0 to 100); Buck Hollow Creek; White River; Bakeoven Creek; Warm Springs River; Trout Creek; and Shitike Creek.

1.6.1. Lower Mainstem Deschutes River, Mouth to Pelton Round Butte Complex (RM 0 to 100); excluding Buck Hollow, Bakeoven, Shitike and Trout Creeks, and the White and Warm Springs Rivers.

The lower Deschutes River flows through a low gradient channel with scattered rapids set in a deep, narrow, arid valley. Stream width averages 263 feet, and varies from 30 to 560 feet, excluding islands. Total water surface area is about 62.1 million square feet at average discharge (Aney et al. 1967). The reach provides important spawning and rearing habitat for fall chinook, summer steelhead and redband trout, and rearing habitat for spring chinook and bull trout. Salmonids also migrate through the reach as they move to and from tributary spawning and rearing grounds. The lower river is part of the federal Wild and Scenic Rivers system and is an Oregon Scenic Waterway.

Uplands
The lower Deschutes watershed displays steppe and shrub-steppe habitats in the canyon and plateau areas, and coniferous forests in the Cascade and Ochoco mountains. Lands are in public, Tribal and private ownership. They are generally managed for agriculture, range, timber harvest and recreational uses.

Riparian Areas
The lower Deschutes River is confined by canyon walls and shows many aspects of a spring-controlled system. The banks are generally lined with a narrow fringe of trees and other riparian vegetation. The channel is remarkably stable and has not shifted more than 200 feet in the last 90 years, despite impacts from two exceptionally large floods (O’Connor et al. 2003; Curran and O’Connor 2003). The growth of white alder along the river reflects the system’s stability. White alder is the dominant riparian tree along the lower Deschutes and typically lives up to 50 years. They need summer

moisture and can withstand occasional flooding, but cannot tolerate weeks of inundation (Minear 1999).

Some riparian areas along the lower Deschutes River have been degraded through land use actions, such as concentrated recreation, overgrazing, road and railroad construction/maintenance, and localized urban development. These activities reduced habitat complexity along stream margins. Riparian characteristics along some degraded reaches have improved significantly over the last 20 years because of camping and vehicle use restrictions, improved grazing management, and other recovery efforts. Reaches along the smaller Deschutes River tributaries are often sparsely vegetated and lack the woody component of a healthy riparian area.

Instream Habitat

A complex aquatic habitat — including large boulders, bedrock irregularities, rooted aquatic macrophytes, overhanging vegetation, and varying water turbulence and depth — provides diverse cover for focal species in the lower Deschutes River. Stream and island margins provide important rearing habitat and escape cover for 0-age fish. Instream habitat complexity is generally lacking in the upper section, except where habitat is associated with river rapids. Side channels associated with islands also provide important spawning and rearing habitat for salmonids. In 1995, 68% of all steelhead spawning between the Reregulating Dam and the mouth of Trout Creek occurred in side channels between islands and channel margins, despite the fact that such side channels comprise less than 10% of the channel length within the reach (Zimmerman and Ratliff 2003; Zimmerman 2000). Other good instream structure, in the form of large boulders and cobble, is associated with old landslides that may have blocked the river flow for short periods. These sites, as described by (O'Connor (2003a) include Trout Creek, White Horse, Buckskin Mary and Box Car rapids. Wood from the riparian zone, mainly dead white alders, accumulates between infrequent high water events and enhances instream habitat. Unlike most streams, large wood from tributaries does not appear to be an important habitat component in the lower Deschutes aquatic ecosystem as infrequent floods large enough to mobilize the wood from tributaries normally deposits that wood out of the wetted channel (Minear 1999). All large wood recruitment to the lower river from the upper subbasin has been blocked for nearly 50 years by the Pelton Round Butte Project.

The lower 46 miles of river substrate contains a high amount of glacial sand and silt that originates from White River, though the Deschutes River is usually capable of transporting this material (Fassnacht et al. 2003). This lower section also periodically receives heavy silt loads from tributaries during high intensity storms on rangeland and adjacent cropland. The fine sediments limit available trout spawning gravel in the lower mainstem as spawning areas often contain a high percentage of glacial sand and silt and are frequently embedded (Huntington 1995). Fine sediments also impact larger gravels used by Chinook salmon. However, the large fish are able to move and clean this substrate during spawning (Huntington 1995).

Spawning gravel for trout and steelhead is limited below White River, but scattered throughout the upper river reach. Because of stable flows, exposed gravel bars are very rare in the lower Deschutes. Mid-channel sand and gravel bars deposited during large floods generally lie only a few inches or feet above the typical annual flow range and rapidly become stabilized by riparian growth until the next significant flow (O'Connor et al. 1999). Some spawning habitat has been lost, especially in the upper portion of this reach, due to cementing of substrates and colonization by mats of rooted macrophytes between infrequent flood events. Important, although limited, habitat for steelhead is found in eastside tributaries Trout, Bakeoven and Buck Hollow creeks. It appears that steelhead use these tributaries at a much greater rate than resident redband trout (Zimmerman and Reeves 2002). Many other short, moderate gradient channels are also used by steelhead for spawning during late winter runoff events. Most reaches in eastside tributaries lack overhanging vegetation. Instream cover is often confined to large gravel, cobble and boulder substrate. High silt/sediment levels (Dry Creek) or gradient and large substrate (Frog Springs Creek) also limit spawning in some tributaries.

Flows

The hydrograph for the lower Deschutes River has not changed substantially from pre-European settlement to today (Gorman 2004). The lower river experiences only small seasonal variations in discharge because of large groundwater contributions. According to Gannett et al. (2003), of the approximately 91% of the flow of the Deschutes River at Madras that originates as groundwater, roughly half comes from discharge to the mainstem Deschutes and lower Crooked Rivers within about 16 km of their confluence. The Deschutes River itself gains about 400 cfs from groundwater inflow between Round Butte Dam and Dry Creek at RM 91.8 (about 2.5 miles below Shitike Creek) (Gannett et al. 2001). River level is also controlled by long-term weather patterns and by Pelton Round Butte Project operations. Below the Reregulating Dam, flows average 4,525 cfs, with maximum monthly averages from January through April of 9,000-9,500 cfs. Low flows of 3,000 to 3,800 cfs may occur in any month, though the lowest flows (ranging from 3,015-3,059 cfs) occur in July, August and September. Mean annual flow near the confluence with the Columbia River (Moody gage) averages 5,739 cfs and ranges from 4,290 to 7,380 cfs. Maximum flows generally occur from January through March and minimum flows between July and October. The two largest flood peaks of record occurred in 1964 (instantaneous flow of 67,300 cfs) and in 1996 (instantaneous flow of 70,300 cfs). Water is withdrawn from the lower Deschutes River for limited irrigation, municipal and industrial uses. Flows from tributaries to the lower Deschutes contribute significantly to peak flows in the mainstem Deschutes River (O'Connor et al. 2003a).

Water Quality

High stream temperatures are a problem in some reaches. Summer water temperatures in the lower Deschutes below White River exceed the 64°F temperature standard for salmonid rearing and the 55°F temperature standard for salmonid spawning. Between the White River and the Reregulating Dam, water temperatures frequently exceed the state water quality standards for bull trout (50°F) and salmonid spawning (55°F) (Table X). Changes in water temperature can alter growth rates and development of salmonid eggs, fry and juvenile fish.

Dissolved oxygen and pH levels exceed ODEQ standards in some lower river reaches. Dissolved oxygen levels in the Deschutes River from White River to the Reregulating Dam fall below the Oregon Department of Environmental Quality's 90% saturation standard during spawning (September 1 through June 30). Measurements taken by PGE biologists (1998) indicate that ambient dissolved oxygen levels fall to 70-75% of saturation, or approximately 7.5-8.0 milligrams per liter in early morning hours during late-summer and early autumn (Lewis and Raymond 2000). Maximum dissolved oxygen levels during this time were approximately 85% saturation, or around 8.6-8.8 milligrams per liter. State and Tribal dissolved oxygen standards require 11 mg/l or 95% saturation for these waters during spawning. The lowered level of dissolved oxygen could impact the development of incubating fish eggs or later life stage development. Intergravel dissolved oxygen levels may reach lethal levels during Chinook salmon egg incubation. In addition, pH levels for the lower Deschutes River exceed ODEQ's statewide pH standard 23% of the time at the river mouth and 11% of the time at Highway 26 (RM 96) (DEQ 2002 303(d) List).

Water turbidity levels rise in the lower Deschutes due to natural discharge of glacial sediments from White River. Turbidity occasionally affects fish production, particularly since juvenile fishes are sight feeders. Meehan (1982) reported that suspended sediment in excess of 50 NTU at water temperatures above 41°F generally reduces feeding success, growth, and competitive ability. Chronically turbid waters, particularly during the spring, can substantially reduce growth of fish fry. Turbidity can also cause physical discomfort or injury to fish, depending upon the concentration and the duration of exposure. High stream flow, combined with elevated turbidity, interferes with the fishes natural abilities to detect and avoid predators.

ODEQ has issued four NPDES permits for this stretch of the river. The City of Maupin discharges treated effluent from their wastewater treatment plant into the Deschutes River. ODFW has three fish hatcheries, which have permits to discharge to the Deschutes River (Lamb 2004).

1.6.2. Buck Hollow Creek

Buck Hollow Creek drains 126,800 acres, with elevations ranging from 680 feet at the mouth to 3,325 feet in the headwaters. The creek extends 36.3 miles from its confluence with tributary Thorn Hollow Creek to where it enters the Deschutes River at RM 43, just below Sherars Falls. The creek supports steelhead and redband trout.

Uplands
About 95% of the Buck Hollow Creek watershed is in private ownership. Primary land uses include range (52%), cropland (19%), Conservation Reserve Program (26%), and roads and urban (3%) (CTWS 1999a). There is one surface water right in the watershed, 0.57 cfs for irrigation of 34 acres (LDLAC 2002). Loss of watershed retention through intensive grazing by sheep and cattle at the turn of the century and changes in upland cover due to cultivation have reduced the watershed's ability to buffer high runoff events. Upland conditions are improving due to changes in land management and restoration efforts over the last 15 years.

Riparian Areas
Riparian areas along Buck Hollow Creek have been heavily impacted by overgrazing, wild fires and catastrophic flooding for the last century. As a result, some reaches of Buck Hollow Creek and its tributaries have incised into the valley floor. In other areas, lateral scour has produced channels that are wide relative to depth, have little or no bank structure or stability, and have very little shade (ODFW 1992). Some reaches lack riparian trees. Sparsely vegetated stream channels, particularly above Finnegan Canyon, are prone to icing and subsequent erosion during occasional prolonged cold periods. Livestock exclosures and new grazing strategies are improving riparian and floodplain conditions in some reaches.

Instream Habitat
Aquatic production in Buck Hollow Creek is limited by the presence of wide, shallow or braided channels that hinder adult fish passage into the upper watershed during low flow conditions. Instream cover is generally lacking, except for small pockets of cobble and boulder (28%). The watershed contains only a small number of scattered pools that provide limited holding and summer rearing habitat. Large woody material is lacking and overhanging vegetation is infrequent. The creek is a gravel-rich system (comprising 46% of the substrate) and sediment from uplands and eroded streambanks appears to be routinely flushed from the system, which prevents severe degradation of salmonid spawning habitat in the system.

Flows
Flows in Buck Hollow Creek are heavily influenced by runoff patterns. Average discharge ranges from as high as 95 cfs in April to as low as 2 cfs from July through October. High flows occur during winter rainstorms, snowmelt, and summer thunderstorms. Low flows occur during extended cold winter periods and from mid-summer to late fall. Tributary flows are frequently intermittent during summer and fall months. The creek is subject to flash flooding during rapid snowmelt or during high intensity summer storms.

Water Quality
Buck Hollow is included on ODEQ's 2002 303(d) list for not meeting the temperature standard for salmonid rearing (64°F) during summer based on BLM data collected at 3 locations along the creek (Lamb 2004). High summer water temperatures commonly exceed 75°F, except in areas of cool water refugia where seeps and springs enter the channel.

1.6.3. White River

White River begins on the White River Glacier on Mount Hood and flows southeast to join the Deschutes River just upstream of Sherar's Falls at RM 47.5. The watershed covers 368 square miles, with elevations ranging from 11,240 feet on Mount Hood to 789 feet at the river mouth. Major tributaries to the White River include Clear, Boulder, Threemile and Tygh creeks. White River Falls, a series of three drops totaling 180 feet, is located two miles above the river's mouth. White River was designated as a National Wild and Scenic River in 1988. The river is designated as recreational, except for a stretch designated as scenic between the mouths of Deep Creek and Threemile Creek.

The lower two miles of White River provide spawning and rearing habitat for resident redband trout and summer steelhead. The drainage contains 217 miles of spawning and rearing habitat for redband trout, which is present in most major creeks and many smaller tributaries. White River Falls prevents anadromous fish access to the rest of the watershed, and isolates populations of redband trout and other resident fish above the falls from those downstream. As a result, areas of upper Rock Creek, Gate, Jordan and Threemile creeks have retained genetic integrity of endemic redband trout (USFS 1995b).

Uplands
More than half the White River watershed is in public ownership. The Forest Service is the largest landowner, with Mt Hood National Forest lands extending over higher elevations in the western half of the watershed and including the headwaters of White

River, Clear Creek, Boulder Creek, Gate Creek, Rock Creek, Badger Creek, Threemile Creek, Tygh Creek and Jordan Creek. The White River Wildlife Area, owned by ODFW, covers a narrow band just outside of the National Forest. The Warm Springs Tribes own most land within the reservation boundaries. The Bureau of Land Management owns sections of land, mostly within the White River Canyon.

Many different vegetative zones exist between the river's mouth and its source, a straight-line distance of less than 20 miles. These zones include one of only two Oregon White Oak plant communities east of the Cascades, which transitions into the conifer forest. The watershed supports timber, grazing and farm uses. Forest lands cover about 188,000 acres in the watershed, with current timber practices emphasizing management for "sustainability" of natural resources. Rangelands represent about 90,000 acres and include both public and private lands. Agricultural lands cover about 47,500 acres in the watershed, with about 38,500 acres non-irrigated as the watershed receives less than 20 inches of precipitation annually. Irrigated farmlands comprise 8,640 acres and orchards 350 acres (Lamson and Clark 2003). Approximately 4,490 acres are included in the Conservation Reserve Program or have been converted to pasture grasses (Clark 2004).

Riparian Areas

Overall riparian condition in the upper White River watershed is good — with diverse vegetation, some wide floodplains, and scattered wetlands and meadows — though some areas have been degraded through forest practices. Riparian vegetative condition declines in the middle White River watershed, primarily because of forest fire and, in some cases, forest practices and overgrazing. Riparian conditions in the Tygh and Threemile stream systems have been degraded, mainly due to agricultural, range and forest practices. Riparian areas in the lower watershed remain in fairly good condition, except in isolated areas within the narrow basalt canyon where steep walls and flashy flows limit vegetative growth. A band of mature cottonwood borders the river above White River Falls.

Instream Habitat

White River carries considerable glacial silts and sands. The river cuts through old mudflows and glacial deposits and is often unstable, particularly in the upper reaches. More than 20 miles of braided channel flow out of the White River Glacier (Lamson and Clark 2003). The fine sand and sediments from the glacier are deposited in slack water areas and affect spawning gravels all the way to the mouth.

Streams that don't drain the glacier contain better instream habitat conditions, though lack of habitat complexity and large wood limits instream habitat condition in Tygh Creek and other drainages. Fine sediment associated with land use practices also reduced instream habitat quality in some reaches.

The White River subbasin contains a number of barriers to fish movement including natural waterfalls, road culverts, dewatered stream reaches, diversion structures and impassable dams at large storage impoundments. Most water diversions in the system are unscreened.

Flows

Flows in White River are heavily influenced by snowmelt and glacial runoff. They peak during periods of runoff in winter and spring, and diminish as the summer progresses.

Mean low and high river discharges into the Deschutes River are approximately 100 cfs and 1,500 cfs, respectively (Heller et al. 1983). Naturally low flows in the system are further reduced by spring-fall irrigation diversions and winter-spring reservoir storage. Irrigation water is generally supplied by diversions from White River tributaries. The lowest flow recorded at White River Falls was 66 cfs in January 1979, followed by 68 cfs in September 1977 (Lamson and Clark 2003).

A study conducted by Huntington (1985) indicated that from 1925 through 1963 river flows peaked during April and May. The peak discharge has now shifted to January and February. This shift in runoff timing — also seen in other lower Deschutes tributaries — may reflect changes in precipitation patterns or changes in natural water storage from land use practices (Huntington 1985). The flow pattern change in White River may partially reflect increased timber harvest, which caused snow to melt more rapidly than it did historically under a closed tree canopy. Runoff in other White River drainages — such as Tygh/Jordan Creek, Threemile Creek and the Oak Springs/Maupin area — increased with the introduction of dryland agriculture and other changes (Lamson and Clark 2003). Runoff rates from dryland agriculture are dependent on management techniques, particularly crop rotation and tillage methods.

Water Quality

Water temperatures in lower White River and several tributaries often exceed the 64°F standard for salmonid rearing during summer months. Stream reaches on the State's 303(d) list for not meeting water quality standards for stream temperature include Clear Creek (mouth to RM 15.1), Gate Creek (mouth to RM 14.3), Rock Creek (mouth to RM 8.1 and RM 8.8 to 14.1), Threemile Creek (mouth to RM 11.3) and White River (mouth to RM 12).

Turbidity associated with glacial silt and rock flour reduces water quality in the White River system. Suspended sediment loads in the upper White River peak in September and October when White River Glacier experiences rapid melting. Coarse sediment transport (sand and small gravel) in lower White River rises in November and December (59,422 tons/month) as stream flows increase with rainfall (ODFW 1997). Stream reaches on the State's 303(d) list for sediment concerns include Gate Creek (mouth to RM 14.3) and Rock Creek (mouth to RM 15.9).

1.6.4. Bakeoven Creek

Bakeoven Creek drains 146 square miles extending from 3,487 feet at Bakeoven Summit to 870 feet at its confluence with the Deschutes River at Maupin, RM 51. Summer steelhead and redband trout spawn and rear throughout the stream system when flows are sufficient to provide access.

Uplands

Steppe and shrub steppe cover much of the Bakeoven Creek watershed, which is sharply dissected with deeply entrenched drainage systems. Valleys of Bakeoven Creek and its major tributaries are relatively narrow and confined by steep, high canyon walls with slopes of 30-70% (Wasco County SWCD 1994). Private lands cover about 96% of watershed, with about 83% used as rangeland and 15% as cropland. About 8,512 acres of cropland are currently enrolled in the Conservation Reserve Program. There are no urban areas in the watershed.

The Bakeoven Creek watershed receives 10-12 inches of precipitation each year and about 80% of the precipitation falls during winter. Soils are often highly susceptible to erosion. Human activities have changed the vegetative community and reduced the watershed's ability to buffer high runoff events. Consequently, the watershed responds quickly to snowmelt and precipitation, and displays a reduced ability to capture, store and safely release water over an extended period of time. The system is vulnerable to flash flooding (Wasco County SWCD 1994).

Riparian Areas

Bakeoven Creek is confined by a narrow V-shaped canyon in some reaches and unconfined, broader valley areas in other reaches. Riparian vegetation includes dense young groves of white alder, juniper, sagebrush, grass, cheatgrass, and willow. Scattered cottonwood and pine line upper reaches (ODFW 1995). Riparian conditions in the watershed were degraded from overgrazing and catastrophic flooding, but are beginning to recover in some reaches because of new livestock grazing strategies. Conditions are considered poor along 59% of Bakeoven Creek, 49.4% of Deep Creek, and 92.3% of Robin Creek (Wasco County SWCD 1994). The generally wide shallow stream channels with sparse riparian cover are prone to icing and corresponding fish loss during prolonged cold periods.

Instream Habitat

The unstable stream channel moves laterally across the valley bottom during high flow events. Intense runoff events have scoured out long reaches of the creek, removed large woody debris, and caused erosion and siltation of pools (CTWS 1999a). During summer flow conditions, the stream channel habitat types include scour pool (13.7%), backwater pools (1.1%), glide (14.5%), riffle (34.8%), rapid (7.9%), cascade (4.8%), step (0.4%) and dry channel (22.6%) (ODFW 1995). Consequently, instream cover is generally lacking, except for the limited quantities of cobble and boulder (28%). Isolated deep pools provide the best over summer habitat for adult and juvenile fish. Fish are often concentrated in these pools with little or no habitat complexity, which exposes them to serious predation.

Flows

High peak flows occur during runoff events and low base flows during the summer months. Stream flow is generally perennial in the upper reaches of Bakeoven Creek and in Deep Creek and intermittent in much of the lower main stream. Most tributaries to Bakeoven Creek are now intermittent (Wasco County SWCD 1994). No active surface water irrigation withdrawals remove water from this stream system, though the watershed contains several large irrigation wells.

Water Quality

Water quality problem areas in the Bakeoven Creek watershed include Bakeoven Creek (mouth to Deep Creek), Salt Creek, Robin Creek and Deep Creek (Wasco County SWCD 1994). The 64°F salmonid rearing temperature standard in the creek is typically exceeded during summer months, except in areas of cool water refugia. Problems in Bakeoven Creek include turbidity, low dissolved oxygen, nutrients, sedimentation, thermal extremes, streambank erosion, low flow (deceased stream flow) and insufficient stream structure. These problems are associated with surface erosion, elimination of thermal cover, and vegetation removal (Wasco County SWCD 1994).

1.6.5. Warm Springs River

The Warm Springs River watershed covers 526 square miles, reaching in elevation from 3,775 feet on the east slope of the Cascades to 1,230 feet at its confluence with the Deschutes River at RM 84. The watershed lies within the Warm Springs Reservation and is managed by the Warm Springs Tribes. The Warm Springs River extends 53 miles in length and provides about 41 miles of anadromous fish habitat, including for spring Chinook. Two major tributaries, Mill Creek and Beaver Creek, also provide anadromous fish habitat.

Uplands

Headwaters in the Warm Springs watershed were historically densely forested, but now are a combination of recently harvested clearcuts, new regeneration, and old or second growth forests. Middle and lower parts of the watershed are more arid. The lower Warm Springs has incised a significant canyon that reaches as deep as the Deschutes River canyon where the two rivers join.

The Warm Springs Tribes have rated watershed stability on the Warm Springs drainage based on findings from a Cumulative Impact Analysis of watersheds on the reservation. The analysis assessed watershed stability and capacity to recover from planned management activities. During the analysis, the Tribes compared current conditions with threshold values using cumulative runoff acreage (CRA), which measures the percentage of compacted soil, bare ground and other impacts of management. Most watershed areas have a CRA threshold value of 25%, but those containing highly erosive soils have a threshold value of 20%. The Warm Springs Tribes determined that Coyote Creek had a current CRA value of 29.8% compared to a threshold value of 20%, and Quartz Creek had a current CRA value of 26.6% compared to a threshold value of 20%. Based on these findings they rated watershed stability in the Quartz and Coyote creek drainages as very poor to fair (CTWS 1999b). They are taking action to mitigate conditions in degraded areas.

Riparian Areas

There has been a slight to moderate loss of riparian vegetation or vegetative species diversity within the Warm Springs drainage, as well as a loss of proper floodplain function. Many stream reaches remain in good to excellent condition, with overall conditions improving as land management practices improve. The greatest losses of habitat quality have occurred along the lower river, although timber harvest and overgrazing have degraded localized areas in the upper watershed. Channel incision has occurred on the Warm Springs River near Ka-Nee-Ta Resort, on Beaver Creek below Quartz Creek, and in the Quartz and Coyote Creek systems. Channel alterations and stream bank armoring in the Ka-Nee-Ta Resort area has impacted two to three miles of riparian and floodplain lands along lower Warm Springs River.

Instream Habitat

The Warm Springs River’s boulder/cobble substrate floor creates good rearing habitat for salmonids. Spawning gravel abundance is likely below historic levels as the volume of large wood in the channel has declined due to riparian area degradation, timber harvest and other human activities. Loss of instream wood often reduces spawning gravel availability as large wood plays a critical role in trapping and storing spawning gravel in river and stream ecosystems (Weldon 2004). The fine sediment content in spawning gravels is also a concern. Instream channel structure and complexity has been lost due to flashier flow regimes, channel simplification, and land use management, particularly in the Warm Spring River's lower reaches.

Flows

Snowmelt dominates runoff in the Warm Springs River and causes flows to peak in the spring, taper off throughout the summer, and drop to base flows in August or September. The river maintains a mean annual flow of 425 cfs. Recorded flows range from 149 cfs to 24,800 cfs. Only limited amounts of water are used for irrigation (CTWS 1999a).

Flow regimes in the Warm Springs River drainage have changed because of the cumulative effects of watershed management activities and channel incision. The stream system now exhibits earlier peak flows, higher peak flows and lower low flows than it did historically (Huntington 1985).

Water Quality

Water temperatures often exceed 70°F through mid to late summer in lower Warm Springs River and are above the suitable range for cold water fish. In addition, the river exhibits excessive sediment loads, primarily due to runoff from several lower Warm Springs tributaries with poor riparian conditions. Two Beaver Creek tributaries, Coyote and Quartz creeks, occasionally contribute significant turbidity to the Warm Springs and Deschutes rivers. Turbidity in Coyote and Quartz creeks averages 32.9 NTU and 35.3 NTU, respectively. A normal measure of turbidity would be less than 5 NTU unless the stream is subject to glacial runoff (CTWS 1999b).

1.6.6. Trout Creek

Trout Creek drains 697 square miles and extends about 51 miles in length from its headwaters in the Ochoco Mountains to its confluence with the lower Deschutes River at RM 87, six miles west of the community of Willowdale. Elevations in the drainage range from 5,940 feet to 1,280 feet. The drainage includes 115.5 miles of perennial streams and 41.2 miles of intermittent streams, with about 113 miles currently supporting summer steelhead production. The watershed once supported healthy steelhead and, potentially, spring Chinook salmon runs, but salmonid production in the Trout Creek watershed is now far below historic levels.

Uplands

Rangelands dominate the Trout Creek watershed, covering about 86% of the drainage. Forestlands cover about 12% of the watershed and lie primarily in the headwaters of Trout Creek, which drain the forests of the Ochoco Mountain Range. Remaining lands are used for agricultural production (1.5%) and residential/urban uses. Principal industries are livestock, timber production and recreation. Primary population centers within the watershed include Antelope and Ashwood.

Intense grazing at the beginning of the last century changed vegetation patterns throughout the watershed, as well as natural watershed processes and habitat characteristics. Soils in the drainage are often highly susceptible to erosion and the general loss of watershed retention capabilities as a result of overgrazing and other human activities reduced the watershed's ability to buffer high runoff events. Consequently, the watershed responds quickly to snowmelt and precipitation, and displays a reduced ability to capture, store and safely release water over an extended period of time. The system is vulnerable to flash flooding. Rangelands and riparian vegetation are slowly improving because of improved management practices.

Riparian Areas

Riparian areas in the Trout Creek watershed have generally been impacted by overgrazing, periodic wild fires and catastrophic flooding for the last century. Today, many streambanks and most riparian areas are in low ecological condition (MDLAC 2001). Currently, about 31% of the riparian areas are in satisfactory condition (Runyon et al. 2002). Increased runoff peaks have overloaded and exceeded the capacity of the natural floodplains in some places. Flood control berms appear to be a key constraint to riparian condition. Willow and alder occupy less than 25% of the stream margin along lower Trout Creek (Runyon et al. 2002). In other areas, riparian condition has been impacted by overgrazing, agricultural practices and other uses. Wide, shallow stream channels with sparse riparian vegetation are prone to icing and corresponding fish loss during prolonged cold periods. Studies suggest that the Mudsprings Creek drainage has the lowest portion (10%) of riparian areas in satisfactory condition in the Trout Creek watershed (Runyon et al. 2002). The upper Trout Creek watershed appears to have the largest proportion of riparian stands in satisfactory condition.

For the last 15 years, Trout Creek has been part of an intensive fish habitat restoration program funded in part by the Oregon Department of Fish and Wildlife and Bonneville Power Administration. Landowners in the watershed have also voluntarily undertaken many projects to improve the watershed’s health, with assistance from the Trout Creek Watershed Council and the Jefferson County SWCD. Livestock management and other strategies appear to be effective in enhancing riparian conditions in several parts of the Trout Creek watershed.

Instream Habitat

Lower Trout Creek flows slowly through a wide alluvial valley where the stream channel was historically unstable and moved laterally across the valley bottom. This natural channel instability was restricted when most of central and lower Trout Creek was diked following the large flood of December 1964. These dikes have significantly affected channel continuity. Channels were isolated from their floodplains, riparian vegetation removed, side channels cut-off, and some channels straightened. These actions altered stream flow velocities, sediment movement and deposition, and generally reduced bed morphology and diversity of aquatic habitat (WPN 2002a). The Army Corps of Engineers plans to modify the dikes within the next few years to improve geomorphic processes (MDLAC 2001).

The upper watershed above Amity Creek contains the largest amount of high quality fish habitat in the Trout Creek watershed. Instream and overhead cover are lacking in most of the watershed and infrequent, shallow pools and low quantity of woody cover provide much of the fish habitat. Stream cover is generally confined to large gravel, cobble and boulder substrate. Spawning and incubating habitat have been deteriorated by elevated fine sediment inputs that filled interstitial spaces in the stream substrate. Lack of high quality spawning area is a prime factor limiting fish production in the watershed. At low or intermittent flows, fish are vulnerable to harassment and predation. Physical barriers, such as irrigation dams and road culverts restrict fish from volitional movement and using connective habitats during critical periods of their life history (CTWS 1999a).

Significant amounts of channel network in several major tributaries — including Antelope, Mudsprings, and Hay creeks — have been channelized or blocked, limiting instream and overhanging cover in these streams. As a result, several lower Trout Creek tributaries, including the Wilson/Hay Creek complex, are no longer accessible to steelhead. Pony Creek no longer has a functional channel connection to Trout Creek because of past agricultural development. Mud Springs Creek supports steelhead only in the area downstream from the Burlington Northern / Santa Fe Railroad Crossing (CTWS 1999a).

Flows

Streamflows in Trout Creek follow seasonal precipitation patterns. They peak in winter and early spring with runoff, and rapidly drop to low levels in summer. Low summer flows in Trout Creek drop further with irrigation diversions. Presently consumptive use of water for irrigation exceeds the estimated volumes of natural stream flow during the summer months in all drainages within the Trout Creek watershed (WPN 2002a). These withdrawals contribute to an inability to meet instream water rights in the areas where they have been established. Analysis by Watershed Professionals Network (2002) found that consumptive water use plus storage exceeds the estimated volume of natural stream flow at the mouth of Trout Creek in the months of June through October in both average (50% exceedance flows) and dry (80% exceedance flows) years. Streamflows in Trout Creek below Amity Creek often average below 1 cfs and sometimes fall to zero during the hot months of August and September (Gorman 2004), During dry years, flows have also fallen below 1 cfs from May through December (WPN 2002a).

Flow fluctuations in Trout Creek are now larger than they were historically. The NRCS estimates that current peak flows in some stream segments are two to three times greater than under presettlement conditions (Jefferson County SWCD 1996). Loss of vegetative cover, decrease in number and size of beaver dams, channel down cutting and channelization, loss of wet meadows and other wetlands appear to be factors responsible for changes in flow patterns, and for moving some reaches of Trout Creek from a perennial to an intermittent flow condition (WPN 2002a).

Mud Springs Creek exhibits an unusually constant hydrograph compared to most other streams in the drainage. Flows in Mud Springs Creek generally vary no more than 10 cfs in any season and provide nearly 10 cfs naturally, suggesting that the system is spring-fed. Outflow from Mud Springs Creek — combined with Agency Plains seasonal irrigation tailwater carried by Mud Springs Creek and Sagebrush Creek, a tributary to Mud Springs Creek — provides most of the summer/fall flow in lower three miles of Trout Creek, with little contribution from the upper watershed (WPN 2002). The Oregon Water Resources Department has operated gaging stations on Mud Springs Creek and Trout Creek below Mud Springs Creek since 1999 and will provide data for analyzing the contribution of this unusual spring dominated tributary (Gorman 2004).

Water Quality

Significant portions of the Trout Creek drainage have been identified as water quality limited stream segments. The entire length of Trout Creek and a number of tributaries (Auger, Big Log, Bull Cartwright, Dick, Dutchman and Potlid creeks) are listed as water quality limited because they exceed the criteria for temperature, habitat modification and sedimentation (ODEQ 2002). By late May, water temperatures in Trout Creek often exceed the DEQ 303(d) limit of 64° F. Temperatures often remain above the recommended level through October.

1.6.7. Shitike Creek

The Shitike Creek watershed covers 76 square miles, ranging in elevation from 5,280 feet in the Cascades to 1,476 feet at its confluence with the Deschutes River (RM 97). The drainages lies within the Warm Springs Reservation. Lower Shitike Creek flows through the community of Warm Springs. The stream extends about 30 miles and provides about 25.7 miles of anadromous fish habitat.

Uplands
The headwaters of Shitike Creek are heavily forested, though the river drops into a more arid environment once it leaves its headwaters. Forest and range management practices have reduced the watershed's ability to capture and slowly release precipitation. The Warm Springs Tribes have rated watershed stability in the drainage as good to very good, with the highest stability in the upper drainage (CTWS 1999b).

Riparian Areas
Many reaches of Shitike Creek remain in good to excellent condition, with overall conditions improving as land management practices improve. Stream channels are generally stable with complex riparian vegetative corridors and good species diversity. One of the largest remaining stands of old growth cottonwood in the area frames the lower six miles of Shitike Creek. Areas with the greatest losses of quality habitat are located on Shitike Creek below RM 5 and in intermittent tributaries, though timber harvest and heavy livestock grazing have degraded localized areas in the upper watershed. Floodplain function has declined substantially along parts of Shitike Creek below RM 4.

Instream Habitat
Shitike Creek's boulder/cobble substrate creates good spawning and rearing habitat for anadromous and resident fish. Spawning gravel abundance, however, is likely below historic levels as the volume of large wood in the channel — which plays a critical role in trapping and storing spawning gravel — has declined due to riparian area degradation, timber harvest and other human activities (Weldon 2004).There has also been a slight to moderate loss of in-channel habitat complexity in the Shitike Creek drainage because of stream channel simplification associated with urban, industrial and transportation activities, and reduced instream structure and cover. Habitat loss is likely most significant in the lower five miles of Shitike Creek, from the mouth to the Head Works. Since the 1920s and 1930s, this section of Shitike Creek has been straightened and channelized, resulting in the disconnection of the stream from its floodplain, a reduction in channel length (sinuosity), increased channel gradient/velocities, loss of side channels and back water habitat, increased sediment movement (Weldon 2004). This has altered channel bed morphology and reduced fish habitat diversity substantially from natural conditions.

Flows
Snowmelt dominated runoff in Shitike Creek causes flows to peak in spring, taper off through summer, and drop to base flows in August or September. The watershed exhibits an altered hydrograph, with earlier peak flows, higher peaks, and lower low flows than occurred under natural conditions. It contributes a mean annual flow of 93.3 cfs to the Deschutes River. Recorded flows in Shitike Creek have ranged from as low as 17 cfs to as high as 4,500 cfs.

Water Quality
Water quality is generally considered good in Shitike Creek, though lower reaches exhibit elevated water temperatures exceeding 70°F through mid to late summer. Water quality degradation occurs periodically due to municipal waste spill/discharge or sedimentation associated with forest practices and range or road network runoff. Intermittent tributaries contribute turbidity and sediment loads to Shitike Creek during high intensity storms.

1.6.8. Summary of Current Conditions in the Lower Deschutes Watershed

While the lower mainstem is relatively stable, the ecosystem as a whole displays strong environmental gradients that influence the salmonids community (Lichatowich et al. 1998; Zimmerman and Ratliff 2003). Habitat in the lower reaches of the mainstem, for example, is influenced by increasing water temperature, pH and from sediment originating in White River. Tributary habitats differ from the mainstem in several obvious ways (flow, temperature stability), and from each other, with habitat conditions within east side tributaries differing from those within streams entering from the west side (LIchatowich et al. 1998).

The lower Deschutes River continues to recover from the February 1996 flood when island and bank erosion occurred in isolated areas. Damage to the riparian vegetative corridor increased in a downstream progression. However, riparian recovery is occurring in many areas throughout the canyon. The flood mobilized bedload from the mouth of Shitike Creek (RM 97) downstream and likely helped to clean and redistribute spawning gravel within the river. Rooted aquatic vegetation that has been spreading over historic Chinook salmon spawning areas upstream from Shitike Creek did not appear to be impacted by the higher flow (Newton 2004).

Stream habitat conditions have generally been improving on many of this area's streams. This improvement has been generated by a number of stream habitat and watershed habitat restoration programs. Many programs have involved cooperative efforts by private landowners and state and federal resource agencies, and the Warm Springs Tribes. All irrigation withdrawal points on anadromous fish streams have been screened to protect fish loss. Screening is also being installed on some diversions from resident fish streams. Water quality deficiencies, including temperature, DO, pH and turbidity are now regularly monitored.

Upland watershed improvement projects have been emphasized by recently developed agricultural watershed management plans. Implementation of conservation management farming practices and the Conservation Reserve Program have retarded storm run-off and reduced sediment delivery to streams. Aggressive juniper control/removal projects have also resulted in improved vegetative ground cover.

2. Crooked River Watershed

The Crooked River watershed is the largest eastside tributary to the Deschutes River. The watershed covers approximately 4,500 square miles (2.9 million acres), stretching west from the Maury and Ochoco mountain ranges to its confluence with the Deschutes River at Lake Billy Chinook (RM 114).

2.1 The Crooked Watershed Natural Environment

The Crooked River flows east to west from its headwaters in the North Fork Crooked River, South Fork Crooked River and Beaver Creek systems. These major tributaries drain the Ochoco Mountains, which are the major range in the basin and a western extension of the Blue Mountains, and the Maury Mountains, a small mountain range to the south of the Ochoco Mountains that is entirely drained by Crooked River tributaries. Watershed elevations range from 7,162 feet on Snow Mountain to 1,945 feet at the river's confluence with the Deschutes in Lake Billy Chinook.

The Crooked River system includes 9,548 miles of stream and rivers and carries an average flow of 1,562 cfs by the time it reaches Lake Billy Chinook. Most of this flow originates from large springs in the lower river canyon near Lake Billy Chinook. Major tributaries to the Crooked River include Ochoco and McKay creeks in the lower watershed and the North Fork, South Fork and Beaver Creek in the upper watershed.

2.1.1. Geology, Soils and Vegetation

The Crooked River watershed is underlain by a variety of geologic and topographic characteristics, but the main Ochoco Mountains are formed primarily of the John Day and Clarno formations. These formations are composed of weathered lava flows and poorly consolidated claystone, siltstone, and volcanic ashflow tuff deposited between 55 and 20 million years ago. The John Day and Clarno formations are susceptible to landsliding, and almost all of the landslides in the Deschutes Subbasin are within these units (O'Connor et al 2003).

Three different ecological provinces make up the watershed. These ecological provinces — the John Day province, Mazama province and High Desert province — are based on broad soil/plant relationships determined from a combination of geologic and ecological features. Primary characteristics of the three provinces are identified below based on descriptions presented in the Crooked River Watershed Assessment (Whitman 2002).

- **John Day Ecological Province:** Most of the drainage is located within this ecological province, including the entire upper Crooked River watershed, and most of the lower Crooked River and the Beaver and South Fork watersheds. The John Day province is characterized by extensive geologically eroded, steeply dissected hills of thick, ancient sedimentary materials interspersed with buttes and plateaus capped with basalt or tuffaceous rock.

  Soils within the province are generally finely textured and sticky when wet. They are highly susceptible to precipitation-driven erosion. The dominant land use is the production of livestock and livestock forage. The area was once heavily covered with perennial grasses, but these grasses and the soil qualities they supported have been lost. Soil erosion is currently a problem within much of the province.

- **Mazama Ecological Province:** The southwestern drainage is located in the Mazama ecological province, which is covered by a continuous mantle of pumice and other volcanic material deposits distributed when Mt. Mazama exploded about 6,500 years ago. Communities include Powell Butte, Brothers, Millican, Terrebonne, and the eastern portions of Redmond's urban growth boundary.

  Soils in the Mazama Province have developed in combinations of pumice and volcanic ash overlying basaltic bedrock or ancient soils at a depth from 10 inches to 15 feet. Thick deposits of pumice or pumice overlying loamy soil characterize upland soils. Low lying area soils include deep, coarse, gravelly pumice soils in drainages and draws of the forested uplands, and deep, gravelly loam soils adjacent to marsh areas. The overlying pumice mantle is believed to act as mulch, which aids vegetation. Vegetation is typically sagebrush and bunchgrass. Portions are used for irrigated agriculture.

- **High Desert Ecological Province:** This ecological province is characterized by closed basins surrounded by terraces that were once formed by ancient lakes. Low mountains, isolated buttes, basaltic ridges, and block faulted igneous formations are interspersed. Elevations average between 4,000 and 4,500 feet. The climate in this region is dry and cold, with an average annual precipitation of approximately 10 inches. Extreme hot and cold temperatures are common, with a chance of frost throughout the year. The only community within this province is Hampton.

  Soils in the province range from deep loam to deep clayey soils in basins and from deep sandy to shallow clayey soils on terraces and fans where hardpans are common. The soils surface on most terraces and fans is rocky, likely a result of fractured basalt. Vegetation communities are dominated by shrub-grasslands, and the limited forested areas are dominated by juniper.

2.1.2. Climate

The Crooked River Basin lies within the South Central Oregon climatic zone; a semi-arid area of high desert prairie punctuated by small mountain ranges and isolated peaks (CRLAC 2003). Mean and annual air temperatures vary widely in the watershed, with cold nights throughout the year, particularly at higher elevations, and hot daytime temperatures during summer months. The growing season is relatively short, particularly at higher elevations, and frost has been recorded in every month.

Precipitation and snowfall levels fluctuate from year to year, with more rain and snow falling at higher elevations. On average, lower elevation areas receive an average of 8 to 10 inches of precipitation each year and higher elevations receive up to 30 or 40 inches of precipitation, primarily as snow in the winter. The highest monthly precipitation occurs in winter, though the basin also receives good rain and snowfalls in late spring and early summer. Late spring and summer precipitation is often quick and intense and can contribute to localized flooding. These high intensity thunderstorms can add substantially to annual rainfall. The spring-summer peaks become much more pronounced with distance away from the Cascade Mountains (Whitman 2002).

2.2. Historic Environment

Early explorers and military expeditions described the Crooked River basin as rich with abundant riparian vegetation and adequate supplies of grass, water and firewood. Forests in the basin were characterized by an open, park-like structure at lower elevations, maintained by frequent ground fires. Large trees were primarily fire-resistant Ponderosa pine at lower elevations, Douglas fir and western larch at middle elevation sites, and true firs at higher elevations. Fires were less frequent on the cooler, higher elevations, but fires that did burn these areas burned a high number of the trees.

On rangelands, early explores found an abundance of bunch grasses (ODFW 1996c). As explained by one early rancher,

> *"This was, certainly, as fine a country then as a stock man could wish to see. The hills were clothed with a mat of bunch grass that seemed inexhaustible. It appeared a veritable paradise for stock* (George Barnes, rancher 1887)."

Western juniper were generally restricted to the rocky outcroppings or moist draw areas naturally resistant to fire. The western edge of the watershed had more juniper than the rest of the basin. Rangeland conditions began to change in roughly the 1870s as livestock grazing became the major land use throughout the entire basin (CRLAC 2003).

Historically, riparian and floodplain areas of the Crooked River watershed had significantly more woody vegetation than now (CRLAC 2003). Floodplains were dominated by bunchgrass and wild rye grass, with very little invasion of juniper and sage communities. The Crooked River had a large floodplain that was described by early settlers as having waist high grasses. Willows were a primary component of riparian species (Ochoco means willow in Pauite) but other common species included cottonwoods, aspen, alder, as well as shrub species such as chokecherry, hawthorn, and dogwood. In some areas, dense vegetation along the Crooked River had to be cut away to facilitate travel (Buckley 1992). Journals of early explorers comment on the abundant grasses and willows. Early pioneers recalled

> *"The valley bottoms were covered with willow and other trees that made travel difficult. Some stream bottoms were covered with wild rye, clover, pea vines, wild flax and meadow grass that was waist high on horseback."*

Another report describing the Crooked River valley noted

> *"The bottom lands of the valley will average from half a mile to mile in width...groves of alder and cottonwood, with dense thickets of willow, exist on its banks... the plains back of the hills are...clothed with a carpet of luxuriant bunch grass* (Buckley 1992)."

Floodplain and riparian vegetation played an important role in reducing erosions. Over the years, some areas of fine-grained valley alluvium were likely incised by gullies that eroded headward up the stream channel network. A study of Camp Creek in the upper Crooked River basin identified several periods of prehistoric incision followed by aggradations that may have corresponded to subtle climatic shifts (O'Connor et al. 2003).

Natural flows in the streams of the Crooked River displayed characteristics of the semiarid climate, with low precipitation producing low runoff. Generally, there were also more springs and watercourses in the basin. Beaver and beaver dams were plentiful and instrumental in maintaining a high water table under most stream valleys. Camp Creek, for example, was a wet meadow with abundant grass, willow and aspen. Consequently, many streams that are currently intermittent were perennial. Trout Creek in the Paulina/Beaver Creek drainage provided a source of food (salmon/trout) to locals in the late 1800's through the turn of the century (Whitman 2002). There was more riparian vegetation, including sedges, grasses, and woody species, and stream channels were well connected to broad valley bottom floodplains. Early settlers reported that the "*Crooked River was as clear as a mountain stream."* The Crooked River 'flooded' practically annually, with a meandering channel that took up the entire valley floor. In 1887, the Prineville School was located "*on the banks of the Crooked River*" at the corner of 2nd and Deer Street (ODFW 1996c). Today this location is nearly one-fifth of a mile from the active channel of the Crooked River.

Rivers and streams were abundant with native fish including rainbow trout, summer steelhead and Chinook salmon (Crook County Historical Society 1981). Ogden's' journals of his expeditions up the Crooked River in 1826 described the excellent quality of beaver habitat and noted that the mainstem and all tributaries he observed were lined with willows and aspen, and grass as tall as 7 feet (Ogden 1950). One entry from Steen's military unit, dispatched in July 1860 to survey a route from Harney Lake to Eugene City, described the Crooked River as a *"Good running stream 30 ft wide 1 ft deep in middle. Good rocky bottom. Plenty of fish"*. Ogden's journal also notes the presence of an Indian fish weir below the junctions of the North and South forks that was apparently used for capturing anadromous fish (ODFW 1996c). Other journals mention good trout and salmon populations in Ochoco and Beaver creek watersheds.

2.3. Current Environment

2.3.1. Hydrology

The semiarid climate of the Crooked River watershed produces low runoff during most of the year and many streams in the drainage have low or intermittent flow conditions during summer months. Approximately two-thirds of the total annual precipitation comes as snow from October through April. Runoff varies dramatically on an annual and seasonal basis, with snowmelt and summer rainstorms contributing to high runoff and flow events. Before construction of Prineville Reservoir, the mean March flow of the Crooked River near Prineville was 100 times the mean August flow (O'Connor et al. 2003).

Most flow in the Crooked River is collected from spring releases, snowmelt and rain in the South Fork, North Fork, Beaver Creek and other tributary drainages in the Ochoco Mountains. Tributaries originating to the south do not contribute as much water, but can be influenced heavily by high intensity storm events such as summer thunderstorms. Below the City of Prineville, there are no known springs of significant size until RM 15, where large springs augment the flow to the confluence. The watershed includes 32 fifth-field watersheds, with an average area of 99,761 acres (Dedrick 2004). The system discharges an average of 1,131,000-acre feet annually into the Deschutes River at Lake Billy Chinook (Whitman 2002).

Two major impoundments, Bowman Dam on the Crooked River (completed in 1960) and Ochoco Dam on Ochoco Creek (completed in 1921), regulate flow patterns in the Crooked River and restrict fish movement. Both facilities were built for irrigation and flood control. The dams were constructed without fish passage facilities and now isolate fish populations in lower stream reaches from habitat areas in the upper watersheds. Other smaller, public, reservoirs in the basin include Allen Creek Reservoir, Antelope Flat Reservoir, Walton Lake, Haystack Reservoir, and Reynolds Pond.

By 1912 diversion of water was so extensive that the riverbed of the mainstem Lower Crooked River near RM 35, where no springs provided water, was frequently dry. Lower reaches of most of the smaller tributaries were also dry in late summer and early fall; only the North Fork and uppermost tributaries contained water at this time of year (ODFW 1996c). Today, there are approximately 750 surface water rights in the Crooked River watershed, excluding reservoir rights, representing 4,000 cfs. The lower Crooked River drainage has the largest number of water rights and largest allocation of surface water. Surface water rights allocated to the lower watershed total 3,566 cfs. Reservoir rights total 227,861 acre feet in the Crooked River watershed, with 167,823 acre feet of these rights allocated to the upper watershed (OWRD 1999).

2.3.2. Water Quality

The ODEQ 303(d) list of water quality limited streams includes several reaches within the Crooked River Watershed that do not meet water quality standards (Table X). Most streams are included on the list because they exceed the state's temperature standard. Portions of the Crooked River are also listed for not meeting water quality standards for pH, bacteria and total dissolved gas (Table X). In addition, since streams are only included on the 303(d) list where data has been collected and submitted to ODEQ, there may be additional water quality problems beyond what is indicated by the 303(d) list. Water quality concerns in each major tributary are addressed in more detail later in this section and will discuss issues beyond just the 303(d) listings.

2.3.3. Land Use and Management

More than 90% of the Crooked River watershed supports agriculture, range or forest land uses. Public lands cover almost 59% of the watershed and are generally forested or grasslands. These include Bureau of Land Management lands, covering 35.2% of the watershed (1,023,215 acres) and Forest Service lands, covering 22.8% of the watershed (463,587 acres in the Ochoco National Forest, 172,136 acres in the Deschutes National Forest, 27,365 acres in the Crooked River National Grasslands, and 75 acres in the Malheur National Forest). In addition, the State of Oregon owns 1% of the watershed (26,650 acres) (USFS 1999-01). The remaining 41% of the watershed (1,193,570 acres) is privately owned. Land use and water utilization on private lands is primarily for livestock grazing, timber harvest, and irrigation. Most irrigated agriculture occurs near the City of Prineville. Other substantial blocks of irrigated cropland lie in the upper watershed along Crooked River and some of the larger tributaries.

Table X. Stream reaches in the Crooked River Watershed that exceed Oregon's Water Quality Criteria, as listed in 2002. All exceedances are for the 64°F summer criteria unless noted otherwise.

Watershed	Streams
Lower Crooked River	Crooked River to Baldwin Dam (RM 0-51) - *also bacteria (summer) and pH (all year)* Crooked River: Baldwin Dam to Prineville Reservoir (51-70)– *total dissolved gas only* Harvey Creek (0-1.4) Little McKay Creek (0-6.7) – *also 55˚F October 1 – June 30* Marks Creek (0-17.1) – *also 55˚F October 1 – June 30* McKay Creek (0-14.7) McKay Creek (14.7-19.5) –*55˚F October 1 – June 30* Mill Creek (0-11.5) – *also 55 F October 1 – June 30* Mill Creek, East Fork (0-7.6) Mill Creek, West Fork (0-4.9) Ochoco Creek (0-36.4)
Upper Crooked River	Allen Creek (Mile 0-10.1) Bear Creek (0-34.3) – *also 55˚F October 1 – June 30* *Cow Creek (0-7.2)* Crazy Creek (0-3.5) Crooked River: Prineville Reservoir to N.F.Crooked R. (82.6-109.2), *also pH (all year)* Crooked River, North Fork (0-44.7) Deep Creek (0-10.6) Deer Creek above private reservoir to headwaters (0.9-4) Double Corral Creek (0-5.4) Fox Canyon Creek (0-6.8) – *also 55˚F October 1 – June 30* Fox Creek (0-4.9) Gray Creek (0-6.7) Happy Camp Creek (0-6.7) Horse Heaven Creek (0-14) Howard Creek (0-9.5) Indian Creek (0-9.1) Jackson Creek (0-5.9) – *also 55˚F October 1 – June 30* Klootchman Creek (1-5.3) Little Horse Heaven Creek (0-2.9) Little Summit Creek (0-10) – *also 55˚F October 1 – June 30* Lookout Creek (0-1.5) Lytle Creek (0-4.2) Peterson Creek (0-10.7) Porter Creek (0-4.5) – *also 55˚F October 1 – June 30* Shotgun Creek (0-5.9) Wickiup Creek (0-8.6) Wildcat Creek (0-4.3) – *also 55˚F October 1 – June 30*
Beaver Creek/South Fork Crooked	Beaver Creek, South Fork (Mile 0-26.4) – *also 55˚F October 1 – June 30* Beaverdam Creek (0-10.8) Dippingvat Creek (0-7.7) – *also 55˚F October 1 – June 30* Dry Paulina Creek (0-13.1) – *also 55˚F October 1 – June 30* Powell Creek (0-12.7) Roba Creek (0-7.2) – *also 55˚F October 1 – June 30* *South Fork Crooked River (0-18)*) – *also 55˚F October 1 – June 30* Sugar Creek (0-11.5) Wolf Creek (0-17.l) – *also 55˚F October 1 – June 30* Wolf Creek, North Fork (0-10.3)

Lands in the Crooked River watershed extend over seven Oregon Counties, with about 64% of the watershed in Crook County. Other counties cover smaller parts of the watershed, including Deschutes County (26%), Lake County (3.4%), Jefferson County (1.9%), Wheeler County (1.9%), Harney County (1.5%), and Grant County (1.3%). The City of Prineville, located along the Crooked River, is the principal community in the basin and the county seat for Crook County. The watershed also contains the towns and communities of Terrebonne, Powell Butte, Paulina, Post, Suplee, Alfalfa, Millican, Brothers, and Hampton (Whitman 2002).

Wild and Scenic Rivers

Several river reaches in the Crooked River Watershed have been designated as Wild and Scenic Rivers under the Oregon Omnibus Wild and Scenic Rivers Act of 1988.

- *North Fork Crooked River* — Total of 34.2 river miles, from mouth to headwaters, except private lands in Big Summit Prairie.

- *Lower Crooked River, Chimney Rock Section* — Total of 8 river miles, from Bowman Dam to State Scenic Highway. 27, mile-marker 12.

- *Lower Crooked River* — Total of 9.8 river miles from the National Grasslands Boundary to Opal Springs (RMs 8 to 17.8).

2.4. Focal Fish Species for the Crooked River Watershed

Before construction of dams and water diversions, the Crooked River supported spring Chinook, summer steelhead, redband trout, bull trout, mountain whitefish, Pacific lamprey and many non-game fish populations. Frey (1942) reported observing abundant lamprey larvae in the Crooked River at the Cove Hydroelectric Plant (inundated by Lake Billy Chinook) in and on the sand in the canal. He also reported that “scrap fish” including lamprey were abundant in the middle warmwater portions of the Crooked River (Nielson 1950). The drainage may have also supported other anadromous species, such as coho salmon, but presence of such species is not documented in any historical accounts. Opal Springs Dam, a small hydroelectric dam on the Crooked River about one mile above Lake Billy Chinook, was constructed in 1921 was a partial barrier to migratory fish. Ochoco and Bowman Dams, completed in 1921, and 1961, respectively, were constructed without fish passage facilities and blocked anadromous fish runs into the Ochoco Creek and upper Crooked River basins. Round Butte Dam was completed on the Deschutes River just downstream of the confluence with the Crooked River in 1964. Fish passage facilities were constructed, but they were not effective and fish passage was terminated in 1968, eliminating spring Chinook and summer steelhead from the lower Crooked River (ODFW 1996c).

Today, spring Chinook, fall/summer Chinook, summer steelhead and lamprey are not present in the Crooked River, though the watershed continues to support several resident indigenous fish populations. Anadromous runs may return to the Crooked River if current efforts to provide passage at the Pelton Round Butte Project are successful. If introduction of these species occurs, passage would be sought over Opal Springs Dam and other smaller mainstem and tributary passage barriers in the Crooked River basin downstream from Bowman Dam. Anadromous fish passage at Ochoco and Bowman dams may not be pursued because of their height and fluctuating pools.

2.4.1. Chinook

Historical abundance and distribution of Chinook salmon in the Crooked River watershed is largely unknown (ODFW 1996c). The watershed may have supported runs of spring and summer Chinook, with summer Chinook returning to the mainstem Crooked River below McKay Creek and spring Chinook moving further through the system to habitat in Ochoco Creek and the upper mainstem and tributaries (ODFW 1996c). Spring Chinook were reported in the watershed into the 1940's, though by this time the run would have been severely impacted by habitat degradation. Spring Chinook may have resided in the Crooked River until completion of Ochoco and Bowman dams in 1921 and 1961, respectively.

2.4.2. Redband Trout

Summer Steelhead

Summer steelhead were historically present throughout much of the Crooked River basin with the exception of the North Fork Crooked River above Lower Falls, an impassable barrier. With planned passage at the Pelton Round Butte Project (Ratliff et al. 2001), steelhead will have access into tributaries and the mainstem downstream of Ochoco and Bowman dams.

Resident Redband Trout

Redband trout, a subspecies of rainbow trout adapted to the arid conditions east of the Cascade Mountains, are present throughout the Crooked River watershed, except in Reynolds Pond, Walton Lake and possibly Antelope Flat Reservoir. Most of the best remaining habitat in the watershed is on Ochoco National Forest lands. Redband trout are the only native game fish left in the upper basin and reside primarily in headwaters of smaller tributaries (ODFW 1996c).

2.4.3. Bull Trout

Bull trout were historically found and caught by anglers in the lower Crooked River. Bull trout spawning in the basin was no documented, but bull trout used the lower Crooked River for juvenile rearing and adult holding areas (Ratliff et al. 1996). Bull trout were caught as recently as the early 1980's up to the City of Prineville (ODFW 1996c; Walt Carter 1992, personal communication). Today, bull trout in the Crooked River basin are confined to Lake Billy Chinook and in the lower Crooked River up to Opal Springs Dam, an impassable barrier since 1982.

2.4.4. Pacific Lamprey

Pacific Lamprey were also present in the river, but very little is known about their life history, abundance or distribution. Completion of the Pelton Round Butte Project ended production of lamprey in the Crooked River system.

2.5. Focal Wildlife Species of the Crooked River Watershed

The amount of riparian and herbaceous wetland, which provided important historic wildlife habitat, has declined drastically in the Crooked River watershed. Oxbow sloughs, willow swamps, and permanent ponds formed by river and stream meanders created this habitat and have been almost entirely lost. A wildlife species thought to have existed in this habitat, but no longer present in the subbasin, is the Columbian white-tailed deer.

[Other information will be added on focal wildlife species/habitats.]

2.6. Current Conditions In Major Drainages

This section describes the current condition of the environment in the Crooked River watershed. It discusses watershed characteristics in several different areas:

- Crooked River, Lower section (mouth to RM 34)
- Crooked River, Prineville Valley section (RM 34-57)
- McKay Creek
- Ochoco Creek
- Crooked River, Chimney Rock sections (RM 57-70)
- Crooked River, Prineville Reservoir Reach (RM 70-85.9)
- Bear Creek
- Sanford Creek
- Crooked River, above Prineville Reservoir
- North Fork Crooked River
- Camp Creek
- Beaver Creek
- South Fork Crooked River

2.6.1. Crooked River, Lower Section (RM 6-34)

Uplands

This section of the Crooked River generally flows through a narrow basalt canyon. Adjacent lands are about 47% publicly owned, with a mixture of BLM and USFS ownership. Lands adjacent to river above Highway 97 are mostly privately owned, with the exception of Smith Rock State Park (RM 23 to 26). Private lands are primarily managed for agricultural and range uses. In 1988, the lower river from the National Grassland boundary below Highway 97 downstream 9.8 miles to Lake Billy Chinook was included in the federal Wild and Scenic River system.

Riparian Areas

The lower Crooked River canyon below Highway 97 displays a remote and relatively undisturbed character, with a near pristine riparian condition. Riparian vegetation in the reach includes willow, alder, cottonwood, aspen, birch, dogwood, chokecherry, and rose. Riparian vegetation has been degraded along the reach from Highway 97 to Prineville.

Instream Habitat

This section of the Crooked River contains a variety of instream habitat, with changes occurring near where Highway 97 crosses the river canyon at RM 18. Instream conditions and complexity in the river downstream of Highway 97 are good and the river canyon contains a mixture of high gradient boulder reaches and long slow glides. Upstream of Highway 97, the river corridor displays a mixture of boulder-strewn riffles and long glides with a low gradient (0.2 to 1.0%). Parts of the channel have been simplified and/or isolated from their floodplain

Flows

Flows in the Crooked River drop at RM 28 where the North Unit Irrigation District withdraws an average of 70 cfs with a pump and flume system and diverts water to

Haystack Reservoir for delivery in the Culver-Madras area. A minimum flow of 10 cfs is bypassed below the pumps. Instream Flow Incremental Methodology (IIFIM) study results (1992) indicate that higher flows would be required to obtain optimal production of adult and spawning redband trout (ODFW 1996c).

Springs begin to augment flows in the reach below Highway 97 and contribute significantly to constant water flow, cooler water temperatures, and water quality. The volume of flow contributed from springs increases as the river flows north, with Opal Springs discharging up to 240 cfs, and the river averaging over 1,550 cfs at Lake Billy Chinook. With the addition of spring inflow, water quality and temperatures improve substantially for supporting coldwater fish species (ODFW 1996c). Opal Springs Dam has been a migration barrier to redband and bull trout, and mountain whitefish, except during infrequent periods of high flow, since it was renovated and retrofitted in 1982 (ODFW 1996c)

Water Quality
Water quality problems (increased temperature and sediment) reduce habitat quality in the Crooked River from RM 34 to the Highway 97 bridge. Summer water temperatures in the reach exceed state water quality standards. This reach also suffers from high pH (year round) and high bacteria (summer), which exceeds state standards, and high BOD and low dissolved oxygen. Water quality improves below Highway 97 with additional flow from spring releases.

2.6.2. Crooked River, Prineville Valley Section (RM 34-57)

Uplands
The Prineville section of the Crooked River flows through a wide floodplain with little confinement by geological formations. Most land adjacent to the river in this section is privately owned. Land use and water utilization on private lands through the valley is for livestock grazing and irrigation for crop production. Major crops include alfalfa, mint, wheat, and potatoes. The section also flows through the City of Prineville urban growth boundary where lands support residential, industrial and commercial uses.

Riparian Areas
Poor riparian condition reduces fish production in the Prineville Valley section of the Crooked River (ODFW 1996c). The river channel has been altered or simplified at several locations throughout the Prineville Valley reach. Soils in the reach are naturally susceptible to erosion and reduction of riparian vegetation through land use actions has worsened the riparian condition.

Instream Habitat
The Crooked River meanders through the Prineville Valley with little confinement and has a low gradient of 0.1 to 0.2%. Channel alterations, active bank erosion and low gradient contribute to a generally poor instream habitat. The general lack of instream habitat complexity and a substrate with a high sediment load further degrades habitat in this reach. Key habitat for spawning and incubation, fry colonization, and adult holding has been lost due to reduced flows, loss of habitat structure and degraded water quality. IFIM study results (1992)suggest higher flows are needed for optimal production of adult and spawning redband trout in this river section (ODFW 1996c).

Flows

Streamflow withdrawals and associated water quality problems limit fish production in this section of the Crooked River (ODFW 1996c). The Crooked River Feed Canal (RM 57) diverts 160 to 180 cfs during the irrigation season. Fish were trapped in this canal until 2001 when Ochoco Irrigation District, in cooperation with the BOR, replaced the old screening system at the canal with a state of the art screening facility (Marx 2004). Other diversions — all unscreened and partial or complete barriers to fish migration— include the Rice Baldwin Ditch at RM 57, the People's Irrigation Ditch near RM 50, and several smaller diversions between the City of Prineville and RM 18. These diversions remove most of the remaining flow and leave the Crooked River below Prineville with very low flows during the summer. Some irrigation return water from Ochoco and McKay creeks augments flows, though other irrigation diversions downstream continue to withdraw water from the Crooked River.

Water Quality

Water diversions and point and non-point discharge in the urban area affect water quality in this reach of the Crooked River. Sections within this reach of the Crooked River are included on the 303(d) list for not meeting water quality standards for fecal coliform bacteria, summer water temperatures and pH. Summer stream temperatures rise as high as 80°F below the City of Prineville because of low flows and low shade. The lower Crooked River has also been identified as having the potential for limitations related to dissolved oxygen, total dissolved gas and nutrients (ODEQ 1998). Water quality for the entire lower Crooked River was reported to be moderate to severe for water quality, fish, and aquatic life (ODEQ 1988).

The only NPDES permit in the Crooked River Watershed belongs to the City of Prineville for their sewage treatment facility. The sewage treatment plant is only allowed to discharge to the Crooked River (RM 47) during the winter months, and the quality and amount of the discharge is regulated by flow in the Crooked River. If flows are less than 15 cfs, no discharge is allowed. During the summer months, the sewage is land applied to the golf course in Prineville (Lamb 2004).

2.6.5. McKay Creek

McKay Creek joins the Crooked River at RM 45.2. The creek and its tributaries, including Allen and Little McKay creeks, provide more than 50 miles of stream habitat and drain about 103 square miles.

Uplands

Upper reaches of McKay Creek and its tributaries flow through public forestlands that are used for livestock grazing, timber harvest, and recreation. Land use and water utilization on private lands along McKay Creek is primarily for livestock grazing, timber harvest, and irrigation for crop production.

Riparian Areas

Many riparian sections along McKay Creek are in a degraded condition. Up to 65% of the creek has been channelized or altered. A large portion (15%) of the riparian area is characterized as unvegetated and the riparian recruitment situation is inadequate for just under 90% of stream reaches in the drainage (Walter 2000).

Instream Habitat
Results from a stream sensitivity assessment indicate that 74% of McKay Creek shows high channel sensitivity (19% moderate and 7% low). Channel condition was found to be better in Little McKay Creek, with no areas rated as having high sensitivity and 44% having low sensitivity (Walter 2000). Shade along McKay Creek is typically 0-30% and pools average less than 10% of the channel.

Flows
McKay Creek flow reflects watershed management and alterations, as well as seasonal water withdrawal for irrigation. Peak stream flows associated with snowmelt are generally earlier and of greater magnitude that historical stream discharge. The stream from the Allen Creek confluence to the mouth at Crooked River is frequently intermittent or dry during the irrigation season. Between Allen Creek and Little McKay Creek, the flow is seasonally reduced to low levels by irrigation withdrawals.

Water Quality
Portions of both McKay Creek and Little McKay Creek are included on the 303(d) list for exceeding both the rearing (64°F) and spawning (55°F) criteria. Recorded water temperatures have reached 75°F on both creeks. Water quality conditions for McKay and Allen creeks are considered moderate to severe for water quality, fish, and aquatic life (ODFW 1996c, ODEQ 1988).

2.6.4. Ochoco Creek

Ochoco Creek joins the Crooked River at RM 45.5. The drainage comprises about 150 miles of stream and drains an area of 360 square miles (230,400 acres). Its two major tributaries, Mill Creek and Marks Creek, meet Ochoco Creek at RM 14 and RM 20, respectively.

Uplands
Headwaters and tributaries of Ochoco Creek begin on the forested hills of the Ochoco National Forest, and flow through narrow valleys and steep v-sided canyons. The lower drainage is generally a broad valley in private ownership, with agricultural lands primarily used for livestock and hay production. Elevations range from 5,500 feet in the headwaters to 2,800 feet at the mouth. Land ownership in the drainage is approximately 48% USFS, 1% BLM and 51% private. The City of Prineville is the only community in the Drainage. Ochoco Dam impounds the creek at RM 11, forming Ochoco Reservoir.

Riparian Areas
Ochoco Creek and tributaries flow through a variety of plant communities, ranging from relatively level wet meadows to narrow forested canyons. Assessments conducted in 2000 on Ochoco Creek and tributaries Mill and Marks creeks, using OWEB methodology, showed that the riparian recruitment situation was inadequate for roughly two-thirds of stream reaches on Ochoco Creek. Rating for tributaries Marks and Mill creeks were even worse (Watershed Professionals 1999). The assessments showed that riparian recruitment was generally inadequate along Mill Creek, West Fork Mill Creek, Marks Creek and Ochoco Creek (Whitman 2002).

Earlier habitat surveys by USFS and ODFW personnel on upper Ochoco Creek (1979) and on Marks and Mill creeks (1977) showed that the stream reaches with the best riparian conditions were upper reaches of Canyon and Ochoco creeks (ODFW 1996c). The riparian corridor along lower Ochoco Creek has been damaged by livestock grazing, channel simplification, urban development in the Prineville area, and agricultural practices. Tributaries Canyon, Fisher and Judy creeks had been impacted by past mining activity. ODFW survey results for Marks Creek indicated that overgrazing, irrigation structures, and stream channelization had adverse impacts on fish habitat, streamside cover, and bank condition. Up to 80% of the banks were eroding. Average shade was 10-30% on Ochoco Forest lands and 0-20% on private lands. A small livestock exclosure on Marks Creek had contributed to riparian vegetation and streambank recovery in the past 12 years (ODFW 1996c).

Instream Habitat
Habitat complexity has been reduced along lower Ochoco Creek through stream channelization and berming. Several reaches are isolated from their floodplains and large wood is in low abundance. Assessments conducted on Ochoco Creek in 2000 for the Crooked River Watershed Council indicated that channel sensitivity was high for 84% of the Ochoco Creek. Channel sensitivity for Mill and Marks creeks was rated as high for the entire channels (Walters 2000).

Flows
Most flow in Ochoco, Marks and Mill creeks below the Ochoco National Forest is diverted for irrigation. There are more than 100 cfs of out-of-stream water rights for appropriation on Ochoco Creek alone, although the creek was withdrawn for further water appropriation in 1915 because of over-appropriation. As a result, Ochoco and Mill creeks are frequently dry above Ochoco Reservoir in July, August and September.

Flows in lower Ochoco Creek respond to water storage and releases from Ochoco Dam. These operations reverse the natural seasonal flow pattern in lower Ochoco Creek. High flows occur during the irrigation season (April to mid-October) and low flows occur while water is stored for the next irrigation season.

Water Quality
Portions of Mill Creek, West Fork Mill Creek, East Fork Mill Creek, Marks Creek and Ochoco Creek are included on the 3030(d) list for exceeding water temperature criterion for salmonid rearing (64^{o}F). Water temperatures have been recorded as high as 78^{o}F on Mill Creek and 80^{o}F on the West Fork of Mill Creek (ODFW 1996c). The spawning criterion (55^{o}F) has also been exceeded in Marks Creek and Mill Creek. In addition, elevated mercury levels have been documented in fish collected in Ochoco Creek and Ochoco Reservoir, likely from inactive mercury (cinnabar) mines located at the headwaters of Canyon Creek. A two-year-old fish collected from Ochoco Reservoir had mercury levels exceeding 0.5 mg/l, approaching the state legal limit of 1.0 mg/l. Older age fish typically have greater levels of bioaccumulated mercury, suggesting that 3 to 4 year old fish may reach or exceed the state health standard (ODFW 1996c).

2.6.3. Crooked River, Chimney Rock Section (RM 57-70)

Uplands
The Crooked River below Bowman Dam is tightly constrained by low, but steep hills.

Most land adjacent to this river section is administered by the BLM. Uplands draining into the section are primarily used for livestock grazing and recreation. The reach extending from RM 70 to RM 62 is part of the federal Wild and Scenic River system.

Riparian Areas

Riparian vegetation conditions in the upper reach remain in fair to good condition. However, tailrace discharges from the dam that improve flows for fish in the 12-mile reach below the dam may limit riparian vegetation growth. The regulated flows are the reverse of natural flows, which are typically high in late winter and low in summer and early fall. These reverse flows of the lower Crooked River in the Chimney Rock section appear to limit growth of streamside vegetation during the growing season.

Instream Habitat

Channel conditions in the upper reach remain stable, though flow regulations limit the ability of the stream channel to rejuvenate through landform developing processes such as large floods. Peak flows that used to occur every 2.5 years (about 4,000 cfs) now occur about every 50 years on average, which has a significant effect on channel morphology (Whitman 2002; McSwain 1999; ODFW 1996). The reach contains limited spawning habitat quality and quantity. In addition, instream habitat complexity is provided by coarse substrate as large wood is lacking.

Flows

Operations at Bowman Dam changed the timing of peak flows as well as their size in the Crooked River. Before dam construction and operation, 75% of the average flow of the Crooked River occurred in the months of March, April, and May (McSwain 1999). Today, flows below Bowman Dam are regulated by the Bureau of Reclamation and managed by the Ochoco Irrigation District. The cold-water releases substantially improve water quantity and fish habitat in this reach (ODFW 1996c), and have created a "tailrace fishery". Flows are typically 200-250 cfs during the summer irrigation season and 30-75 cfs during the winter storage season. Before the closure of Bowman Dam in 1960, average peak discharges typically ranged from 3,000-7,000 cfs (OWRD 1998). Since construction of the reservoir, flows have ranged from as low as 10 cfs during winter months, the minimum flow required by the project, to as high as 3000 cfs (OWRD 1998). The goal of the flood control operation is to limit the outflow from the reservoir so as not to exceed 3,000 cfs. Flows have been reduced to 0 cfs for up to two hours annually during inspections of the gate and stilling basin by Bureau personnel, causing some stranding and mortality of fish and aquatic insects (ODFW 1996c).

IFIM study results (1992) indicated that optimal fish production in the Chimney Rock segment occurs with flows of approximately 75-150 cfs for fry and juvenile redband trout, while optimal production for spawning and adult redband trout occurs at flows exceeding 200 cfs (Hardin 1993). Uncontracted storage in Prineville Reservoir of 80,360 acre feet may be available to meet instream flow requirements for fish and other aquatic resources, contingent upon Congressional reauthorization of the project, for retention in the reservoir and release into the Crooked River (Marx 2004).

Water Quality

Cold-water reservoir releases strongly influence water temperatures in the reach, where summer water temperatures average 47°F to 50°F, with a high of 54°F; while winter temperatures average 37°F to 40°F, with a low of 32°F. Water discharged from the reservoir rarely exceeds 54°F. A 1989 survey (Stuart) found an abundant population of redband trout in the Crooked River immediately below Bowman Dam where the discharge of cold water from the hypolimnion of the reservoir supplies cold water to the river. The flows, however, are frequently turbid due to sediments suspended in the water at Prineville Reservoir. Water in the Crooked River is generally turbid throughout the lower basin downstream to RM 16 where sufficient spring inflow contributes to good water clarity and cooler temperatures (ODFW 1996c).

Variable discharges at the dam, however, have created problems and issues somewhat unique to the lower Crooked River. Nitrogen super saturation occurs when water is spilled over Bowman Dam or high volumes are released through the outlet structure (ODFW 1996c). In a high water event during April 1989, gas bubble disease was observed in over 85% of the rainbow trout captured during electrofishing surveys in the Crooked River from Bowman Dam downstream to Prineville. A saturometer recorded nitrogen super saturation levels in the water — entrained as water is discharged into the stilling basin — as high as 109% two weeks after the water had been discharged at this level. One month later, saturation levels were still at 108%, recorded at 0.5, 3, and 5 miles below Bowman Dam. These levels cause mortality in egg and fry stages and cause serious fin erosion and disease in older age classes. Modification of the dam's discharge tube, spillway and stilling basin is recommended to eliminate this problem during high water discharge (ODFW 1996c). This reach of the Crooked River is included on the state 303(d) list for exceeding criterion for total dissolved gas.

2.6.6. Crooked River, Prineville Reservoir Reach (RM 70 to RM 85.9)

This reach of the Crooked River extends from above Bowman Dam to the upper end of Prineville Reservoir. It comprises approximately 16 miles of the mainstem Crooked River and several hundred miles of tributary streams, including Bear Creek and Sanford Creek. Prineville Reservoir lies approximately 17 miles south of the City of Prineville. The reservoir has a maximum surface area of 3,030 acres and a present storage capacity of 155,000 acre-feet. Maximum depth is 230 feet with an average annual drawdown of 25 to 30 feet. The elevation at full pool is 3,235 feet above mean sea level.

Uplands
Headwater tributaries drain the north and south slopes of the Maury Mountains and pass through a mixture of private, USFS and BLM lands before reaching Prineville Reservoir. The area surrounding the reservoir is characterized by rolling hills and flat plateaus bisected by broad stream valleys. Vegetation consists primarily of western juniper intermixed with big sagebrush, bitterbrush, rabbitbrush and a variety of other shrub, grass and forb species. Grasses include native species of Idaho fescue, bluebunch wheatgrass, and wildrye. Exotic species include crested wheatgrass and cheatgrass.

Riparian Areas
There are 36 miles of shoreline along Prineville Reservoir, of which 34.5 are in public ownership and administered by the BOR. Habitat along Prineville Reservoir is characterized by a lack of shoreline vegetation, an expansive mud flat substrate in the upper end, and a boulder and cobble strewn substrate in the lower end (ODFW 1996c). Erodible soils are present along more than 90% of the reservoir shoreline (ODFW 1996c), and water level fluctuations hinder the growth of a stable riparian community

along the reservoir edge. Tributary streambanks are often also highly erodible and lack adequate riparian cover.

Instream Habitat
Severe drawdown in some years — such as in 1991 and 1992 — limits food production and living space for all fish species. Additional habitat limitations for fish include low to moderate concentrations of nutrients in the water, high suspended sediments which limit photosynthesis, annual water level fluctuations, very low abundance of aquatic vegetation, a lack of structural complexity, and water that is too cold for optimal warmwater fish production and too warm for optimal trout production (ODFW 1996c).

Flows
Irrigation and flood control functions drive dam operations. Irrigation water is released from April 15 to October 15, and the reservoir level is lowered accordingly. The reservoir must be at or below 93,000 acre-feet from November 15 to February 15 for flood control purposes. If the reservoir exceeds that level, water is released to lower the level to 93,000 acre-feet. After February 15, most inflow is stored for irrigation needs. During drought years, when water levels are below 93,000 acre feet during the storage period, a majority of the inflow is stored to bring the reservoir up to the minimum flood control level. In addition to irrigation and flood control releases, minimum flows of 10 cfs are authorized for fish and wildlife purposes in the Crooked River below the reservoir. Since 1990, the BOR has released 30 to 75 cfs in the Crooked River during winter, depending on flood and snowpack conditions, to improve river flows. Presently, 70,300 acre-feet of space in the reservoir are allocated, with the remaining 82,700 acre-feet of active space still unallocated. During drought years, OID and NUID have requested and received non-contracted water on a one-year basis to meet irrigation needs (ODFW 1996c).

Water Quality
Prineville Reservoir has been severely impacted by high quantities of suspended sediments, or turbidity, since the early 1970's. This turbidity is a result of erosion occurring on the mainstem Crooked River, Camp Creek, Eagle Creek and Bear Creek, and shoreline erosion of the reservoir itself from wave action from wind and boats. Erodible soils along the reservoir shoreline contribute to turbidity when waves loosen soil on the shoreline (ODFW 1996c). The watersheds upstream of the reservoir are formed from highly erodible soils, including montmorillinite clay; and upland and riparian areas are in poor condition. These factors result in increased erosion rates. Eroding streambanks from timber harvest, roading, and improper livestock grazing contribute large quantities of sediment to the reservoir during the spring run-off period. As a result, the reservoir is muddy during the spring months and often late into the summer. When washed into the reservoir, the montmorillinite clay stays in suspension for several years, increasing reservoir turbidity and preventing sunlight penetration into the water column. The lack of light penetration ultimately reduces potential primary food production in the reservoir (i.e. zooplankton), which adversely affects fish production.

2.6.7. Bear Creek

Bear Creek begins above Antelope Flat Reservoir on the south side of the Maury Mountains and empties into Prineville Reservoir. Bear Creek and tributaries drain approximately 260 square miles, or 10% of the basin upstream of Prineville Reservoir.

Uplands

The Bear Creek watershed contains a mixture of private, USFS, and BLM lands. Bear Creek and most of its tributaries in the Maury Mountains flow through a variety of plant communities, including wet meadows and forested communities. Lower portions of tributary streams and the mainstem flow through wider valleys with sagebrush and juniper communities in uplands, and irrigated meadows and hay fields along Bear Creek.

Riparian Areas

Limited habitat surveys indicate that much of Bear Creek is unshaded, with streamside vegetation primarily grasses, sedges, and an occasional willow. The Bear Creek drainage is composed of highly erodible soils and eroded cutbanks occur along much of the creek. Loss of historic riparian tree and shrub vegetation has reduced vertical habitat complexity and has resulted in channel down-cutting with the corresponding loss of water storage capacity of the floodplain and riparian area.

Instream Habitat

Much of the Bear Creek channel has incised into the fine valley soils, with a corresponding drop of former floodplain water table. The stream generally lacks any large woody debris or appreciable instream habitat complexity. The substrate is predominantly fine sediment with widely scattered patches of marginal quality spawning gravel. Physical and water quality barriers limit trout production and movement.

Flows

Flows decline to low levels during summer months, creating fragmented or isolated trout populations. Several water diversions remain unscreened.

Water Quality

Bear Creek is included on the 303(d) list for exceeding both the state’s rearing (64^{o}F) and spawning (55^{o}F) temperature criteria. The creek also often carries a great sediment load per volume of flow, although overall discharge is far less than the Crooked River.

2.6.8. Sanford Creek

The Sanford Creek basin covers an area of approximately 20 square miles and joins the Crooked River at Prineville Reservoir.

Uplands

Sanford Creek flows from public forests on the northwest corner of the Maury Mountains and through a mixture of BLM and private lands before emptying into the upper Prineville Reservoir. Most of the drainage is privately owned. Much of Sanford Creek flows through sagebrush and juniper lands. Highly erodible soils cover most of the drainage.

Riparian Areas

Most of the creek is unshaded, with streamside vegetation consisting primarily of grasses, sedges, and an occasional willow. Eroded cutbanks occur along much of Sanford Creek.

Instream Habitat

Stream habitat conditions in Sanford Creek are similar to those in Bear Creek. The stream channel is generally incised into the fine soils of the stream’s floodplain. The channel lacks instream habitat complexity, summer flows are very low, and the substrate in predominantly composed of fine sediment.

Flows
Low flows during summer months limit trout production and movement. Several water diversions remain unscreened.

Water Quality
High summer water temperatures and high turbidity limit trout production. Water quality barriers also hinder fish movement and create fragmented or isolated trout populations.

2.6.9. Crooked River, above Prineville Reservoir (RM 85.9)

The upper Crooked River drainage above Prineville Reservoir collects flow from the upper mainstem Crooked River and the North Fork Crooked River, Camp Creek, South Fork Crooked River, and Beaver Creek drainages.

Uplands
Generally, land in the upper basin is equally split among federal and private ownership. Small tributaries to the mainstem drain public forest lands and flow through a variety of plant communities, including wet meadows and forested areas. Lower reaches of tributary streams and the mainstem Crooked River flow through wider valleys with sagebrush and juniper communities in the uplands, and irrigated meadows and hay fields along the stream bottoms. Land use and water utilization on private lands is primarily for livestock grazing, timber harvest, and irrigation, while public lands are used for livestock grazing, timber harvest, and recreation.

Riparian Areas
Habitat surveys indicate that much of the mainstem river and tributaries have open canopies providing little to no shade (ODFW 1996c). Habitat surveys conducted by USFS (1998) in the upper Crooked River drainage found that the loss of riparian tree and shrub species had reduced vertical habitat complexity and reduced water storage capacity of riparian areas.

Instream Habitat
The mainstem Crooked River has a low gradient with long, slow moving shallow pools and long glides. Many stream reaches have been disconnected from adjacent floodplains. Severely eroded cutbanks with very little riparian vegetation occur along much of the river, and several portions have been channelized. The river has a substrate of fine sediments in pools and glides with occasional riffles of cobbles and boulders. Spawning gravel is very limited (ODFW 1996c).

Flows
Most of the upper Crooked River is characterized by low summer flows. Summer flows range from 1 to 7 cfs with numerous temporary irrigation dams, mostly earth and gravel, diverting much of the flow throughout private lands. During drought years, the mainstem Crooked River has a very low flow or becomes intermittent during the summer months, making it unsuitable for salmonid production.

Water Quality
The Crooked River from Prineville Reservoir to the confluence with the North Fork Crooked River is included on the ODEQ 303(d) list for summer temperatures (64^oF), pH, flow modifications. Streams water temperatures often exceed 70^oF and have been recorded as high as 83^oF. The reach has also been identified as having the potential for limitations related to bacteria, dissolved oxygen and nutrients (ODEQ 1988). Water quality conditions in many streams in the upper basin are moderate to severe for fish and aquatic life (ODEQ 1988). Erosion from this reach of the mainstem Crooked River — and from Camp, Eagle, Lost and Conant creeks and other tributaries — contributes to turbidity and sediment loads in Prineville Reservoir (ODFW 1996c).

2.6.10. North Fork Crooked River and tributaries

The North Fork Crooked River begins in the Ochoco Mountains, 75 miles east of Prineville, and joins the Crooked River at RM 109.2. The drainage covers 340 square miles, or 13% of the upper basin. The North Fork and tributaries comprise 250 miles of river and tributaries including Deep, Gray, Indian, Stump, Elliot, Johnson, Committee, Allen, Fox, Crosswhite, Brush, Lookout, Shady, Beetle, Yellowjacket, Ross, and Peterson creeks.

Uplands
Headwaters of the North Fork Crooked River and tributaries generally drain mixed conifer forests. The North Fork originates in the forest meadows of Williams Prairie in the Ochoco Mountains. Approximately 75% of the North Fork Crooked River basin lies on USFS, 12% on BLM, and 13% on private lands, the latter on or near the Big Summit Prairie and along the lower North Fork Crooked River. Ownership of lands along the North Fork Crooked River is 26% USFS, 23% BLM, and 51% private (Whitman 2002).

Riparian Areas
The North Fork and tributaries are formed by spring releases, rain and snowmelt. In the high elevation areas, the streams flow through rolling broad valleys or steep v-sided canyons. Below the mouth of Deep Creek, the North Fork enters a steep, rugged canyon (500 feet depth) with basalt flows and rimrock formations that create large, deep pools.

Habitat surveys conducted by the Forest Service (1995) in the North Fork watershed showed that riparian habitat has been simplified and that present riparian vegetation was dominated by exotic species, such as tufted hairgrass and timothy (Whitman 2002). Surveys conducted previously by ODFW in 1972 and 1978 also indicated riparian area degradation and showed that the river was generally open with 10% or less shade, with most shade from old growth ponderosa pine or fir, and sheer rock canyon walls (ODFW 1996c, Ferry et al. 1979). Stream survey results for the North Fork Crooked River basin above the mouth of Deep Creek in 1994 also indicated that most streams had low shade and very low large woody debris, although cutbanks were relatively minimal (ODFW 1996c, Johnson et al. 1994).

Instream Habitat
Instream habitat in much of the lower North Fork Crooked River drainage is in a degraded condition. Stream reaches have little habitat complexity, and habitat diversity is limited by a general lack of large wood and overhanging cover. North Fork Falls,

located on the North Fork approximately 8.5 miles upstream from its confluence with the mainstem Crooked River, limits movement of redband trout in and out of most of the North Fork drainage. The falls also historically limited steelhead access to potential habitat in the upper drainage.

Flows

Most streams in the North Fork Crooked River drainage have late summer flows of less than 2 cfs, although Deep Creek, a major tributary below Big Summit Prairie, and the North Fork Crooked River below the confluence of Deep Creek have generally greater flows of 5 to 10 cfs. Flow measurements for the North Fork Crooked River just above Deep Creek averaged from 2 to 6 cfs from July to October, while springtime flows ranged as high as 1,500 cfs (ODFW 1996c).

Over 200 cfs of out-of-stream water rights have been appropriated from the North Fork Crooked River and tributaries, including Gray, Indian, Stump, Elliot, Johnson, Committee, Allen, Fox, Crosswhite, Brush, Lookout, Shady, Beetle, Yellowjacket, Ross, and Peterson creeks (ODFW 1996c). The small impoundments and irrigation diversions have altered much of the flow and isolated some populations of rainbow trout in the upper North Fork Crooked River. In the northeast corner of Big Summit Prairie, Allen Creek Reservoir and its associated irrigation distribution system, and Peterson Reservoir, have isolated populations of redband trout in tributaries of the North Fork Crooked River from the mainstem, since construction of the impoundments in the 1940-50's (ODFW 1996c).

Water Quality

Several reaches in the North Fork watershed are included on the 303(d) list for exceeding state water temperature standards for salmonid rearing, including the North Fork (RM 0-44.7) and Deep, Fox, Gray, and Peterson creeks. Headwater streams are generally located in mixed conifer forests and have cool water, however, as these streams approach Gray Prairie, Big Summit Prairie, and Little Summit Prairie, the impacts of water withdrawal and livestock grazing reduce flows and significantly raise water temperature (ODFW 1996c). Several reaches in the watershed are also listed for flow and habitat modifications (ODEQ 1998).

In addition, inactive mercury (cinnabar) mines located at the headwaters of Johnson Creek may adversely impact water quality. Elevated mercury levels have been documented in fish collected in Johnson Creek (ODFW 1996c; Bruce Anderson, USFS Hydrologist, personal communication).

2.6.11. Camp Creek

Uplands

Camp Creek begins in the arid Price Valley of the Maury Mountains and joins the Crooked River at RM --. Soils in the drainage are highly erodible and the drainage has been impacted by overgrazing and other watershed changes.

Riparian Areas

The creek was historically a wet meadow with abundant grass, willow, and aspen. This condition changed due to overgrazing, beaver removal and other activities, which incised the stream channel and transformed the riparian areas into severely eroded streambanks. Today, Camp Creek remains below its historic condition. While riparian density, instream channel conditions and perennial flows have improved significantly in some reaches since the 1960s with improved land management, riparian vegetation composition in low gradient reaches has not returned to historic conditions.

Instream Habitat
Reaches of the stream channel have incised into the valley floor, with ongoing bank erosion. Lack of instream habitat complexity, low flows, and high sediment loading all contribute to poor instream habitat in Camp Creek. The stream no longer supports a resident trout population.

Flows
Flows in Camp Creek decline significantly due to irrigation withdrawal and are extremely low or intermittent during summer months (ODFW 1996c).

Water Quality
Summer water temperatures increase dramatically with flow withdrawals (ODFW 1996c).

2.6.12. Beaver Creek

Beaver Creek and tributaries comprise several hundred miles of river and tributaries and drain an area of about 540 square miles, or 22% of the upper Crooked River basin. Tributaries to Beaver Creek include South Fork Beaver Creek, Paulina, Sugar, Wolf, Dippingvat, Roba, Widow, Dobson, Freeman, and Tamarack creeks. Beaver Creek joins the Crooked River at RM ---.

Uplands
Beaver Creek collects flow from springs and snowmelt fed streams on the Ochoco National Forest, and from intermittent streams on plateaus of moderate elevation. The creeks and tributaries flow through a variety of plant communities, including wet meadows, forests, arid sagebrush and juniper lands, and irrigated pasture hay fields. Some springs in the drainage are hot. Temperatures of springs near Paulina and Suplee range from 70 to 112 °F. Beaver Creek and lower elevation tributaries run through valley bottoms with irrigated alfalfa and grass fields.

Riparian Areas
Limited habitat surveys suggest that much of Beaver Creek and its tributaries are unshaded, with streamside vegetation of primarily grasses, some sedges, and an occasional willow or cottonwood. Surveys by ODFW found poor riparian conditions in the Beaver Creek drainage (ODFW 1996c).

Instream Habitat
Beaver Creek has a low gradient and a high pool:riffle ratio characterized by long slow moving shallow pools with long glides. Much of the river has a substrate of fine sediments in pools and glides, with occasional riffles of cobbles and boulders. Spawning gravel is very limited in much of Beaver Creek (ODFW 1996c).

Flows
Summer flows on the mainstem and lower tributaries range from 0 to 5 cfs with numerous irrigation dams diverting much of the flow throughout the private lands. The

diversions create low instream flows and several create fish passage barriers to potential upstream habitat.

Water Quality
Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production in the mainstem Beaver Creek (ODFW 1996c). Several streams in the Beaver Creek drainage are on the state 303(d) list, including South Fork Beaver, Dippingvat, Sugar, Dry Paulina, Roba and Wolf creeks. Sedimentation also causes water quality problems in the drainage.

2.6.13. South Fork Crooked River

The South Fork Crooked River drainage includes about 36 miles of river and numerous miles of tributaries, draining about 800 square miles or 32% of the upper Crooked River basin before joining the Crooked River at RM---. The South Fork Crooked River is formed by the outflow of several springs, including some hot springs. One major tributary, Twelvemile Creek, flows into the South Fork Crooked River at RM 19.5. Many streams in the basin are unnamed and intermittent or ephemeral. More than one-third of this drainage does not contribute runoff in most years.

Uplands
Headwaters of the South Fork Crooked River begin as springs and ponds in the high desert northwest of Brothers, Oregon. The river flows through a mixture of narrow, steep rimrock canyons and areas of wider rimrock canyons and irrigated hay meadows.

Riparian Areas
Habitat surveys in 1975 and 1977 found that the South Fork Crooked River canopy is generally open with little to no shade, with streamside vegetation of primarily grasses, some sedges, and an occasional willow (ODFW 1996c).

Instream Habitat
The South Fork Crooked River has a relatively high pool:riffle ratio ranging from 50:50 to 80:20 characterized by long slow moving pools with long glides. Much of the river has a substrate of fine sediments, occasional riffles of cobbles and boulders, and spawning gravel is very limited.

Flows
Summer flows ranged from 2 to 9 cfs, with numerous irrigation dams diverting much of the flow throughout the private lands.

Water Quality
The South Fork Crooked River (RM 0-18) is included on the state 303(d) list for exceeding summer rearing temperature (64°F) and spawning temperature (55˚F from October 1 to June 30. Sedimentation causes water quality problems in some areas.

2.6.14. Summary of Current Conditions in the Crooked River Watershed

Streams of the Crooked River watershed exhibit characteristics of a watershed that is not safely capturing, storing and releasing water (Whitman 2002). Much of the Crooked River drainage is dominated by soils vulnerable to erosion due to steep slopes, high clay content and poor vegetative cover. As a result of overgrazing, beaver removal, timber harvest, fire suppression and other actions, watershed function has changed and impacted watershed hydrology. Loss of native vegetation in riparian areas throughout much of the watershed has increased erosion and reduced the storage capacity of drainages — resulting in larger peak and lower low flow events (Whitman 2002).

An extensive reservoir and irrigation system also affects the natural hydrology of the Crooked River watershed. This system alters the timing and intensity of flows in much of the lower basin, impairing the ability of native vegetation to remain established or re-colonize denuded areas (CRLAC 2003). Prineville (1961) and Ochoco (1921) reservoirs play a large role in controlling floodwaters in the Lower Crooked River Watershed. Operations at Bowman Dam have changed the size and timing of peak flows in the Crooked River. Before closure by Bowman Dam, 75% of the average flow of the Crooked River occurred in March, April, and May. Today this natural seasonal flow pattern is reversed, with high flows during the irrigation season when water is released, and lower flows while water is stored for the next irrigation season. Streamflows have also been altered in Ochoco Creek below the Ochoco Dam, as well as in other parts of the watershed where public and private reservoirs have been created for water storage (Whitman 2002). Surface water rights are overallocated for the entire watershed and water withdrawals impact flows and water quality conditions for fish and other aquatic species during certain times of the year.

Channel modification, particularly along Ochoco Creek and McKay Creek through the greater Prineville urban area, and almost the entire length of the Crooked River has resulted in a stream system disconnected from its floodplain and essentially designed as a water transport system (ODFW 1996c). This channel straightening, along with degraded vegetation conditions in riparian and upland areas, and the erodible soils present throughout much of the drainage, contribute to the now characteristic flashiness of flows within the watershed (Whitman 2002). The intensity of floods, such as the 1964 flood, has been exacerbated by stream channel incision, loss of riparian area, and general loss of contact with historic floodplains. The Post/Paulina area is particularly impacted by floods due to landscape condition. Rapid snow melt, or a rain on snow event, sends water rushing from degraded headwater tributary streams to lower Beaver Creek and the upper Crooked River where flooding can occur because of much faster runoff — as opposed to historic conditions where the uplands and floodplain associated with small tributaries were in good condition and peak flows and peak flow duration were moderated.

In the lower watershed, changes in the timing and size of peak and channel maintenance flow events have restricted channel-forming processes in the Crooked River and Ochoco Creek. Controlled releases have also limited the amount of sediment available in streams throughout the Lower Crooked River watershed. Natural wetland and riparian areas, particularly within the Prineville urban area, have been filled, removed or relocated, altering the storage and transport of water through this area of the basin and increasing the flashiness of flow events. Roads in the basin generally follow stream courses; many riparian areas are degraded by the presence of roads and road crossings (CRLAC 2003).

Some of these conditions are being improved through voluntary actions. Voluntary involvement by private landowners in riparian improvements has increased since the 1960s. Actions have been taken to reduce livestock impacts to riparian areas — including riparian fencing to exclude cattle, the creation of riparian pastures and modified grazing schedules, and off-stream water developments to encourage livestock use of upland areas. These management changes have resulted in increased vegetation in riparian zones, however, the composition and extent of the riparian community has not been restored. Particularly at lower elevations, riparian communities in the basin are dominated by non-native grasses or herbaceous vegetation that lacks the root stability of the woody vegetation or sedge communities that existed historically CRLAC 2003).

3. Upper Deschutes Watershed

The upper Deschutes River watershed encompasses the portion of the Deschutes Subbasin from the Pelton Round Butte Project upstream 132 miles to its headwaters in the Cascade Mountain Range.

3.1. Upper Deschutes Natural Environment

Covering an area of approximately 1,547,639 acres, the upper Deschutes River watershed extends east to the Crooked River drainage, south to the Klamath drainage, west to the crest of the Cascade Range and north to the Pelton Reregulating Dam (RM 100). It consists primarily of a long, wide plain ranging in elevation from 1,945 feet where the Deschutes River enters Lake Billy Chinook to 4,300 feet in the south. The highest point in the watershed is South Sister Mountain, elevation 10,358 feet, located along the watershed's western boundary in the Cascade Mountains.

From its source at Little Lava Lake, the Deschutes River flows approximately 132 miles before reaching Lake Billy Chinook. It gathers flow from springs in the upper watershed and from Snow, Cultus, and Deer creeks and Cultus and Quinn rivers above Crane Prairie Dam; and Browns, Davis and Sheep Springs creeks between Crane Prairie and Wickiup reservoirs. Below the reservoirs (RM 226), the Deschutes collects flow from three major tributaries, Fall River (RM 205), Spring River (RM 190) and the Little Deschutes River (RM 193) before reaching the City of Bend. Between Bend and the Reregulating Dam, the Deschutes River picks up Tumalo Creek (RM 160), Squaw Creek (RM 123), Crooked River (114), and the Metolius River (RM 112). The upper basin also contains more than 400 high elevation lakes including Odell, Crescent, Davis, Cultus, Little Cultus, Lava, Little Lava, South Twin, North Twin, Hosmer, Elk, Sparks, East, and Paulina lakes (ODFW 1996a).

3.1.1. Geology, Soils and Vegetation

The upper Deschutes watershed covers a mosaic of landforms and topography created through at least 35 million years of glacial and volcanic activity (Yake, 2003). The watershed falls within two major geologic provinces, the Cascade Range and the Basin and Range provinces. The oldest rock in the upper basin, a basalt, is part of the John Day formation and is believed to be about 12 million years old (Yake 2003). Layering this rock are deposits made 10 to 6 million years ago when lava, sediments and ash were shed by the emerging Cascade Range and from volcanic areas in the eastern portion of the basin. These layers – the Deschutes and Dalles formations – were deposited at a time when the basin was changing rapidly, particularly in the upper basin. The formations are topped by basalt flows from local sources that range from about 6 to 4 million years old and cover large parts of the uplands (O'Connor et al. 2003).

Parent soils in the watershed are primarily composed of ash, cinders, and pumice deposited from past volcanic eruptions. Pumice and ash tephras were expelled during the eruption of Mt. Mazama. This material remains in 0.5 to 1.0 meter depths on a gradient north to south and is the primary soil material holding the roots of vegetation in the area (Yake 2003; USFS 1997c). Below these deposits lie hard basalts, adesites, tuffs, breccias, glacial till and outwash gravels that were deposited during past volcanic eruptions. Because of the relatively recent volcanic activity, soils in the watershed have not had time to develop and mature (UDLAC 2003). The volcanic ash soils covering most of the watershed are light in color and have low fertility levels. They contain minor amounts of hard rock material and have little structural development — making them very sensitive to lateral soil movement or displacement.

The springs that provide most of the water for the Deschutes River were formed by past volcanic lava flows and the sedimentation from explosive volcanic events and glacial activity (Gannett et al. 2003). The highly permeable volcanic rocks allow rain and melting snow to easily sink into the ground and trickle downward to the water table.

Residual and non-forested soils cover a much smaller part of the watershed. These soils are generally found in areas of rocky mountain peaks, wet meadows, canyon walls, barren flats and scabs, cinder cones and lava flows. They are composed of older or weathered ash and residual material and have a thicker, darker surface and slightly better cohesion than the other volcanic ash soils in the watershed. The soils are reddish in color and textures range from gravely to stony fine sandy loam or clay loam. They are highly susceptible to detrimental soil compaction (Yake 2003; Crown Pacific FEIS 1998). Detailed information on soil types found in the Upper Deschutes Soil Survey is available at the USDA Agricultural Services Center (Deschutes SWCD office) in Redmond.

Vegetative communities vary over the upper Deschutes landscape. Mountain hemlock, alpine, and subalpine plant communities cover much of the high elevation areas and other areas where high precipitation occurs. Mixed conifer and ponderosa pine communities are common at middle elevations. In semiarid, lower elevation areas along the eastern edge of the basin, dominant species include sagebrush, juniper, and sparse ponderosa pine communities. Lodgepole pine occurs over a wide range of site conditions and elevations.

The upper watershed also displays a variety of riparian vegetations and conditions. Above Bend, riparian areas along the upper Deschutes River support stands of lodgepole pine and ponderosa pine, with understories of spiraea, snowberry, alder and willows, and herbaceous layers of forbs and sedges. Several large willow/sedge meadows are scattered along the reaches, as are lodgepole (wet) habitat (USFS 1996d). About 1,850 acres of meadow and 5,070 acres of lodgepole (wet) habitat exist along the Deschutes River above Bend (Yake 2003). Riparian vegetation condition along the brood floodplains of the Little Deschutes River include dense willow communities interspersed with wet meadows. Many remaining wet meadows and forested wetlands are associated with the high groundwater table in the La Pine area. Below Bend, the river corridor reflects the more arid, high desert climate. Deciduous vegetation consisting of alders and willows dominate riparian areas along river benches and islands.

3.1.2. Climate

The climate in the upper Deschutes watershed is considered continental. Lying in the rain shadow of the Cascade Mountains, the area receives much less precipitation than the western side of the Cascades. Storms approaching from the Pacific Ocean rise as they reach the mountains and release most of their moisture on the western slopes of the Cascades, creating a much drier climate on the eastern slopes. Most precipitation that reaches the watershed falls as snow between November and March. Mean annual precipitation varies widely, ranging from 140 inches in higher elevations down to 10 inches in the Deschutes Valley and the eastern part of the watershed (ODFW 1996a).

Temperatures in the watershed are characterized by moderate days and cool nights. Bend averages about 10 days per year with temperatures above 90°F. Low winter temperatures average between 20 and 30°F. Extreme temperatures can range from 100°F to minus 30°F.

3.2. Historic Environment

Historically, stable flows in the upper Deschutes River's supported lush riparian zones. Springs and seeps frequently occurred along the stream banks between the present sites of Wickiup Dam and the City of Bend. Below Bend, the tightly confined canyon of the Deschutes River exhibited many of the conditions seen today. Deciduous vegetation consisting of alders and willows dominated riparian areas along benches and islands. Juniper, scattered pine and various grasses and forb species armed the stable riverbanks created by a very uniform flow regime. The large springs in the lower reaches maintained relatively cool and stable year-round temperatures that provided ideal conditions for salmonid growth and survival.

Historic vegetation patterns in forested areas were shaped by frequent fire activity. Most stands were open in appearance and dominated by ponderosa pine. Journal notes by the Williamson, Abbott railroad survey crew in 1853 reflect these conditions. In the survey, Abbott wrote:

> *"We found yellow pine still abundant, forming by far the most constant feature in the vegetation of our route from Pit River to the Columbia. Near or distant, trees of this kind were always in sight; and in the arid and really desert regions of the interior basin we made whole days marches in forests of yellow pine, of which the absolute monotony was unbroken either by other forms of vegetation, or the stillness by the flutter of a bird, or the hum of an insect. The volcanic soil, as light and dry as ashes, into which the feet of our horses sank to the fetlock, produces almost nothing but an apparent unending succession of large trees of P. Ponderosa (Yake 2003; USFS 1998d)."*

Open stands of large trees also covered much of the Little Deschutes drainage. In 1843, Lieutenant John Fremont's expedition crossed through the Little Deschutes River drainage near the present community of Crescent. He wrote in his journal:

> *"The great beauty of the country in summer constantly suggested itself to our imaginations… the rich soil and excellent water surrounded by noble forests made a picture that would delight… these (ponderosa) pines are remarkable for the red color of their boles… all day we traveled over pumice stone; beautiful firs but no grass here (Gray 1986)."*

Other early surveyors also described vegetation conditions during their surveys. Notes from the Cascade Reserve Forest Survey of 1903 identify vegetation included mountain hemlock, huckleberry, laurel, manzanita, willow, and alder (Yake 2003).

In the Metolius watershed, the area of riparian vegetation probably resembled that seen today. Tall stands of ponderosa pine armored the stream corridor, along with a well-developed growth of deciduous vegetation consisting of chokecherry, red-osier dogwood, alder, willow and possibly cottonwood. The stream channel was very stable and constrained over most of its length, except for a few locations were braiding occurred. Water quality was excellent, with low contributions of fine sediment and cool summer streamflows (CTWS 1999a). There was also more large wood in the streams. Trees falling into the stable spring fed streams and rivers slowly developed floating island habitat, supporting first forb and graminoid plant associations and eventually shrubs. These islands were cover for aquatic wildlife, amphibians, and birds, and provided structural diversity in riparian areas for many other species (USFS 1996b).

The Squaw Creek watershed also displayed higher quality habitat conditions before the late 1800s when flow allocations for irrigation began. Higher summer flows created deeper pools for fish use during summer months and riparian vegetation, such as willows and cottonwood, provided cover for off-channel and pool habitat. The broad floodplain of Indian Ford Creek allowed safe refuge from flooding and may have been an important rearing habitat for redband trout. Water temperatures in Squaw Creek reflected the higher summer flows and healthy riparian areas. Before the late 1800s, water temperatures in the lower reaches of Squaw Creek were probably near ODEQ standard for temperature. Houslet (1998) found that if average summer flows were not diverted, the average maximum water temperature for August would be near 66.5°F above Alder Springs.

3.3. Current Environment

3.3.1. Hydrology

Water storage and releases drastically alter the natural flow regime of the Deschutes River. Two water projects, Crane Prairie Reservoir (1922) and Wickiup Dam (1945), regulate flows in the upper Deschutes River. Flows are also influenced by storage and release of flows from Crescent Lake in the upper Little Deschutes River.

Water storage projects at Wickiup Dam, Crane Prairie and in the Little Deschutes River — and water diversions for irrigation — have replaced the stable natural flows in the Deschutes River above Bend with flows as low as 20 cfs below Wickiup Dam in the winter when the reservoirs are being filled, and as high as 2,000 cfs during the height of the summer irrigation season when water is being released from the reservoirs. Presently, the maximum is about 1,600 cfs (Gorman 2004). Flows released out of Wickiup increase downstream with groundwater and runoff contributions from Fall river (90-160 cfs), Spring River (180-210 cfs) and the Little Deschutes River (5-3,500 cfs) above the City of Bend, and from Tumalo and Squaw creeks and springs below Bend.

Nearly all water released from Wickiup Reservoir during the irrigation season is diverted into six major canals. River flow below the diversion points during the summer is very low. Until recently, summer flows dropped to about 30 cfs. However, recent instream transfers and conservation work have brought that minimum up to 35 cfs (UDLAC 2003). The irrigation canals, mostly unlined and dug through highly porous soils, leak a substantial amount of water. Some estimates have put the overall transmission losses at 50% (UDLAC 2003). Several irrigation districts are working on lining and piping projects to conserve water. North Unit Irrigation District, for example, has lined the first twelve miles of its canals to prevent seepage so that irrigators can use the saved water on their farms.

In 1983, the Oregon Department of Fish and Wildlife received three instream water rights for the Deschutes River from Wickiup Dam downstream to North Canal Dam. These rights are 300 cfs from Wickiup Dam to the Little Deschutes River; 400 cfs from the Little Deschutes River to Spring River; and 660 cfs from Spring River to North Canal Dam. These instream water rights have a priority date of November 3, 1983 and are junior to existing water rights. These instream water rights are currently not being met on a year-round basis.

3.3.2. Water Quality

Water quality problems exist in several reaches of the Deschutes River and tributaries, including seasonal temperature extremes (i.e. high summer temperatures and winter icing), high erosion rates, low dissolved oxygen and other problems (Table x).

Table x. Stream reaches in the Upper Deschutes Watershed that exceed Oregon's Water Quality Criteria, as listed in 2002. [replace with table similar to other two]

Stream Segment	Temp	pH	Dissolved Oxygen	Chlorophyll *a*	Bacteria	Habitat Modification	Flow Modification
Deschutes River (Lake Billy Chinook)		summer		spring/ summer/fall			
Deschutes River (Lake Billy Chinook to Steelhead Falls)		summer					
Deschutes River (Steelhead Falls to North Unit Main Canal)	summer	summer					annual*
Deschutes River (North Unit Main Canal to Central Oregon Canal)		summer					
Deschutes River (Central Oregon Canal to Wickiup Reservoir)			annual			annual	Annual
Deschutes River (Wickiup Reservoir to Crane Prairie Reservoir)	summer						
Lake Creek, North Fork (mouth to Suttle Lake)	summer						
Lake Creek, South Fork (mouth to Suttle Lake)	summer						
Odell Lake		summer					
Squaw Creek (Alder Springs to Maxwell Ditch)	summer						Annual
Tumalo Creek (mouth to Columbia Southern Canal)							Annual
Crescent Creek (mouth to Crescent Lake)	summer						
Little Deschutes River (mouth to Hemlock Creek)	summer						
Paulina Creek (mouth to Paulina Lake)	summer						
Willow Creek	summer						

3.3.3. Land Use and Management

Approximately 75% of the Upper Deschutes Watershed is in public ownership. The primary land manager in the watershed is the Forest Service, which manages about 66% of the watershed [need to add Little Deschutes]. Other public lands in the watershed are managed by the Bureau of Indian Affairs (0.01%), Bureau of Land Management (8.60%), and state agencies (0.55%).

Privately-owned lands cover about 25% of the upper watershed (Yake 2003). Private owners manage most of the land adjacent to the Deschutes and Little Deschutes rivers, and over half of the lands adjacent to Tumalo and Squaw creeks. Private land use varies throughout the watershed. Most lands around the La Pine area are used as grazed timberland and for subirrigated agriculture. Cropland and pasture irrigated with Deschutes River water extend from the Bend area to the Lower Bridge-Terrebonne area. Forage, cereals and seed crops are the dominant crops grown on irrigated lands, with irrigated pasture and alfalfa accounting for most of the consumptive use of water (UDLAC 2003). Subdivision of large farms and ranches into “hobby” farms has resulted in an increase in livestock numbers. Livestock include llamas, horses, beef and breeding cattle, poultry, sheep, goats and a few dairy cows.

Wild and Scenic Rivers

A total of 147.3 miles of stream within the Upper Deschutes Watershed were included in the Wild and Scenic Rivers program in 1988. The river segments are to be managed “to protect river values and the management plan shall be coordinated with resource management planning for affected adjacent Federal lands (USFS 1996a)”. Designated river reaches include:

- Deschutes River from Wickiup Dam to the north boundary of Sunriver (RM 226.7 to RM 186.2), recreational.
- Deschutes River from the north boundary of Sunriver to Lava Island Camp (RM 186.2 to RM 175), scenic
- Deschutes River from Lava Island Camp to the Bend Urban Growth Boundary (RM 175 to RM 172), recreational.
- Little Deschutes River from headwaters to Hemlock Creek (RM 97 to RM 84), scenic?.
- Crescent Creek, a tributary to the Little Deschutes River, from Crescent Lake Dam to Country Road 61 crossing (RM 84-97), recreational.
- Big Marsh Creek, a tributary to Crescent Creek, from headwaters to its confluence with Crescent Creek, recreational.

Several segments of the Deschutes River have also been designated as State Scenic Waterways. State Scenic Waterway designations for this section of the Deschutes River include; Little Lava Lake to Crane Prairie Reservoir (RM 253 to RM 230), the stream gauge below Wickiup Dam to General Patch Bridge (RM 226.6 to RM 199), Harper

Bridge to the Central Oregon Irrigation District diversion (RM 192.6 to RM 171), Sawyer Park to Tumalo State Park (RM -- to RM 159), and from Deschutes Market Road bridge to Lake Billy Chinook (RM 134.5 to RM 120, excluding the Cline Falls hydroelectric facility). State Scenic Waterway designations include the river and the riparian areas extending one-quarter mile on either side of the river. Sections in the Upper Deschutes Watershed are designated as either Community River Areas in recognition of close private development, or Recreational River Areas, which have easy access to the river.

3.4. Focal Fish Species of the Upper Deschutes Watershed

Before construction of the Pelton Round Butte Project in the 1960s, the Deschutes River (up to Big Falls), Squaw Creek and the Metolius River supported runs of spring and fall Chinook, summer steelhead and Pacific lamprey. Anadromous fish passage was terminated in 1968 with the failure of fish passage facilities at the Pelton Round Butte Project, eliminating salmon and steelhead runs from the Upper Deschutes River watershed and also ended upstream migrations of lampreys and redband and bull trout.

Today, the Upper Deschutes Watershed supports healthy resident indigenous fish populations. Currently Portland General Electric and Warm Springs Power Enterprises are pursuing efforts to reintroduce anadromous fish upstream of Round Butte Dam. The intent of the plan is to restore sockeye and spring Chinook salmon and summer steelhead to their historical range in the upper Deschutes drainage.

3.4.1. Chinook

Historically, spring Chinook returned to the upper Deschutes River (up to Steelhead Falls or Big Falls) and to Squaw Creek and the Metolius River. The Metolius River was the major spring Chinook spawning and rearing area in the upper Deschutes watershed. Reports of early explorers (1855 and 1874) note that salmon in the Metolius River were very abundant (Nehlsen 1995; Davidson 1953). The last good Chinook run (149 spawning salmon and 200 redds observed) was reported in the Metolius and tributaries in 1953, after which the run began to decline (Nehlsen 1995). Spring Chinook were last documented in the Metolius by spawning ground counts in 1967 (ODFW 1996a). Spring Chinook were observed in the Deschutes River at the Steelhead Falls fish ladder trap in 1953. In Squaw Creek, records of spawning salmon and redds in Squaw Creek from 1951-1960 showed a high count of 30 in 1951 and 0 by 1960 (Nehlsen 1995). Accounts of spring Chinook abundance are not available before 1950.

Today, a small landlocked Chinook population may exist in Lake Billy Chinook. However, ODFW receives only infrequent reports of their presence and has captured only one individual in recent years (Marx 2004).

3.4.2. Redband Trout

Summer Steelhead

Historically, Big Falls was likely the upstream limit of anadromous fish migration, as steelhead are believed to have negotiated Steelhead Falls in high winter or early spring flows (Nehlsen 1995). The length of this migration period increased in 1922 after the fishway was constructed, which allowed them to move upstream through the fish ladder for a period of years. It was determined that a minimum flow of about 300 cfs in the

Deschutes River at Bend was required to assure adequate efficiency of the fishway. After 1930, such flows were available only in November through April, possibly hampering summer and fall migrating fish in their attempts to move above Steelhead Falls. Fishways were constructed at Big Falls and Cline Falls in the 1920's, but no steelhead were ever observed attempting to pass either falls (Nehlsen 1995; Mathisen 1985a). Summer steelhead were trapped in the Steelhead Falls fishway in 1953, 1954 and 1955. Eighteen fish were recovered at the falls during those years (Nehlsen 1995).

Squaw Creek was historically a primary spawning area for summer steelhead in the Upper Deschutes Basin. In 1952 and 1953, Montgomery estimated that a minimum of 582 steelhead used Squaw Creek in 1952 (461 counted) and 1,000 spawned in the creek in 1953 (619 counted) (Nehlsen 1995). By this time, steelhead use had already declined because of irrigation diversions and other uses. Steelhead were also documented in the Metolius River, but in very small numbers. Elders from the Warm Springs Tribe of Warm Springs do not believe they were indigenous to the Metolius (ODFW 1996a; Terry Luther, personal communication, 1993).

Resident Redband Trout

Historically, redband trout were found throughout the Upper Deschutes watershed in waters connected to the Deschutes River. Presently, they are found in the mainstem Deschutes River from Lake Billy Chinook upstream to the headwaters, the Little Deschutes River, Crescent Creek, Squaw Creek, Tumalo Creek, and Odell Creek.

3.4.3. Pacific Lamprey

Pacific lamprey probably occurred in the Deschutes River above the Pelton Round Butte Project, however, very little is known about their life history or abundance in the watershed.

3.4.4. Sockeye

Sockeye salmon once migrated up the Metolius River and into the Lake Creek-Suttle Lake complex to spawn. The run was suppressed by the 1930's due to passage problems at artificial dams on Lake Creek near the outlet of Suttle Lake. The last sizable run of sockeye in the Metolius was 227 adults reported in 1955, though most of these adults were likely hatchery returns from the Oregon Fish Commission's Metolius Hatchery on Spring Creek (Nehlsen 1995). The native run of sockeye in Suttle Lake and Link Creek was reported extinct by 1940 (Frey 1942).

3.4.5. Bull Trout

Bull trout were historically found throughout most of the Deschutes River subbasin. There are many historical photos of large bull trout or "Dolly Varden" as they were called from both the Upper Deschutes River near Bend and from the Metolius River basin. Bull trout were extirpated from the Deschutes River mainstem in the 1950's due primarily to flow manipulations and dams with no upstream fish passage (Buchanan et al. 1997). Today, they are found in Odell Lake, occasionally in Odell Creek and Davis Lake, Squaw Creek below Alder Springs, the Metolius River and tributaries, Crooked River downstream of Opal Springs Dam and in the Deschutes River from Lake Billy Chinook upstream to Big Falls (Marx 2004).

3.5. Focal Wildlife Species of the Upper Deschutes Watershed

Ponderosa pine and lodgepole pine woodlands are a wildlife habitat in the upper watershed that has been fragmented. Maps of historic and current wildlife habitat show that these woodland habitats — pure ponderosa pine or lodgepole pine forests or mixed forests — existed historically in large areas in the southern subbasin south of Bend. These habitats have been reduced and fragmented apparently due to suburban development and encroachment by other conifer forest types. A wildlife species that occurs in this habitat, and that is thought to have declined since historic times, is the white-headed woodpecker. Mule deer are also an important species that utilize this habitat.

[Additional information will be added once focal wildlife species/habitats are identified.]

3.6. Current Conditions in Major Drainages

This section describes current environmental conditions within the major reaches and drainages of the upper Deschutes River from the Pelton Round Butte Project to the headwaters. These include:

- the Deschutes River, Pelton Round Butte Project
- Willow Creek
- Metolius River
- Deschutes River, Lake Billy Chinook to Bend
- Squaw Creek
- Tumalo Creek
- Deschutes River, Bend to Benham Falls
- Deschutes River, Benham Falls to Wickiup Dam
- Spring River
- Little Deschutes River
- Fall River
- Deschutes River above Wickiup Dam.

3.6.1. Deschutes River, the Pelton Round Butte Project (RM 100-120)

The Pelton Round Butte Project spans a 20-mile reach of the Deschutes River. The project consists of three dams and their associated reservoirs. The Reregulating Dam (RM 100.1) sits at the downstream end of the Project. Above this small reservoir, Pelton Dam forms Lake Simtustus. Round Butte Dam, immediately above Lake Simtustus, creates Lake Billy Chinook, which inundates the lower reaches of the Crooked and Metolius rivers, as well as a considerable stretch of the Deschutes.

> **Reregulating Reservoir —** The Reregulating Reservoir extends about 2.5 miles between the Reregulating Dam and Pelton Dam. The small reservoir has a maximum pool elevation of 1,435 feet and fluctuates approximately 20 feet in elevation daily to maintain steady outflow into the Deschutes River while electricity is generated (PGE 1999). Because of large water level fluctuations, fish production is

minimal and no public use is allowed at this reservoir. Fish routinely enter the reservoir through the Pelton Dam turbines and pass the Reregulating Dam into the lower river.

Lake Simtustus — Lake Simtustus extends about 7 miles above Pelton Dam to the base of Round Butte Dam. Two small tributaries enter Lake Simtustus. Seekseequa Creek, a seasonally dry stream, joins the lake from the west and Willow Creek joins the lake from the east. Lake Simtustus is a narrow reservoir confined between 800-foot high walls of the Deschutes River canyon. The reservoir has a normal maximum surface elevation of 1,580 feet above sea level, approximately 18 miles of shoreline, and 540 surface acres (PGE 1999). Because of the steep canyon walls, only about 12% of the reservoir is less than 10 feet deep. The lake fluctuates little in elevation year-round and the shoreline supports dense growths of alders, shrubs and grasses.

Lake Billy Chinook — Lake Billy Chinook extends about 9 miles up the Deschutes River canyon, 7 miles up the Crooked River canyon and 13 miles up the Metolius River canyon. The reservoir has a maximum depth of 400 feet and a surface area of 4,000 acres. Over 60% of the reservoir is more than 100 feet deep and only 6% is less than 10 feet deep. In a typical year, the reservoir is drawn down about 10 feet from November until February or March, and refilled in April and May (PGE 1999).

Fish habitat in Lake Billy Chinook is characterized by steep shoreline topography, boulder, cobble and sand substrate, and generally good water quality. The steep topography and coarse substrate around the reservoir limit the growth of emergent vegetation. Habitat in the reservoir is well-suited for kokanee, which rears in the reservoir and moves into the Metolius River to spawn. Habitat conditions improve considerably in the transition zones at the mouths of all three rivers. This habitat is particularly well-suited for resident salmonids. The three areas provide habitat for an abundance of rainbow and brown trout. The Metolius River Arm also provides good habitat for juvenile and subadult bull trout (PGE 1999).

3.6.2. Willow Creek

Willow Creek and tributaries drain about 180 square miles. The creek begins on forested slopes of the Ochoco Mountains and flows west 34 miles to join the Deschutes River in Lake Simtustus (RM 105). The drainage supports redband trout.

Upland Conditions
From its mountainous headwaters, Willow Creek flows through private range and agricultural lands, and through the Crooked River National Grasslands and the City of Madras. Land use in the watershed is 10% forest, 65% rangeland, and 25% cropland. About 70% of the cropland is irrigated for crops including grass seed, alfalfa, seed potatoes, carrot seed, grains, flower seed, hay, nursery crops, herbs, mint, sugar beets, onion seed, and garlic. Non-irrigated crops include hay, small grains, CRP, and pasture. Sixty percent of the cropland (15,000 acres) is classified as Highly Erodible Land (MDLAC 2001). Public lands on the Crooked River National Grasslands are used for livestock grazing and recreation.

Riparian Conditions
Habitat surveys conducted by ODFW in July 1980 showed that Willow Creek and many of its upper tributaries were in poor to very poor habitat condition. Stream shade

averaged 17%, with less than 20% shade on public lands and 12% shade on private lands (ODFW 1996c). Riparian conditions in some reaches are improving through better land management and habitat restoration. Conditions improve below the City of Madras, where the creek flows through a narrow basalt canyon to its confluence with the Deschutes River. Livestock use and human access are limited in this lower reach.

Instream Conditions
Lower Willow Creek flows through a rough, narrow canyon and has good instream habitat, including spawning gravels and deep pools. The stream has been channelized through the town of Madras and is dry, or nearly dry in this reach from summer through fall. Upstream from Madras the stream is again confined within a rimrock canyon and generally lacks instream wood. However, considerable structural diversity is maintained from large rocks and boulders. Upstream of the Crooked River Grasslands some reaches have been channelized and the stream is incised in some areas with active bank erosion. Instream habitat complexity is generally lacking and the substrate has a high fine sediment content.

Flows
Flows in Willow Creek are typically highest from February to May with heavy rains or snowmelt, and lowest during summer. Low summer flows drop further in upper and middle reaches where they are diverted for irrigation. Streamflow above the town site of Grizzly between October 1967 and December 1978 averaged 1.51 cfs, with long periods of no flow. A high flow of 52 cfs occurred in April 1978. Flows are typically highest from February through May (MDLAC 2001).

ODFW's habitat surveys have shown that flows were moderate in forested upper reaches, ranging from 0.5 to 3 cfs, but became intermittent to nonexistent when the stream entered irrigated farmlands. Streamflows were also intermittent to nonexistent in the middle section of Willow Creek, with the exception of the Crooked River National Grasslands, where flows ranged from 0.5 to 3 cfs. Streamflow below the Grasslands once again became intermittent to nonexistent when adjacent to irrigated agricultural lands (ODFW 1996c).

Streamflow is most consistent in the canyon below Madras downstream to Lake Simtustus where access and livestock utilization are minimal. Habitat conditions improve below RM 4.5 where spring releases increased flows in Willow Creek downstream to the mouth. ODFW surveys indicate that together 12 small springs add an estimated 22.7 cfs at an average temperature of 68^{o}F. The streamflow at the mouth of Willow Creek was estimated at 27 cfs (ODFW 1996c).

Water Quality
Stream temperatures range from 51^{o} to 88^{o}F (ODFW 1996). Stream temperatures in Willow Creek exceed the state water quality standard of 58^{o}F. Water quality conditions for Willow Creek were reported to be moderate to severe for water quality, fish, and aquatic life (ODEQ 1988).

3.6.3. Metolius River

The Metolius River is one of the largest spring-fed streams in Oregon. The river originates from three springs and flows 29 miles to its mouth in Lake Billy Chinook. The drainage covers 315 square miles and contains 110 miles of perennial streams, 324 miles of intermittent streams, 42 lakes and 121 ponds. Major tributaries to the Metolius include Lake, Spring, Jack, Canyon, Abbot, Candle and Jefferson creeks and the Whitewater River.

Upland Conditions

Land ownership in the Metolius River drainage is approximately 60% federal (Deschutes National Forest), and 40% private and Tribal land. Primarily land uses include recreation, timber, farming and residential. A 28.6-mile reach of the Metolius is designated as Wild and Scenic. Fisheries, scenery, hydrology, geology, recreation, wildlife, and ecological values in the designated stretch are classified as “Outstandingly Remarkable” in the Metolius Wild and Scenic River Plan (USFS 1996b).

Riparian Conditions

The stable flows within the Metolius River promote a healthy riparian corridor along the stream and undercut banks. Good riparian growth also exists along most of the river’s tributaries. There are few wetlands along the Metolius, but several tributaries have extensive marshy areas, particularly in the Lake Creek area.

Instream Conditions

Healthy riparian vegetation and undercut banks along the Metolius create good fish habitat. Stream channels are generally stable with functional floodplains and habitats created by beaver activity, including ponds and wetlands. High quality spawning gravel suitable for redband trout is most abundant above Gorge Campground.

The Metolius River has a relatively uniform gradient, which increases from 25 ft per mile between the headwaters and Lower Bridge, to 44 ft per mile in the lower reaches. Pool, riffle, and glide characteristics are not as well defined as those of similarly sized rivers because of the river’s spring-fed nature, the lack of flood events, and the relatively uniform gradient within a volcanic bed. Low supplies of large wood limit fish habitat in the Metolius River. Habitat enhancement projects initiated since the early 1980s have increased fish cover in the river, particularly above Camp Sherman Bridge. In addition, the USFS and Warm Springs Tribes now manage the Metolius River corridor to increase the amount of wood entering the stream (USFS 1995a; CTWS 1992).

The cool spring-fed tributaries to the lower Metolius River — Jack, Canyon, Candle and Jefferson creeks and Whitewater River, which drains Mt. Jefferson — contain abundant spawning gravel, undercut banks, side channels and wood that form high quality bull trout rearing habitat (Ratliff et al. 1996). The tributaries also support few fish species that compete with bull trout, probably because of the cold water (USFS 1995a).

Flows

The Metolius originates from spring releases of 100 to 110 cfs and runs bankfull at all times. Average flows at the river’s mouth range from 1,653 cfs in June to 1,360 cfs in October. Flows for a 69-year period from 1913, and 1922 to 1989 measured just above the river’s confluence with Lake Billy Chinook averaged 1,493 cubic feet per second (USGS 1990). The lowest discharge (1,080 cfs) occurred in February 1932 and the highest discharge (7,530 cfs) occurred in December 1964 (USGS 1989).

Water Quality

Water quality is generally excellent throughout the Metolius system due to spring sources in the tributaries and in the mainstem. Water testing has shown low dissolved solids, low alkalinity, and low conductivity. Phosphorus levels have measured higher than the recommended DEQ maximum. The tributaries generally have low conductivity and nutrients, compared to the Metolius River water.

Water temperatures in the Metolius generally do not exceed 50°F (measured at Bridge 99) during the summer. The cool flows are preferred by bull trout, but limit growth of redband trout, which prefer temperatures of 55-65°F. Unlike most rivers, summer temperatures in the Metolius River generally get colder with distance downstream because tributaries entering the lower river are cooler than those near the headwaters. The headwater spring has summer temperatures of about 48°F, while Spring Creek enters the Metolius at about 44°F. The river's cool, stable flows create a unique habitat for fish. Fish in the river experience less disease and parasite problems than typically found in warmer rivers. Still, water temperatures in the lower Metolius River can exceed the temperature standard for bull trout (50°F) during certain seasons of the year. Lake Creek is also listed for exceeding summer temperature criterion.

3.6.4. Deschutes River, Lake Billy Chinook (RM 120) to Bend (RM 164.8)

The Deschutes River extends 44.8 miles between Lake Billy Chinook and the City of Bend at North Canal Dam. The reach includes 120 miles of perennial streams, and tributaries Squaw Creek and Tumalo Creek. Several falls exist within the reach, including Steelhead, Big, Odin, Cline and Awbrey falls. Big Falls (RM 132) was historically considered the upstream limit of anadromous fish passage. A significant amount of flow from the Deschutes River is diverted for irrigation at the upper end of this reach.

Upland Conditions
Land ownership in the reach is approximately 61% private, 34% federal, 3% state and 2% county. Land uses include farming, rural residential development, municipal and recreation. The area includes the fast growing communities of Bend and Redmond.

The Deschutes corridor changes dramatically below Bend, leaving the forested landscape and entering a high desert landscape where upland vegetative communities are dominated by juniper and sparse ponderosa pine communities. The well-defined basalt canyon varies in width from a few hundred yards to one-half mile. The canyon gradually deepens to about 700 feet and becomes narrower near Lake Billy Chinook.

Riparian Conditions
The riparian area in canyon sections is narrow and dominated by woody species, such as alder, red-osier dogwood, willow, chokecherry, rose and by sedge, rush and various grasses. Few areas are broad enough to support extensive willow or sedge growth. Riparian vegetation is thicker when springs emerge from the canyon walls.

Instream Conditions
ODFW habitat surveys (1993) describe habitat conditions within five sections of this reach. The survey was completed during the summer low flow period. Findings from this survey, as described in ODFW's Upper Deschutes River Watershed Fish Management Plan (1996), are summarized below:

> **Steelhead Falls to Long Butte, 25 river miles —** The reach of the Deschutes River from Steelhead Falls to Long Butte is constrained by steep (80%) and moderate v-

shaped hill slopes (15%). Average width of the active channel was 109 feet with a wetted width of 62 feet. Gradient averaged 0.6%. Streambank stability was excellent and protected by non-erodible substrate and vegetation. Instream wood material was lacking to absent. Habitat area was 29% pool, 37% riffle, and 19% glide. Pools through the section averaged 8.6 feet in depth. Streambed substrate was classified as 28% cobble, 23% boulder, 18% bedrock, and gravel 16%. Sand and silt substrate made up the balance. Special cases through the section include Awbrey, Cline, Steelhead and Big falls. An additional 24 steps or falls were identified.

Long Butte upstream 1.3 miles — The river valley became more open in this section. The active channel averaged 96 feet with a wetted width averaging 47 feet. Gradient averaged 0.5%. Streambank stability was excellent and provided almost solely by streambank vegetation. Wood material was lacking. Habitat distribution was classified as 61% riffle and 38% glide. No pool area was identified. Substrate was classified as 48% cobble, 24% gravel, 13% sand, and 11% boulder, with silt and bedrock comprising the balance.

Upstream end of Long Butte section to Tumalo, 1.3 river miles — This river section is constrained by steep, v-shaped hill slopes. No actively eroding areas were identified and non-erodible streambank and vegetation provided stability. The active channel width averaged 87 feet with a wetted surface width of 47 feet. Gradient through the section was 0.4%. Habitat distribution was 70% pool, 17% riffle, and 11% rapids. Substrate included 34% boulder, 28% cobble, 13% sand and 11% for each gravel and bedrock. Wood material contribution was insignificant through the section.

Tumalo to upstream end of Tumalo State Park, 3.5 river miles — Above Tumalo, valley width increases with the river constrained by terraces. The entire length of streambank was stabilized by vegetation. Active channel width averaged 125 feet, with a wetted width of 54 feet and depth of 0.49 feet. Gradient was 0.3%. Glide habitat comprised 49% of the total area with riffles 38% and pools 12%. Substrate was classified as 40% cobble, 28% gravel, 14% boulder, and 10% silt. Sand and bedrock made up the remaining substrate.

Tumalo State Park to North Canal Dam, 5.8 river miles — Steep V-shaped hill slopes contain most of the channel between Tumalo State Park and North Canal Dam. Active channel width averaged 85 feet, with a wetted width of 47 feet. Depth averaged 3 feet. Section gradient was 1.2%. Streambanks were stabilized by non-erodible substrate and vegetation, and no eroding streambanks were identified. Habitat distribution included 32% pool, 22% glide, 25% riffle, with the balance composed of cascades, step/falls, and rapids. Substrate through the section was 34% boulder, 25% cobble, 15% bedrock, 14% gravel, 9% sand, and 4% silt.

Survey results showed that good spawning habitat in the Deschutes between Steelhead Falls and Bend is not abundant, though there is good spawning habitat in the Foley Waters area just upstream of Steelhead Falls (ODFW 1996a). Biologists determined that spawning is most likely confined to small pockets of gravel in the mainstem and in the lower two miles of Squaw Creek and in Tumalo Creek. They determined that carefully selected placement of gravel and rearing habitat throughout the mainstem should greatly increase available brown and redband trout spawning habitat — though improved summer flows would be needed to realize any benefit (ODFW 1996a).

Flows

Before irrigation began in the late 1800s and early 1900s, flows in the Deschutes River at Bend normally ranged from 1,500 to 1,600 cfs during summer months. Flows occasionally dropped to 1,100 to 1,200 cfs in mid-winter, but only for a few days. By the 1920s, following irrigation development in Deschutes and Jefferson counties, nearly the entire flow at the North Canal Dam at Bend was diverted during the irrigation season. Today on average, 90% of the water in the Deschutes is diverted near RM 164 during the high withdrawal months of June through September (Yake 2003). Inflow from two tributaries, Tumalo and Squaw creeks, and from springs beginning near Steelhead Falls, add streamflow to the Deschutes River below Bend. Still, flows between Bend and Lower Bridge reach as low as 30 to 35 cfs in hot summer months during the irrigation season (although historical short-term flows to 1 cfs have been recorded).

Water Quality

The reach of the Deschutes above Steelhead Falls is included on the state 303(d) list for exceeding water temperature criterion for salmonid spawning (September 1 through June 30) and for salmonid rearing. The highest recorded water temperature for the reach was 81°F in 1994 (ODFW 1996a). The reach is also listed for exceeding state pH standards. Increases in water temperature and pH have been attributed to a combination of higher ambient air temperatures, low flows, lack of riparian vegetation, agricultural return flow, and excessive growth of aquatic vegetation (primarily algae) during the summer (BOR 1997). Low flows are believed to be the main cause of increased water temperatures and to contribute to nutrient concerns (UDLAC 2002).

3.6.5. Squaw Creek

Squaw Creek begins on the Bend Glacier of Broken Top Mountain, flows 39 miles in a northeasterly direction through the City of Sisters, and enters the Deschutes River at RM 123.1, about five miles below Steelhead Falls and a few miles above Lake Billy Chinook. Elevations range from more than 9,000 feet in the headwaters to about 2,100 feet at the mouth of Squaw Creek.

Squaw Creek was once the primary spawning area for steelhead in the upper Deschutes watershed. The drainage also supported populations of spring Chinook and redband trout. Steelhead and resident redband trout migrated up Squaw Creek to the lower falls near the wilderness boundary. They also migrated up Indian Ford Creek to the Black Butte Ranch area and into lower Snow Creek. Spring Chinook were likely confined to a smaller area of the drainage. There are no historic records of bull trout or lampreys in Squaw Creek, but it is likely that both bull trout and lampreys frequented the stream historically. Today, Squaw Creek continues to provide important habitat for native redband tout and brown trout in the lower 15-mile reach, primarily due to springs that provide water during low flow periods. Trout production occurs mainly in those stream reaches having ample summer flows and lower water temperatures. Bull trout have been observed in the lower stream reach in recent years. Introduced brown trout and brook trout are also present in Squaw Creek (Lewis 2003; Hubler 2000).

Upland Conditions

Squaw Creek watershed covers 230 square miles. It drains the glacial flanks and forests of Broken Top and the Three Sisters in the Cascade Mountains, and then sagebrush steppe before reaching the Deschutes River at RM 123. It also flows through the City of Sisters and through lower valley farm and ranch lands.

Riparian Conditions

Riparian areas along upper Squaw Creek are generally in good shape, though some areas show damage from timber harvest and recreation use. The most severe riparian condition is within the stream section beginning just south of Sisters and extending downstream for eleven miles. This section was further degraded after the 1964 flood. In an attempt to repair damage and reduce future risks from flooding, the reach was cleared of debris and the channel was straightened and widened by up to 150 feet. Downstream of Sisters, Squaw Creek has a broad riparian area comprised of floodplains, willow stands, and cottonwood bottom lands. In some areas, riparian communities are limited by geology, or have been altered from grazing and channelization.

Instream Conditions

Riparian floodplains along Squaw Creek once served as a dynamic system of gravel bar deposits and pool formation while floods covered vulnerable areas. These bottomlands also may have been some of the most productive habitats for steelhead and salmon spawning and rearing. Alterations to these riparian communities from overgrazing and channelization have reduced habitat quality for the native redband trout and other species ODFW 1996a). In particular, channel simplification has reduced channel complexity and stability from RM 18.8 to 23.5. Large wood volume is low or absent from the channel below RM 25. Seven irrigation diversions, all unscreened, also impact fish passage during low stream flows.

Flows

Streamflow in Squaw Creek is notoriously “flashy”, fluctuating from extreme high flows to low flows that at times go subsurface. Glacial runoff maintains a consistent level of flow in Squaw Creek, which is augmented by rain and snowmelt in late spring. Fall and winter flows of 70 cfs rise to 200 cfs or more as snow melts in June. Rain and snow flood events can often cause flows to rise above 1,000 cfs. Flows in Squaw Creek are lowest during October and March, providing a mean and record flow of 60 and 63 cfs, respectively (Curtis 1994). Releases from springs supplement flows in some reaches below the town of Sisters and near the mouth of Squaw Creek. Alder Springs (RM 2) provides an important refuge for bull trout, redband trout and other fish populations.

Natural flow pattern in Squaw Creek remains generally undisturbed from the headwaters to about RM 23.5, where a series of irrigation diversions remove most water from the stream. The stream is largely dry near the town of Sisters in summer months, although recent projects have put some water back in this stream section. Between Sisters and RM 17, flows gradually improve with spring releases and return flow. Springs near Camp Polk Road (RM 17) contribute about 7 cfs to flows in Squaw Creek. Indian Ford Creek, which joins Squaw Creek at RM 20, also dries up due to irrigation diversions and natural seepage. Water lost in this tributary system may resurface as springs in lower Squaw Creek. Alder Springs contributes about 20 cfs to the stream. At the mouth, nearly 100 cfs discharges to the Deschutes because of spring inflow (UDLAC 2003).

Water Quality

Water quality in Squaw Creek differs significantly from the nearby Metolius River. The Oregon Department of Environmental Quality rated Squaw Creek as severely impacted by turbidity, low dissolved oxygen, nutrients, streambank erosion, decreased stream flow, and insufficient stream structure. Most of these factors can be linked to reduced flow from irrigation and domestic water use, or channel alterations from the 1964 flood and subsequent channel modifications.

The stream exhibits high water temperatures during summer months. High water temperatures particularly limit fish production in reach between RM 1.5 and 25. Below water diversions near the City of Sisters, water temperatures in Squaw Creek can rise to over 70^{o}F. In 1994, ODFW measured water temperatures in Squaw Creek at RM 6.0 from April 15 to October 1. Results showed a mean temperature of 62.1^{o}F, a minimum temperature of 42.8^{o}F and a maximum temperature of 86^{o}F. The warmer water temperatures result in lower dissolved oxygen as the stream flows through the dry canyon section (ODFW 1996a). Black Butte Ranch (on Indian Ford Creek) has an NPDES permit for discharge of the treated effluent from their wastewater treatment plant into Indian Creek. They are not allowed to discharge in the summer (Lamb 2004).

3.6.6. Tumalo Creek

Tumalo Creek and tributary Bridge Creek originate as springs and as snowmelt from Tumalo and Broken Top mountains, approximately 20 miles west of Bend. It enters the Deschutes River at RM 160.2 just north of the City of Bend. The mainstem of Tumalo Creek is approximately 16 miles long. Four tributaries — North Fork, South Fork, Middle Fork and Bridge Creek — contribute 20 additional stream miles to the basin.

Upland Conditions
Tumalo Creek flows from subalpine park-like vegetation near Broken Top through areas of Douglas fir dominant –mixed conifer forest, manzanita dominant shrubland, ponderosa pine forest and woodland, and finally western juniper woodland before joining the Deschutes River (Yake 2003). Land ownership in the drainage is 67% federal (Forest Service), 24% private, 8% city (Bend), 1% county (Deschutes) and >1% state (Parks). Primary land uses in the basin are recreation, timber, farming, residential, mining, and water withdrawal. Bridge Creek, a major tributary to Tumalo Creek, is a principal source of water for the City of Bend, which maintains a diversion facility in Tumalo Creek (RM 15). Approximately 2.6 miles of Tumalo Creek flows through Shevlin Park, owned and operated by Bend Metro Park and Recreation District.

Riparian Conditions
Riparian conditions remain good along much of Tumalo Creek and its tributaries. Areas along three miles of Tumalo Creek and one mile of Bridge Creek burned in 1979 during the Bridge Creek Fire. Salvage operations following the fire removed large amounts of large woody debris from the stream and streambanks.

Instream Conditions
While the system contains good spawning gravel, fish production in lower Tumalo Creek is limited by lack of pool habitat and a limited supply of large wood. Instream habitat diversity is also restricted in reaches burned by the Bridge Creek Fire. Fish movement barriers include the Tumalo Feed Canal diversion (RM 2.5) and Tumalo Falls (RM 15.4).

Flows
Tumalo Creek flows drop below the Tumalo Feed Canal, an irrigation diversion point at RM 2.5, during the irrigation season. Since 1992, a minimum flow of 2.5 cfs has been

maintained in the creek below the feed canal. This minimum was increased to 5.8 cfs in 2001 when an instream water right was placed on the creek from the Tumalo Feed Canal to the mouth. The water savings has been largely due to conservation efforts by the Tumalo Irrigation District. The only significant diversion from Tumalo Creek above the feed canal is the City of Bend. Low summer flows in Tumalo Creek below RM 2.5 continue to restrict fish movement.

Water Quality
Naturally cold water temperatures in upper Tumalo Creek limit salmonid production. In the lower reach below RM 2.5, summer water temperatures rise to levels that restrict salmonid production during the irrigation season.

3.6.7. Deschutes River, Bend (RM 164.8) to Benham Falls (RM 181)

Benham Falls, a high gradient natural cascade, separates the Deschutes River into two logical sections, with low gradient above the falls and high gradient below. Below Benham Falls, the Deschutes courses through lava formations that result in falls and copious whitewater. Rainbow trout are the dominant fish species in the reach.

Upland Conditions
Much of this reach of the Deschutes flows through ponderosa pine forests on the west side and lava flows on the east. The lower end of this reach of the Deschutes River flows through City of Bend urban growth boundary.

Riparian Conditions
Lava flows, boulders, and rubble armor a considerable portion of the streambed and banks from the erosive action of high irrigation flows. On the east side, relatively undisturbed patches of ponderosa pine, alder and aspen dominate riparian vegetation in areas that escaped lava flow. Vegetation along the west side of the Deschutes shows signs of disturbance from recreational use, particularly from Benham Falls to Lava Island Falls (Yake 2003). Riparian conditions along the Deschutes River through the City of Bend have been disturbed by industrial, residential and commercial uses.

Instream Conditions
Four major falls comprise about 13% of the Deschutes from Meadow Camp (RM 173) to Benham Falls. Benham, Dillon and Lava Island falls may hinder upstream fish movement at certain flows. The higher flows in this section provide deeper pools and considerable turbulence, both of which provide fish cover. Still, high stream gradient and high flows and water velocities in this reach limit spawning and rearing of trout. High flows carry gravel and woody material to the stream margins where they become stranded as flows drop during winter months. Thus, both spawning gravels and large woody structure are limited in the reach. Aquatic organisms, including fish, are trapped inside channels and backwaters as flows are rapidly curtailed in the fall (ODFW 1996a).

Three dams within the City of Bend's urban growth boundary have no fish passage facilities (Yake 2003). The North Canal Dam (RM 164.8) and Pacific Power and Light Dam (RM 166) are complete barriers to upstream fish movement. The Colorado Street Dam is a partial barrier to upstream fish movement.

Flows
The Deschutes River between Benham Falls and Bend displays a more stable flow regime compared to the upper section of the Deschutes below Wickiup Reservoir. Inflow from the Little Deschutes River, Fall River, Spring River, and various springs maintain a more adequate winter flow. Some instream flow is lost in the several subterranean lava tubes that are present in the reach. For the water years October 1955 to September 1982, the mean monthly flow at Benham Falls ranged from 731 cfs in October to 2,426 cfs in July (USGS 1990). The higher winter flows help reduce the "icing" problems experienced in the reach from Wickiup Dam to Fall River. Still, the magnitude of flow variation in the reach adversely affects the aquatic ecosystem.

Water Quality
The river reach between Bend and Benham Falls is included on the state 303(d) list of exceeding water quality criteria for temperature, dissolved oxygen, chlorophyll *a,* turbidity and pH. Water temperatures in the Deschutes River from Bend to Benham Falls exceed the temperature criterion for salmonid fish spawning between September 1 and June 30. Above RM 168.2, the reach is also listed for exceeding dissolved oxygen criterion for spawning, cold water dissolved oxygen criterion, chlorophyll *a* criterion, and state sediment and turbidity standards. Below RM 168.2, this reach of the Deschutes River is listed exceeding the state pH standard (Yake 2003).

3.6.8. Spring River

Spring River originates from a spring source and is approximately one mile long, joining the Deschutes River from the west at RM 191.

Upland Conditions
Spring River, because of its extremely short length and spring water source, has a much abbreviated watershed. Uplands are primarily forested.

Riparian Conditions
Streambank ownership is approximately 20% federal (Forest Service) and 80% private. Vegetation along the river corridor is predominantly pine forest along with sedges, forbs, willow and alder. Public access is very limited, especially from the bank, though the river is accessible by boat from the Deschutes River during favorable flow conditions.

Instream Conditions
Habitat observations suggest that there is a lack of trout cover in Spring River, both hiding for adult fish and juvenile rearing. What cover exists is primarily in the upper quarter-mile and comprised of a few logs and overhanging vegetation (ODFW 1996a). Spawning gravel is limited.

Flows
While there is no stream flow gauging station on Spring River, state personnel periodically measure flows. These records show flows at the mouth ranging from 299 cfs in April 1907 to 118 cfs in November 1925. The most recent flow measurement at the mouth was 124 cfs in January 1995. Spring River has a flat gradient and water depth is influenced by fluctuating water levels in the Deschutes River. Water depth in Spring River drops when the irrigation season ends and Deschutes River flows are reduced to enable storage in upstream reservoirs (ODFW 1996a).

Water Quality
Naturally cold water temperatures limit salmonid growth in Spring River. There are no extensive water temperature records for Spring River, but a maximum temperature of 48°F was recorded in 1970 (OSGC 1970).

3.6.9. Little Deschutes River

The Little Deschutes River begins near Mule Peak in Klamath County and drains approximately 1,020 square miles, flowing approximately 97 miles north to its confluence with the Deschutes River at RM 192.5. Crescent Creek is the largest tributary to the Little Deschutes.

Upland Conditions
Lands along the lower Little Deschutes River from the mouth to the Gilchrist Mill Pond (RM 63) are primarily privately owned. These lands are generally used for residential development, livestock grazing, and timber management. The drainage also contains the communities of La Pine and Gilchrist. Undeveloped lands dominate the section above RM 58.2, with public ownership of lands along the Little Deschutes River increasing above the Gilchrist Mill Pond. Almost equal amounts of private and public lands exist below Highway 58 and mostly federal forestland above Highway 58.

Riparian Conditions
Heavily eroding streambanks and degraded riparian areas are common in the first 38 stream miles due to overgrazing and urban development along the stream corridor. Many stream sections from RM 44.6 to RM 63 also show the impacts of overgrazing (ODFW 1996a). Riparian condition along the upper Little Deschutes River is generally good. Livestock grazing only occurs along one stretch of this river section, which lies just above the Gilchrist Mill Pond area and exhibits a degraded riparian condition. Conditions improve above this stretch. Riparian vegetation transitions from a willow and sitka sedge community to the bog blueberry and sitka sedge community that is more common at higher elevations. Riparian cover is also lacking along sections of Crescent Creek with heavy livestock use.

Instream Conditions
Spawning habitat is lacking in the lower Little Deschutes, but becomes more available upstream. ODFW surveys (1989-90) between the mouth of the Little Deschutes and RM 63 found a river gradient of 0.17%, and habitat type distribution at 86.4% glide, 10.8% primary channel pool, 1.0% side channel, and only 0.9% riffle. The surveys noted an increase to 17% riffle habitat from RM 61 to RM 63. Stream channel substrate from RM 0-63 was sand (81%), gravel (14%), hard pan (4%), cobble (1%) and small boulders (1%). The area had some of the best spawning habitat in the Little Deschutes due to low silt content within the gravels (ODFW 1996a).

Habitat conditions in the Little Deschutes River improve above Gilchrist Mill Pond (RM 63). Between RM 63 and 80, there are numerous side channels and backwater areas throughout the section. Large wood and instream complexity is lacking, but overhanging vegetation and undercut streambanks provide good cover for fish. Spawning habitat is abundant, with many tailouts and riffles containing good quality gravel. Above RM 80, habitat distribution is mainly glide with pool habitat secondary. Spawning habitat in this reach is lacking, especially in low gradient areas. Riffle habitat dominates in higher gradient areas. Dominate fish cover transitions from overhanging banks and aquatic vegetation in the lower areas to predominately wood moving upstream.

Flows

Flows in the Little Deschutes River are mostly unregulated except for minor storage and release effects of water from Crescent Lake, which serves as an irrigation storage reservoir. Releases from Crescent Lake during the irrigation season boost flow in the Little Deschutes. Average summer flows exceed natural flows, but are lower than high flows that would occur naturally during the months of April, May and June. Flow regulation has little effect on winter flows in the Little Deschutes River. The average flow was 385 cfs between 1924 and 1987. Flows typically drop to their lowest levels in October, with an average flow of 85 cfs between 1923 and 1995. Flow monitoring in the lower Little Deschutes recorded an all time low of 5.5 cfs in 1994.

Flow fluctuations in Crescent Creek from irrigation demands are the greatest factor limiting fish production, especially upstream of Big Marsh Creek. Flows are often low from September to April during reservoir storage and high during the rest of the year.

Water Quality

Several segments of the Little Deschutes River are listed as water quality limited streams on the 303(d) list. These reaches include: Little Deschutes for temperature (both spawning and rearing) from Crescent Creek to Hemlock Creek (RM 54.1-78) and for dissolve oxygen (both spawning and rearing) from mouth to Crescent Creek; Crescent Creek for summer temperature (mouth to RM 26.1) and Paulina Creek (RM 0-13.2). The lower portion of the Little Deschutes was not included for temperature because the data submitted to DEQ was collected in a drought year (Lamb 2004). Streams where data was only collected in a drought year were listed as “potential concern” rather than actually included on the list. The Little Deschutes River from the mouth to Crescent Creek is also listed as needing data for bacteria, flow modification, habitat modification, nutrients and sediments (ODEQ 1988). In addition, Crown Pacific holds an industrial NPDES permit for discharge of cooling water and process wastewater into the Little Deschutes at the town of Gilchrist (Lamb 2004).

3.6.10. Fall River

Fall River originates from a spring and flows east to the Deschutes River, entering the river from the west at RM 204.5. The river stretches 8.15 miles long and drains a small watershed of 45.1 square miles. The river provides important habitat for redband trout.

Upland Conditions

Streambank ownership is approximately 59% federal (Forest Service), 38% private, and 3% state (State Parks and ODFW Fall River Hatchery). Ponderosa pine and bitterbrush cover much of the uplands area (Yake 2003).

Riparian Conditions

From its headwaters, Fall River flows in a very gentle gradient. The dominant vegetation along the stream is lodgepole pine, with scattered willow and bog birch. A variety of grasses and forbs line most of the river.

Instream Conditions
Stream surveys by ODFW and Forest Service (1989 and 1991) showed that Fall River contained limited amounts of large wood, instream cover and pool habitat to support local trout populations. Spawning gravel was also limited and often embedded with fine sediment. River substrate was largely sedimented alluvial gravels, sand, pumice, and basalt outcrops. A 1967 Oregon State Game Commission stream survey of Fall River classified a total of 7,071 square yards of spawning gravel of which 2,990 square yards was rated as good and the remainder marginal (ODFW 1996a; Griggs 1967).

Lower Fall River up to the falls (RM 2.0) remains an important spawning area for Deschutes River brown trout. Several habitat enhancement projects have been implemented to increase spawning gravel and wood material content below the falls.

Flows
Fed by springs, the river exhibits a very stable flow regime. The historical mean flow from 1938-1989 was 148 cfs. The maximum discharge was 254 cfs in 1965 and the minimum was 67 cfs in 1969 (USGS 1989).

Water Quality
Daily water temperatures recorded at the Fall River hatchery for the years 1990-94 showed an annual average daily temperature of 45°F, with a range of 34-60°F. There are no known water quality limitations in Fall River. Fall River hatchery has a NPDES permit for discharges of hatchery water to Fall River.

3.6.11. Deschutes River, Benham Falls (RM 181) to Wickiup Dam

The Deschutes River below Wickiup Dam shows the effects of water storage and releases since 1949. While natural flows remained stable throughout the year, regulated flows change drastically; altering channel morphology, water quality and fish production in the river below the dam. This river section from Wickiup Dam to Benham Falls exhibits distinct stream morphology, with a lower gradient compared to the river below Benham Falls.

Uplands
The headwaters of the upper Deschutes River generally collect flow from public forestlands managed by the Forest Service for recreation and timber harvest. Much of this area lies above 4,500 feet in elevation.

Riparian Areas
Riparian areas below Wickiup Dam are dominated by ponderosa and lodgepole pine forests, willow thickets and sedge meadows. Several reaches within this section show damages from past and present land use. Riparian condition has been reduced by flow fluctuations, harvesting or thinning of lodgepole pine, overgrazing, and recreational use (USFS 1996d). In addition, the section contains the community of Sunriver and residential lands south to La Pine, which have seen tremendous growth during the past 30 years. Much of the land along the Deschutes between General Patch Bridge and Harpers Bridge, where 96% of the riparian land is privately owned, has been altered by private development (Yake 2003).

Nearly 15% of the banks along the Deschutes from Benham Falls to Wickiup Dam are currently bare and badly eroding (ODFW 1996a; Century Testing Laboratories

Incorporated 1978). A 1978 streambank erosion survey estimated that bank erosion in the reach generally range from zero to two inches per year, but jumps to eight inches per year at many locations (Yake 2003). This erosion appears to have started subsequent to the operation of Wickiup Dam and may have resulted from changes in the timing of high and low stages. A comparison of 1943 and 1991 photographs reveals that the Deschutes River between Wickiup Dam and Benham Falls widened an average of 20% during the 48-year period (ODFW 1996a; USFS 1994).

Instream Habitat

Downstream of Wickiup Dam, the Deschutes River is generally a meandering stream (with the exception of Pringle Falls at RM 217), with gradient averaging less than 1% until it reaches Benham Falls. Sloughs and oxbows are found throughout the section. River substrate is generally silt, sand, and pumice with an underlayer of clay and siltstone. Alluvial gravel is found mixed with these substrates, and dominates the substrate in some riffle and higher water velocity areas.

The aquatic environment in this section has been degraded, primarily due to extreme seasonal flow fluctuations caused by irrigation releases and storage in the reservoirs. The reach has little habitat complexity and lacks large wood, boulders and pool habitat. High flows push much of the large woody debris to the stream margins where it becomes unavailable once flows recede. Many aquatic organisms must semiannually redistribute themselves, and find themselves in winter pools that lack adequate cover (ODFW 1996a). Low winter flows also leave the limited spawning gravel along the stream margins as unavailable or barely usable by spawning fish (ODFW 1996a). Further production is lost because small fish and aquatic invertebrates become stranded in pools and side channels when flow recedes and they soon perish.

Low winter flows expose streambanks to "frost heave", with loosened soil washing downstream when flows increase in the river during the beginning of irrigation season. At a flow of 30 cfs, about 50% of the stream channel is exposed to frost action cycles (USFS 1994). When the river is at the minimum flow of 20 cfs below Wickiup Dam, even more of the channel is exposed.

Fish habitat improves progressively in the Deschutes River with flow supplementation from Fall, Little Deschutes, and Spring Rivers — though there is still high turbidity, flow fluctuations and icing in the reach above Sunriver. Below Sunriver, higher low flow and banks armored with boulders and rubble reduce frost heave and subsequent erosion. Spawning gravels are limited, but Fall and Spring rivers provide about one mile of high quality spawning habitat. Lava formations in the reach create pools that support larger fish during low flows and provide rubble, cobble and boulder substrate that are important winter habitat for juvenile trout.

Flows

While natural flows historically remained very stable year-round, the regulated flows below Wickiup rise and plunge dramatically through a year (Yake 2003). Before development of Crane Prairie (1922) and Wickiup (1942), natural flows rarely dipped below 500 cfs in the low flow months of winter, and occasionally rose to around 1,400 cfs during the peak runoff period in May or June (USFS 1994). Today, water storage creates low flows during the fall, winter and spring, and water releases for irrigation cause sustained high summer flows — opposite of the natural streamflow regime. Since 1946, the managed flows have created the equivalent of a 25-year flood event sustained for the six-month irrigation season (USFS 1996d). Flows currently are managed to vary between 20 cfs in winter to under 1,600 cfs during high irrigation demand in summer months (Gorman 2004). The minimum flow of 20 cfs represents a 95% reduction from natural unregulated flows (USFS 1996d).

Flows in the Deschutes River improve with releases from Fall River (90-160 cfs), the Little Deschutes River (140-350 cfs) and Spring River and nearby springs (180 to 210 cfs) (USFS 1996d). Nevertheless, flow manipulations still cause extreme variation in water levels and flows in the reach. For the years 1963-82, the maximum discharge was 2,591 cfs and the minimum 487 cfs (River Task Force 1986) at the Benham Falls gauge. The average discharge for a 70-year period (1907-13, 1925-87) had been 1,418 cfs (USGS 1989).

Water Quality

Water quality in the Deschutes River declines below the reservoir. The river reach is included on the state 303(d) list of exceeding water quality criteria for temperature, dissolved oxygen, chlorophyll and turbidity. Temperatures from Benham Falls to Sunriver exceed the temperature criterion for salmonid fish spawning between September 1 and June 30. The reach from Benham Falls to Wickiup Dam is listed for exceeding dissolved oxygen criterion for spawning, and the reach upstream to RM 189.4 (below Sunriver) is also listed for exceeding the cold water criterion. The reach upstream to just below Sunriver is also listed for exceeding chlorophyll *a* levels from June 1 to September 30. In addition, the upper Deschutes River below Wickiup Dam experiences higher than normal turbidity levels during water releases from spring through summer. Turbidity levels increase as much as 30 times after spring water releases for irrigation (Yake 2003; Forest Service Turbidity Monitoring Study 1991-1993 data). This turbidity is caused as water releases from Wickiup send a rush of high flows down a channel that had been dewatered for most of the winter. The gush of water erodes exposed streambanks that typically experience repeated freezing and thawing during the winter, creating high levels of turbidity.

3.6.12. Deschutes River, Wickiup Reservoir to Headwaters

The eight-mile reach of the Deschutes River above Crane Prairie is the only reach of a total 252 miles where the flow regime remains unaltered by dams. Except for overgrazing, recreation sites and transportation impacts — the section remains relatively natural (ODFW 1996a). Consequently, the Deschutes River from its headwaters to Crane Prairie Reservoir was designated as a State Scenic Waterway in 1988. In addition, the Crane Prairie Osprey Management Area, covering 10,600 acres, was established in 1970. The reservoir also supports many other water-associated birds such as bald eagles, blue herons, cormorants, mergansers, kingfishers, ducks, geese, and swans.

Uplands

The headwaters of the upper Deschutes River collect flow from public forestlands managed by the Forest Service for recreation and timber harvest. Crane Prairie was a natural meadow in which the Deschutes River, Cultus River, Rock Creek, Cold Creek, Quinn River, Deer Creek, and Cultus Creek converged. The Deschutes River originates approximately 8.4 river miles north of Crane Prairie in Little Lava Lake, a spring-fed body of water. Portions of the watershed have an extensive road network that provides access to most streams, lakes and associated recreation sites. There has been limited timber harvest and grazing in the area.

The area surrounding Odell Lake is also forested. Plant communities upslope of Odell Lake are primarily mountain hemlock or mountain hemlock/lodgepole pine. The watershed includes several recreation sites.

Riparian Areas

The stream channel is bordered by lodgepole pine forests and riparian meadows. Grasses include Kentucky bluegrass, blue-joint reed grass, tufted hairgrass, and blue wildrye. Lupine, false hellebore and a variety of rushes and sedges are also present (USFS 1989). Mountain alder and spruce are found along with lodgepole pine (ODFW 1996a).

The riparian condition around the Odell Lake watershed is generally excellent, except for localized recreation sites where human influences have altered the form and function of riparian and floodplain areas (USFS and BLM 1999).

Instream Habitat

Much of the spawning gravel in the headwaters occurred in the area now inundated by Wickiup Dam and the reservoirs, and is no longer available. The best trout spawning and rearing habitat is now found in the Deschutes River above Crane Prairie and is used by redband trout, brook trout, whitefish, and kokanee. Of the approximately 13.5 total miles of tributary habitat available in the Cultus and Deer Creeks and Cultus, Quinn, and Deschutes rivers, over three quarters of it is in the Deschutes River (ODFW 1996). Other tributaries to Crane Prairie Reservoir provide varying amounts of trout spawning and rearing habitat for both reservoir and resident fish populations. According to 1989 Forest Service stream surveys, much of the available spawning gravel in these tributaries is embedded with naturally occurring fine sediment. Other factors, including low or non-existent stream flows during the summer and fall in Cultus and Deer creeks, render these streams unusable for fall spawning species such as brook trout, whitefish, and kokanee (ODFW 1996a).

Trapper Creek is the only tributary to Odell Lake with a known spawning population of bull trout. Juvenile bull trout rear in Trapper Creek, Hemlock Creek, and Odell Creek, and probably several other tributary streams intermittently (USFWS 2002b). A 1996 USFS habitat survey found 35% of the total habitat units in Trapper Creek had bull trout-size spawning gravels; however, spawning habitat was limited by other factors, including water depth and velocity (USFWS 2002b). Low levels of large wood also limit bull trout production in Trapper Creek. The 1996 survey found only five side channels for rearing, constituting only 5% of the total habitat area in the 0.8-mile reach of Trapper Creek below a 7.5-foot waterfall (USFWS 2002b). Bull trout may also occupy Maklaks Creek, which originates as springs and seeps on Maklaks Mountain and flows 0.43 miles to its confluence with Odell Creek. Water quality appears suitable for bull trout ranging from 40.1^{o}F at the source to 41.9^{o}F at the Odell Creek confluence.

Flows

The Deschutes River flows about 8.4 miles from Little Lava Lake to Crane Prairie Reservoir. The spring-fed flows are very stable with minimal daily, monthly, and even annual fluctuations in water flows and temperatures (Mathisen 1990). Unlike most streams in Oregon, flow in this reach of the Deschutes is lowest in the winter and peaks in August to early September (ODFW 1996a).

Odell Lake is a natural lake in the Cascade Mountains. The lake covers 3,600 acres and has an average depth of 40 meters. Trapper Creek is the only tributary of Odell Lake that responds to runoff events (USFWS 2002b). Most of the basin exhibits fixed drainage patterns fed by spring releases. Davis Lake, a shallower natural lake (20 feet maximum depth), has no surface outlet, however, many seeps in the lava flow allow water into Wickiup reservoir (USFWS 2002b).

Water Quality

Generally, water quality in the Deschutes River above Crane Prairie remains good, though problems do exist. The State of Oregon has listed Odell Lake and parts of Odell Creek as water quality limited for pH and of concern for chlorophyll *a*. Monitoring by USFS and ODEQ personnel during 2001 found summer pH levels consistently exceeding the upper limit of 8.5 standard established by ODEQ (USFWS 2002b). Odell Creek is also listed for exceeding state water temperature standards for spawning and rearing. Summer water temperatures in Odell Creek generally exceed 70°F, as a result of the discharge of warm surface water from Odell Lake (USFWS 2002b). In addition, Lava Lake is on the 303(d) list for exceeding the cool water dissolved oxygen criterion. Cold water temperatures may also limit trout rearing potential in the Cultus River, Snow Creek and other tributaries and some lakes.

Water quality in the Deschutes River between Crane Prairie Reservoir and Wickiup Reservoir deteriorates during mid-summer because of warm water releases out of Crane Prairie. Algae released with the flow discolors the water and triggers algae blooms in Wickiup Reservoir (ODFW 1996a).

Deschutes Subbasin Wildlife Assessment

Presented to the

Deschutes Resources Conservancy
In fulfillment of contract 220019

For services in conjunction with development of a Subbasin Plan
for the Deschutes River Subbasin
as part of the

Northwest Power and Conservation Council
Provincial/Subbasin Planning program
under the Northwest Power Act

By

Gary Hostick
Ecological Services, Inc.
Bend, Oregon

May 2004

*Section numbering follows outline in *Oregon Specific Guidance*, Sept. 15, 2003.

Deschutes Subbasin Wildlife Assessment

1. Executive Summary

The Deschutes Subbasin is made up of diverse wildlife habitats, including Cascade Mountains east slopes, the Deschutes River and many tributary valleys, and arid steppe habitats characteristic of the Great Basin. Significant changes to wildlife habitats have occurred in the subbasin since historic times, resulting from agricultural development in the river valleys and steppe habitats, management of the forests for wood resources, and more recently an influx of people seeking the desirable living environment of Central Oregon. These changes have resulted in the loss of wildlife habitats, most notably the nearly complete loss of wild grasslands, and changes in remaining habitats such as forests, where forest tree species composition in the Cascades have shifted toward mixed conifers from pine forest types. These changes in habitat have resulted in changes in the wildlife species found in the subbasin.

2. Introduction

2.1. Description of Planning Entity.

This report will assemble and analyze wildlife information for the Deschutes Subbasin as part of the Northwest Power and Conservation Council’s Provincial/Subbasin Planning program conducted under the Northwest Power Act (Northwest Power Planning Council 2001.)

2.2. List of Participants.

Wildlife biologists with government agencies working within the subbasin volunteered to serve on the Deschutes Subbasin Wildlife Team (2003) to provide input during the plan development. Members of the Deschutes Coordinating Council (2003) also provided comments on early development of wildlife information.

2.3. Approach.

The status of wildlife in the Deschutes Subbasin (herinafter “subbasin”) will be described by designating a short list of *focal wildlife species* from the full range of species occurring within the subbasin, and by designating a short list of *focal wildlife habitats* from the full range of habitats in the subbasin. Available data pertaining to the focal species and focal habitats in the subbasin will then be summarized and presented, and opportunities for conservation or restoration of the focal species and focal habitats will be outlined at the end of the assessment.

Wildlife information will be presented at three different levels of detail for the subbasin: the Columbia Plateau Ecoprovince, a larger study area that is made up of 11 subbasins including the Deschutes subbasin; the assessment unit level, of which there are 8 in the subbasin; and the hydrogic unit code

(HUC) 6th level subwatershed level, at the 1:24,000 scale. There are 341 HUC6 fields in the Deschutes Subbasin (O'Neil p.c.)

Information from the Northwest Habitat Institute Interactive Biological Information System (IBIS) will be used as the primary source of wildlife information for this assessment.

Wildlife information will be organized according to instructions and outlines in the following reports: *Oregon Specific Guidance* (Anon. 2003,) *A technical Guide for Developing Wildlife Elements of a Subbasin Pla*n (Scheeler et al. 2003,) and *An Oregon Technical Guide for Developing Wildlife Elements of a Subbasin Pla*n (Anon. 2003.) Sections of this report will be numbered after *Appendix C: Outline for Oregon Subbasin Plan, revised 4/6/2003* from *Oregon Specific Guidance* to simplify the inclusion of this wildlife assessment report into the subbasin plan, and to present information in the expected format. Font style and outline format are kept as simple as possible to facilitate the integration of this report into the final subbasin plan. Most of the tables and figures presented in this assessment will appear as appendices, due to the length and numbers of tables and figures.

The term "wildlife" will include amphibians, reptiles, birds, and mammals. Although the word "terrestrial" will be used in reference to wildlife, it will be understood that aquatic environments are required by some wildlife species, and that this term will be a general descriptive term only.

3. Wildlife Assessment

Regional context. The Deschutes River flows into the Columbia River from Oregon on the south near the community of The Dalles, draining the eastern slope of the northern Cascade Mountains and the western edge of the Blue Mountains in Oregon. The Deschutes subbasin is bordered by the Willamette Subbasin on the West, the Klamath Subbasin on the south, and the John Day Subbasin on the east. The subbasin takes in most of Wasco and Sherman counties, and all of Jefferson, Crook, and Deschutes counties. The subbasin is part of the Columbia Plateau Ecoprovince, along with 10 other subbasins in Oregon and Washington, in the Northwest Power and Conservation Council planning framework. Wildlife resources in the subbasin will also be presented within the context of the Columbia Plateau Ecoprovince.

3.1. Focal species selection..

In order to select focal species, various lists of species of special status occurring within the subbasin were examined.

Lists of all species thought to occur in the subbasin historically (1860) and currently (1999) and scientific names are presented in Appendix tables A and B respectively. A list comparing historic and current lists of wildlife, showing species added to the subbasin and lost to the subbasin since historic times, with notes on suggested additions and deletions, is presented in Appendix table C.

Threatened, endangered, or sensitive species listed by state or federal government entities that are thought to occur currently in the subbasin are listed in Appendix table D.

Wildlife recognized by local biologists as rare or significant to local areas in the subbasin are shown in Table 1, with reference to assessment units (AUs.) Maps of historic and current wildlife habitats in the subbasin, with AU boundaries shown, are presented in the Appendix.

Table 1. Wildlife species recognized as rare or significant to a local area.

Species	Significance	Assessment Unit(s) Locations of Local Areas
Mule deer (white-tailed deer and black-tailed deer are also present in the subbasin)	Ungulate winter range degradation (George, p.c.)	Lower Westside Deschutes, Middle Deschutes.
Bighorn sheep (reintroduced population)	Ungulate winter range degradation (Kunkel, p.c.)	Lower Westside Deschutes, Lower Eastside Deschutes.
Mountain goat (former population)	ungulate winter range degradation (ODFW 2003b)	White River, Lower Deshutes, Middle Deschutes
Sharp-tailed grouse (former population) habitat	Habitat loss, grasslands (Kunkel p.c.)	LOWER EASTSIDE DESCHUTES, Upper Crooked, Lower Crooked
Greater sage grouse	Habitat degradation, shrub-steppe (Hanf, p.c.)	Lower Crooked River, Upper Crooked River
Golden eagle habitat	Threat of habitat degradation, rimrock and cliff nesting sites (Gilbert p.c.)	All except Cascade Highlands

Managed Wildlife Species. Currently, 68 wildlife species are harvested during hunting seasons in the subbasin (Appendix table E.)

HEP Wildlife Species (those used in loss assessments for hydrosystem development.) Twenty-four wildlife species used in the HEP process are thought to occur currently in the subbasin (Appendix table F.)

Partners in Flight high priority bird species used for monitoring. A total of 111 species occurring in the subbasin were listed by the Partners in Flight organization (Appendix table G.)

Critical functionally linked species. A list of critical functionally linked species thought to occur historically in the subbasin are listed in Appendix H.

Species of special cultural significance. Biologists with the Confederated Tribes of the Warm Springs Reservation of Oregon declined to draw up a list of especially important wildlife species, stating that tribal members consider all forms of wildlife to be culturally important. Although some species are important primarily for one purpose, such as food, often a single species is important for several reasons. For example, mule deer are important as food, but non-food parts of each animal could be valuable for clothing, regalia, medicine, and other uses. The presence of frogs in a small spring might indicate that the water is safe to drink. The complex relationship between tribal members and wildlife of all species in the subbasin is a fundamental part of tribal culture (Calvin 2004.)

Focal wildlife species selected. Focal species were selected by considering listed species, and by considering species of concern by local biologists. Focal species were chosen to represent a “guild” of species whenever possible, for example, the sharp-tailed grouse could represent grassland species, and the sage grouse could represent shrub-steppe species. Seven species were selected (Table 2.)

Table 2. Focal species selected and rationale for selection, and associated habitats.

Focal Species	Rationale for Selection*	Associated Habitats
American beaver	Riparian habitat species, modifies habitat. On list 4, 5 and 6.	Riparian, herbaceous wetlands.
Columbia spotted frog	Riparian habitat and herbaceous wetlands habitat species. List 1 and 2.	Riparian, herbaceous wetlands
White-headed woodpecker	Large ponderosa pine tree habitat species. List 1, 2 and 3.	Ponderosa pine forest and woodlands.
Mule deer	Ungulate winter range habitat species. Lists 2, 4, and 5.	Ungulate winter range.
Greater sage grouse	Shrub-steppe habitat species. Lists: 1,2,3,4,5.	Shrub-steppe.
Columbian sharp-tailed grouse	Grassland species. List 2 and 3.	Lower Eastside Deschutes interior grasslands.
Golden eagle	Cliff and rimrock habitat, grassland, shrub-steppe habitat species. List 2.	Cliff and rimrock habitats, grassland, shrub-steppe.

* 1=threatened, endangered, and state sensitive species, 2=species recognized as rare or significant to a local area, 3=Partners in Flight species, 4=HEP species, 5=game species, 6=critically functionally-linked species.

3.2. Focal species characterization.

Species accounts for each focal species are presented in the Appendix. These accounts present biological, populations and trends data if available. A summary of status for each focal wildlife species in the subbasin is presented in Table 3. Of the focal species selected, only the sharp-tailed grouse has been extirpated from the subbasin (Csuti, et.al 2001.) American beaver are thought by local biologists to be extirpated from many former habitat areas in the subbasin, as are Columbia spotted frogs. No introduced species were chosen as focal species.

Table 3. Focal species distribution, populations, and trends.

Species	Distribution in Assessment Units	Population and trends
American beaver	All	Historically depleted, but now recovered. Currently harvested during hunting and trapping season, population tracked by ODFW.
Columbia spotted frog	Upper Crooked River	Remnant population. Declining.
White-headed woodpecker	All	Status unknown.

Table 3. Focal species distribution, populations, and trends.

Species	Distribution in Assessment Units	Population and trends
Mule deer	All	Game animal. Population tracked by ODFW. Declining in some areas due to development on winter ranges.
Greater sage grouse	Upper Crooked River, Lower Crooked River.	Game bird. Population tracked by ODFW. Declining.
Columbian sharp-tailed grouse	Extirpated.	Extirpated.
Golden eagle	All.	57 active nest territories counted in 2000 (Clowers 2004.) Population trend unknown in Oregon (Ibid, Marshall 2003.) Some indications of decline in the general region of northern Great Basin (Marshall 2003 p. 162.)

3.3. Environmental conditions for focal species.

Rather than attempt to describe the status of all habitats in the subbasin, a shorter list of *focal habitats* were selected to represent environmental conditions in the subbasin for focal species. Focal habitats were selected from the complete list of habitats in the subbasin by examining current habitats compared to historic habitats *at the subbasin level* as presented by IBIS data, and selecting those habitats that were reduced significantly from historic acreages. Some focal habitats, habitat attributes, and habitat components occurring within the more general habitats were also selected based on concerns by local biologists and others, even though IBIS information was not available to assess the status of these habitats, attributes, and components.

As additional information, focal habitats status in the subbasin were compared to status at the larger ecoprovince level to discover if the focal habitats status in the subbasin were similar to the status if those habitats on a larger scale. Then, focal habitats status at the smaller assessment unit level within the subbasin are presented, followed by focal habitats status at the smallest unit, the HUC 6 small watershed level. Condition, trend, connectivity, and spatial issues for focal habitats are presented, as is the protection status of focal habitats. Projected future status of focal habitats with no future actions is also presented.

3.3.1. Selection of focal habitats at the subbasin level.

IBIS Map Data. Historic and current habitat maps of habitats for the entire subbasin from IBIS show substantial changes since 1850. The historic map (see Appendix maps) shows broad bands of habitats running north and south. Beginning on the west side of the subbasin, a band of mountain fir and hemlock forest habitat types is shown in higher elevations of the Cascade Mountains. Then, a band of ponderosa pine forest, mixed with some lodgepole pine forest, is shown running from the Columbia River southward, approximately along the eastern foot of the Cascades. At the southern end of this band of mostly ponderosa pine woodland, larger blocks of lodgepole pine forest begin to break into the band of ponderosa pine. East of the Deschutes River, a band of mostly shrub-steppe habitat with interspersed interior grassland and Western juniper woodland areas again runs north-south, with a large block of shrub steppe habitat shown in the southeastern section of the subbasin, and a large block of Western juniper woodland southeast of Redmond. Along the east edge of the subbasin, an area of ponderosa pine forest is shown in the Blue Mountains east of Prineville, and a large block of interior grassland habitat is shown in the northeastern section of the subbasin southeast of The Dalles.

The current habitat map of the subbasin shows fragmentation of the large blocks of ponderosa pine, lodgepole pine, and shrub-steppe habitats formerly existing in the subbasin, and the complete loss of the grassland habitats thought to have existed in 1860. The band of mixed conifer forests running north-south in the Cascade Mountains on the west side of the subbasin is shown to have encroached into the lower-elevation ponderosa pine and lodgepole pine forests along the eastern foot of the Cascades. The large block of juniper woodland south and east of Redmond and Prineville is shown to have spread throughout the former shrub-steppe habitat running through the center and into the southeastern part of the subbasin, fragmenting the shrub-steppe habitat. Other conifer forest types are shown to have encroached into the former ponderosa pine forests in the Blue Mountains east of Prineville.

Acreages from IBIS Maps. Historic and current habitat acreages reflect the proportions shown on the habitat maps, since the acreage information is derived from the maps, but shows the habitat information in a quantitative format (Table 4).

Riparian and herbaceous wetland habitats are not shown in sufficient accuracy of scale on the IBIS maps to be useful (O'Neil, p.c.,) and this was a concern for local biologists, who considered these two habitats to be the highest priority habitats for restoration or conservation in the subbasin. Due to the linear nature and small areas of occurrence of riparian wetlands, this habitat was not considered to be displayed in accurate scale. The interpretation of satellite imagery for herbaceous wetlands was felt to be possibly inaccurate due to similarity in the light reflection signature of agricultural areas.

Although riparian habitat quality is also considered in the fish habitat models presented in this plan, it is only considered at a minimal level, rating vegetation shading on the immediate shoreline. The riparian wetland and herbaceous wetland habitat descriptions for wildlife include much wider areas out from the stream channel in many areas, including important areas such as oxbow sloughs, backwaters, marshes, seasonal wetland areas, and near-stream springs and seep areas which are important habitat. It is suggested that the riparian evaluations for fisheries habitat models would not correspond to an evaluation of riparian wetlands and herbaceous wetlands for wildlife. Therefore, it is apparent at the very beginning of this evaluation that there is a lack of data for riparian wetlands and herbaceous wetlands in the subbasin, since no alternate source of data on historic or current riparian wetlands or herbaceous wetlands is known.

Other habitats also are not shown in large enough scale or for other reasons are not considered to show significant results (Ibid.) Canyon shrublands, for example, were a recent addition to the habitat type list, and could not be compared with historic data, and also was an unsuccessful attempt to display a linear habitat, therefore this habitat is not discussed. These habitats and other habitats that were not thought to be shown as useful acreages for comparison are indicated as "n/a" under the percent change column in Table 4.

Table 4. Current and Historic Wildlife-Habitat Acreage Changes, Deschutes Subbasin

Habitat ID	Habitat Name	Current Acreage	Historic Acreage	Change from Historic	Percent change
1	Mesic Lowlands Conifer-Hardwood Forest	2,267	34,970	-32,703	n/a
3	Southwest Oregon Mixed Conifer-Hardwood Forest	173	0	173	n/a
4	Montane Mixed Conifer Forest	546,968	194,288	352,680	182%
5	Interior Mixed Conifer Forest	676,086	350,133	325,953	93%
6	Lodgepole Pine Forest and Woodlands	213,432	532,706	-319,274	-60%
7	Ponderosa Pine & Interior White Oak Forest and Woodlands	1,320,270	1,860,264	-539,994	-29%
8	Upland Aspen Forest		741	-741	n/a
9	Subalpine Parkland	38,839	25,361	13,478	n/a
10	Alpine Grasslands and Shrublands	14,636	12,425	2,211	n/a
12	Ceanothus-Manzanita Shrublands	2,996	0	2,996	n/a
13	Western Juniper Woodlands	1,347,101	790,348	556,753	70%
14	Interior Canyon Shrublands	82,856	0	82,856	n/a
15	Interior Grasslands	4,684	630,630	-625,946	-99%
16	Shrub-steppe	1,982,194	2,299,065	-316,871	-14%
17	Dwarf Shrub-steppe	127,843	5,683	122,160	n/a
18	Desert Playa and Salt Scrub Shrublands	3,225	1,418	1,807	n/a
19	Agriculture, Pastures, and Mixed Environs	337,369	0	337,369	n/a
20	Urban and Mixed Environs	22,026	0	22,026	n/a
21	Open Water - Lakes, Rivers, and Streams	57,774	76,139	-18,365	n/a
22	Herbaceous Wetlands	51,512	20,263	31,249	n/a
24	Montane Coniferous Wetlands	15,781	0	15,781	n/a
25	Interior Riparian-Wetlands	7,568	21,251	-13,683	n/a
	Total Acres:	6,855,591	6,855,680		
*Acreages are estimates only. Subbasin total acreage may vary slightly between Current and Historic due to mapping procedures.					
*Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.					
*Subbasin Habitat Acreages Generated by IBIS on 10/13/2003 11:45:52 AM.					

Large-scale losses in habitats in the subbasin. The loss of over 600,000 acres of estimated historical interior grassland habitat in the subbasin, nearly all of the grassland in the subbasin, is a large-scale shift in habitat. The indicated loss of over 300,000 acres of shrub-steppe habitat in the subbasin, although amounting to a relatively low percentage of 14 percent of the estimated historic shrub-steppe acreage, is also a significant change in habitat area. The apparent loss of ponderosa pine and lodgepole pine forests due to encroachment of other conifer forest types indicated on the historic and current maps is reinforced by the acreage data showing an increase of nearly 700,000 acres in other conifer habitats since historic estimates, with corresponding decreases in ponderosa pine forest and lodgepole pine forests of over 500,000 acres and over 300,000 acres respectively, for a loss of over 800,000 acres combined of ponderosa and lodgepole forests, a significant major habitat shift in the subbasin.

Large-scale increases in habitats in the subbasin that may explain large-scale losses. Increases in mixed conifer forests, juniper woodlands, and agriculture areas are large-scale changes in habitat in the subbasin. The increase in agriculture acreage would be expected, but the acreage number shown of 337,000 acres should be considered only an approximation in light of the known coarseness of the interpretation of the satellite data related to this habitat, which is especially difficult to define (O'Neil, p. c.) The increases in mixed conifer forests would also be expected, since it is apparent from inspection of the historic and current habitat maps that these habitats have encroached on the pine habitats at lower elevations along the Cascades. The increase in juniper woodland might also be expected, since the loss of grassland habitat in the subbasin could be partially attributed to encroachment by juniper woodland, as well as conversion to agriculture.

Selection of three focal habitats on the basis of IBIS maps and acreage data at the subbasin level. Based on the above maps and acreage data at the subbasin level, the following habitats were selected as focal habitats. Focal habitats were designated as those habitats that have been reduced more than 25% in acreage from historic levels in the subbasin:

- Interior grasslands (99% reduction)
- Lodgepole pine forest and woodlands (60% reduction)
- Ponderosa pine forest and woodlands (29% reduction)

Selection of focal habitats on the basis of concern by biologists and others. Local biologists and others also identified habitats attributes and habitat components that are thought to be reduced in acreage or reduced in quality from historic levels, although IBIS data or other data were not available to support these hypotheses. These habitats and components are:

- Riparian and wetland habitats (loss of water suppy, loss of vegetation, loss of channel structures such as backwaters and oxbow sloughs, loss of springs and seeps)
- Shrub Steppe habitats (loss of plant diversity, succession advanced to juniper woodland habitat, or other vegetations)
- Habitat structure: large tree (late seral stage) structure, snag structure, rock structure such as cliffs and rimrocks degraded by development such as rock pits and dwellings).
- Habitat plant diversity: dwarf shrub-steppe brush species (loss,) quaking aspen (loss,) white oak (loss,) and cottonwood groves (loss.)
- Ungulate winter range areas (degradation.)

- CRP lands which provide grassland habitats for wildlife (gain in grassland habitat on land classed as agricultural land.)

Summary of focal habitats selected. If the habitats selected by biologists and others are combined with the habitats that are more than 25% reduced from historic levels as displayed by current vs. historic IBIS maps and acreage data, the following list of focal habitats and habitat attributes and components is produced (Table 4A.)

Table 4A. Focal habitats selected for the Deschutes subbasin.

Focal habitat	Description of focal habitat
Interior grasslands	IBIS Habitat 15.
Lodgepole pine forest and woodland	IBIS Habitat 6.
Ponderosa pine forest and woodland	IBIS Habitat 7.
Lower Eastside Deschutes Interior Riparian-Wetlands	IBIS Habitat 25. (no IBIS data)
Herbaceous Wetlands	IBIS Habitat 22. (no IBIS data)
Shrub Steppe habitats	IBIS Habitat 16.
Habitat structure: large tree structure (late seral,) rock structure.	Habitat attribute within other habitat designations.
Habitat plant diversity: dwarf shrub-steppe brush species, quaking aspen, white oak, and cottonwood groves.	Habitat attribute within other habitat designations.
Ungulate winter range areas.	Habitat attribute within other habitat designations.
CRP lands which provide grassland habitats.	Farmed land condition producing grassland habitat.

3.3.2. Focal habitats status for the Columbia Plateau Ecoprovince.

The Deschutes Subbasin is part of the larger Columbia Plateau Ecoprovince, which is made up of eleven subbasins, including the Deschutes Subbasin. Wildlife habitats thought to occur historically and currently in the Columbia Plateau Ecoprovince are displayed in the Appendix maps. These maps show that some changes that have occurred in the larger ecoprovince are similar to changes that have occurred in the Deschutes Subbasin. Specifically, changes to the four focal habitats that are shown by IBIS historic and current data for the Deschutes subbasin are shown as changing for the ecoprovince in a similar manner. Shrub-steppe and grassland habitats have been largely replaced by agricultural uses, and ponderosa pine and lodgepole pine habitats have been reduced and fragmented. Montane mixed conifer habitats have apparently increased, as have juniper woodlands. These changes are further displayed in color-coded maps presented in the Appendix maps

3.3.3. Focal habitats status for the assessment unit level.

In order to display more local information, the subbasin was divided into eight smaller areas designated as *assessment units* (AU's) (see subbasin Appendix maps.) The changes in wildlife habitats within the AU's as indicated by map data are summarized and discussed in the following sections. Since no map data are available for riparian or herbaceous wetlands, these habitats are not discussed.

Cascade Highlands AU. This higher-elevation AU was historically covered predominately with ponderosa pine forest, with substantial acreages of lodgepole pine forest and mixed conifer forest also present (see Appendix table I.) Currently, 80 percent of the former lodgepole and ponderosa pine forests have been lost. The losses in pine forests are accounted for in the increases in other mixed conifer forests.

Upper Deschutes AU. This AU was historically predominately covered with ponderosa pine and lodgepole pine forests. Over 179,000 acres of lodgepole pine forest habitat have been lost, representing 50 percent of the historic area of this habitat. All of the former grassland existing in this AU, an area of approximately 37,000 acres most of which was located between Tumalo and Sisters, has also apparently been converted to other uses or habitats. A substantial loss of shrub-steppe habitat amounting to approximately 29,000 acres, representing 57 percent of the historic habitat area, has also been lost. These losses are largely balanced by gains in mixed conifer forests (145,000 acres,) and agriculture and urban areas (55,000 acres.) Another 30,000 acres of habitat gains are indicated in montane coniferous wetlands and herbaceous wetlands categories, but the location and status of these habitats in the AU are not known. The accuracy of these latter classifications is somewhat doubtful until ground-truthing can be carried out and these habitat descriptions are further clarified (O'Neil, p.c.)

Middle Deschutes AU. Over 15,000 acres of grassland, or 100 percent of the historic grassland which is thought to have occurred in this AU has been lost. Map data also indicates a loss of mesic lowlands conifer-hardwood forest of over 16,000 acres. This habitat description was originally meant to describe habitats on the west side of the Cascades that included red alder and bigleaf maple intermixed with conifer species. The mapping data that indicates this habitat east of the Cascades could be recognizing areas of quaking aspen, black cottonwood, and possibly willow intermixed with conifer species. If this is the case in this AU, this mapping data could indicate a loss of substantial acreage of these mixed hardwood areas. It should be remembered that the historic habitat areas are largely educated estimates by vegetation and soils specialists, therefore this indicated loss would be an estimate by specialists. Substantial losses in pine forest areas are also indicated in this AU, with a combined estimated loss of over 156,000 acres of ponderosa pine and lodgepole pine forest, or about 48 percent of the historic area. These losses are again balanced by substantial increases in other mixed conifer forests.

Lower Westside Deschutes AU. Substantial losses in pine forest habitats have occurred since historic conditions in this AU, mostly consisting of losses in ponderosa pine forests, where a loss of over 85,000 acres or 37 percent of the former area is thought to have occurred. Three large areas of former grassland in the center and north end of the AU amounting to over 99,000 acres were also lost. These losses are balanced by gains in shrub-steppe habitat and forested habitats, as well as conversion to agriculture. Groves of white oak are present in this AU, and are thought to have declined from former acreages and to be threatened with future continued declines in acreage. White oak groves are probably included in the ponderosa pine and lodgepole pine forest classifications.

White River AU. A substantial loss of over 56,000 acres (57 percent) of ponderosa pine forest is indicated in this AU, as well as a loss of over 26,000 acres (36 percent) of shrub-steppe habitat. These losses are balanced by gains in mixed conifer forest and agriculture lands. Substantial groves of Oregon white oak are present in this AU, according to local biologists, and these groves are probably included in the ponderosa pine and lodgepole pine forest classifications.

LOWER EASTSIDE DESCHUTES AU. This AU is where most of the historic grasslands in the subbasin were located. All of these grasslands were lost, a loss of an estimated 371,000 acres of habitat. This habitat loss was balanced by similar large increases in shrub-steppe and juniper woodlands habitats

(160,000 acres) mixed conifer forest habitat, agriculture (71,000 acres) and some loss can be put down to a change in habitat description where part of the former grasslands may have been classified into a habitat classification called canyon shrublands, although this habitat description needs clarification.

Lower Crooked AU. This AU was historically predominately composed of pine forests, juniper forest, shrub-steppe, and grassland, with shrub-steppe the largest area of habitat at over 464,000 acres. The grassland habitat was lost (35,000 acres.) Eighty-nine percent of the lodgepole pine forests were also lost (75,000 acres.) Substantial acreages of juniper forest, ponderosa pine forest, and shrub-steppe were also lost, although the percentage losses ranged only between 8-11 percent. These losses in habitat were balanced somewhat by gains in mixed conifer forest (14,000 acres,) but mostly by gains in agriculture and dwarf shrub-steppe habitat. Large areas of the eastern part of this AU indicated on the current habitat map as dwarf shrub-steppe habitat actually were cleared of sagebrush in the past and planted to exotic perennial grasses, and subsequently used intensively as livestock rangeland, and it is thought by local biologists that this area may have been incorrectly labeled as dwarf shrub-steppe if that classification was the closest to the spectral analysis results. This habitat question needs clarification.

Upper Crooked AU. This AU was historically predominately covered with shrub-steppe habitat, at an estimated 1 million acres. Next in acreage were ponderosa pine forests at 454,000 acres, followed by juniper woodlands at 179,000 acres. Shrub-steppe and ponderosa pine forests were reduced from historic acreages in the AU by 38 and 35 percent respectively, amounting to a substantial habitat shift in the AU. These losses were balanced out by gains in juniper woodlands (401,000 acres) and mixed conifer forests (111,000 acres.) Scattered areas of grasslands amounting to nearly 61,000 acres were also historically present in this subbasin, and these grasslands were reduced by an estimated 93 percent to the remaining small area of about 4,000 acres. Areas of historic lodgepole pine forests amounting to an estimated 17,000 acres were also lost in the AU.

3.3.4. Focal habitats status at the HUC 6 level.

A total of 341 HUC6 (habitat unit code 6th level) small watersheds are present in the subbasin. Focal habitats data at the HUC6 level are displayed as color-coded changes from historic levels to current levels (see last 12 maps in the Appendix.) Two disclaimers must be remembered when looking at these color-coded maps, however. First, if a HUC6 is shown in red, for example, that would indicate a greater than 75% decrease in habitat area, but it must be remembered that this may indicate a decrease from only 10 acres of habitat to 1 acre of habitat, to present an extreme example. The point being that the acreages that the color-coded data was drawn from are not shown, nor are the locations of the historic habitat within the HUC6. Second, it is not clear from the maps if the non-colored (white) HUC6s are areas where the focal habitat did not occur, or if it is an area where the habitat did occur historically, but the change in area fell within the 49% increase to 49% decrease category. Ideally, the acreage and location data for each HUC6 would be displayed on a table linked to each map HUC6, along with other detailed data concerning past and ongoing projects and stream reach priorities. This level of detail was not attained in this report but will remain as a goal for future work. For the present, the approximate locations of past and ongoing projects and priority stream reaches for restoration and conservation are shown on the background of wildlife habitat changes on these maps. The maps are also supplied on CD format so the maps can be manipulated using Adobe software to increase the detail, so that stream names, for example, can be seen.

From these maps, it is apparent that a significant number of past and ongoing projects have been and are being initiated in the subbasin. These maps will be a possible starting point to begin coordinating the approach to restoring priority wildlife and fisheries habitats within the guidelines given in this plan.

3.3.5. Condition, trend, connectivity and spatial issues for focal habitats.

A summary of condition, trend, connectivity and spatial issues for focal habitats at the AU level is presented in Table 5. These issues will be evaluated at the HUC 6 level in later drafts.

Table 5. Habitat Condition, Trend, Connectivity and Spatial Issues in Assessment Units.

Assessment Unit	Habitat	Condition	Trend	Connectivity	Spatial
Cascade Highlands	Ponderosa pine forest	Loss large trees	Losses in acreage	Fragmented	Higher-elevation losses
Upper Deschutes	Lodgepole pine forest	Loss dead and large trees	Losses in acreage	Fragmented	Loss of two large areas
Upper Deschutes	Grassland	n/a	n/a	n/a	Loss of one large area
Middle Deschutes	Ponderosa and lodgepole pine	Loss dead and large trees	Losses in acreage	n/a	Higher-elevation losses
Lower Westside Deschutes	Ponderosa pine forest	Loss large trees	Losses in acreage	n/a	Higher elevation losses
Lower Westside Deschutes	Grassland	n/a	n/a	n/a	Loss of three large areas
Lower Westside Deschutes	Oak groves	n/a	Losses in acreage	n/a	n/a
White River	Oak groves	n/a	Losses in acreage	n/a	n/a
White River	Ponderosa pine	Loss large trees	Losses in acreage	n/a	Higher elevation losses
White River	Shrub-steppe	n/a	Loss in acreage	Fragmented	n/a
LOWER EASTSIDE DESCHUTES	Grasslands	n/a	Loss of all acreage	n/a	n/a
Lower Crooked	Grasslands	n/a	Loss of all acreage	n/a	n/a
Lower Crooked	Lodgepole pine	Loss large trees and dead	Loss of acreage	Fragmented	Higher elevation losses
Lower Crooked	Dwarf shrub-steppe	Mis-classified	n/a	n/a	n/a
Upper Crooked	Shrub-steppe	Changes in composition	Loss of acreage	Fragmented	n/a
Upper Crooked	Ponderosa pine	Losses of large trees	Loss of acreage	Fragmented	Higher elevation losses
Upper Crooked	Grassland	n/a	Loss of all acreage	n/a	Stream valley losses

3.3.6. Protection classes for focal habitats.

Protection classes for three focal habitats at the subbasin level are shown in Table 6. Since grassland habitat are no longer present in the subbasin, no protection status is shown. Approximately 1/3 of ponderosa pine habitat are thought to have no protection from future degradation, and the remaining 2/3 is thought to have only low protection from degradation in the future. Approximately 1/4 of lodgepole pine forests have no protection from future degradation, and nearly all of the remaining habitat is thought to have only low protection from future degradation. Descriptions of protection classes are shown after Table 6.

Table 6. Protection levels for three focal habitats for the entire subbasin.

Habitat	Protection	Acres
Lodgepole pine forest and woodlands		213,359
	High	2,241
	Low	158,902
	Medium	223
	None	48,136
	(blank)	3,857
Ponderosa pine forest and woodlands		1,319,771
	High	13,196
	Low	807,038
	Medium	17,244
	None	472,092
	(blank)	10,201
Shrub-steppe		1,981,496
	High	5,831
	Low	742,581
	Medium	76,800
	None	1,144,492
	(blank)	11,792
Grand Total		3,514,625

Base data from IBIS 2004, and Barrett 2003. Tabulated and summarized by Mark Garner, Natural Resources Consulting, Inc., Bend, OR.

[1] Protection class descriptions:

High

- An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

Medium

- An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

Low

- An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area.

None

- There are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.

Some protections are in place for focal habitat attributes and components (Table 6A.)

Table 6A. Protections in place for focal habitat attributes and components.

Habitat Attribute or Component	Protection mechanism in place currently
Tree species: aspen, cottonwood, oak.	Some mgt on public land for aspen
Structure: large diameter trees, rimrocks, cliffs	Some mgt on spotted owl nest areas for large trees, some setbacks through Deschutes county planning for rimrocks.
Ungulate winter ranges	County planning department ordinances in place in most counties providing some protections.
CRP	Some protections in place as long as contracts are in force.

3.3.7. Potential and projected future condition of focal habitats *with no future actions*.

Estimated potential and projected future condition of focal habitats and focal habitat attributes and components with no future actions are shown in Table 7. A discussion of the table summary follows.

Table 7. Projected and potential future condition of focal habitats and focal habitat components and attributes, with no future actions.

Habitat or component	Best potential condition	Worst potential condition	Projected future condition (20 yrs.)
Riparian, herbaceous wetlands	Slower loss	Increasing loss	Continued loss. Although no trand data are available, losses are thought to far exceed restoration work. Restoration may take years, but permanent losses occur within

Table 7. Projected and potential future condition of focal habitats and focal habitat components and attributes, with no future actions.			
Habitat or component	Best potential condition	Worst potential condition	Projected future condition (20 yrs.)
			hours or days.
Grasslands steppe	Restoration of some areas.	No restoration.	Some restoration on Crooked River Natl Grasslands
Shrub steppe	Slower loss, some restoration on public and private lands	Loss private lands, continued degrade on public lands	Continued loss and degradation due to vegetative succession and changes. Some restoration on public, private lands.
Ponderosa pine forests	Slower loss private, some mgt on public	Continued loss private and public	Continued loss public and private
Lodgepole pine forests	Slower loss	Loss of all except public	Loss of all except public
Habitat structure	Slower loss	Accelerated losses	Accelerated losses
Plant diversity	Some mgt public and private lands	Continued loss	Some mgt private and public
Ungulate winter range	Slower degradation	Accelerated loss and degradation	Accelerated losses and degradation
CRP lands	Improved mgt of contracted acreage for grassland habitat	Losses of lands from program	Unknown

Riparian wetlands and herbaceous wetlands. Although historic and current map and acreage data from IBIS is not useful to indicate the status of these habitats in the subbasin, these habitats are thought to be greatly reduced from historic conditions, and are considered to be extremely valuable for species diversity within the subbasin. The future status of remaining habitats with no action is thought to be continued loss from conversion to various other uses.

Interior Grassland Habitat. With no future actions, it is estimated that most of the remaining small areas of grassland will be lost. Some acreage of grassland on the Crooked River National Grasslands near Madras will be conserved or restored, and some areas of grassland currently in CRP contract lands may be managed for natural grassland habitat in the future, but these will amount to relatively small acreages.

Shrub-steppe Habitat. Over 1/3 of the acreage of remaining shrub-steppe habitat is thought to have no protection from degradation in the future, and nearly another 1/3 of the total acreage has only low protection status. With no future actions, it is projected that shrub-steppe habitat will continue to decline as juniper invasion continues and vegetation becomes more decadent.

Ponderosa pine forest and oak woodlands. Although the apparent result of the decline in ponderosa pine forest is increased acreage of other conifer forests, the mechanisms causing the change are unknown, therefore the future trend with no action is unknown.

Lodgepole pine forests. These forests occur in the same general zone as ponderosa pine, and are shown in the IBIS maps to have been reduced by over 300,000 acres, or 60 percent of the historic habitat acreage. It should be noted that the remaining acreage of this habitat is only approximately 200,000 acres, compared to ponderosa pine at 1.3 million acres in the subbasin. Remaining acreages of lodgepole pine forest are also fragmented. Much of the former area of lodgepole pine forest existed north of Bend in the Sunriver-Lapine area, and this is an area of continued development for dwellings and suburban and urban uses, therefore it is thought that lodgepole pine forests will continue to decline in this area with no action. The mechanisms causing declines in other areas are unknown, therefore the future status of the lodgepole pine forests in these areas with no action taken is unknown.

Structure: Large late-seral tree forest component, large ponderosa pine trees. Local biologists indicate the continued need to consider the structural diversity within forests as a measure of the forest wildlife species productivity. For example, the structural diversity provided by large ponderosa pine groves in a late-seral condition are thought by local biologists to contribute valuable structural diversity to pine forests, and to provide habitat for a wider array of wildlife species than would otherwise exist in these forests. Large late seral ponderosa trees are thought to be required by species such as the white-headed woodpecker. Another example would be large-tree riparian cottonwood forests, a structural component of riparian wetlands habitat. Large-tree cottonwood riparian forests are thought by local biologists to have been nearly lost in the subbasin. Similarly, groves or stands of large late seral tree component within other conifer forests such as true fir, hemlock, and Douglas fir provide valuable structural diversity within these forests for a variety of wildlife species. Some protections are thought to be in place for large tree stands or groves of Douglas fir forest in a late seral condition within spotted owl nest areas; however, in other areas or tree species with protections are known, therefore, the future status of this component in the subbasin with no action is thought to be continued decline as harvest and loss from other causes occurs.

Structure: Large late-seral tree forest component large juniper trees. Juniper forests composed of large trees up to 1,500 years old that occur in an area east of Bend and Redmond may be threatened by the broad perception that juniper forests are of little value or actually threaten other habitats and therefore should be removed. This perception among biologists has been apparently fostered by the observed encroachment by juniper woodland into former shrub-steppe habitats in the controlled-wildfire environment in the subbasin. This encroachment has long been a concern among fisheries and wildlife biologists in the subbasin according to local biologists, since the expansion of juniper was perceived as a loss of shrub-steppe habitat that is a component of high-quality mule deer and pronghorn antelope habitat, and was also observed to impact surface and subsurface water runoff in stream systems (as the junipers grew in, surface water runoff gradually disappeared, removing surface water from the system.) Projects have been undertaken to manually cut away younger-age junipers in some fairly large areas in the subbasin. Local biologists assert that older-age large-tree-component juniper forests are a valuable part of the wildlife habitat in the subbasin, that a wide array of wildlife occur in these forests, and that these large-tree forests should be managed for conservation in the future. Although some protections are thought to be in place, the areas and details are not known, therefore the status of this forest component in the future with no action is thought to be continued decline as losses of trees occur for various reasons.

Structure: Rimrock and cliff habitats. Rock habitats are not described by the IBIS data source as a separate habitat, but are listed within habitat types as a structural component. No known source of mapped rock habitat areas or acreage estimates are known. Of concern by local biologists are the river canyon rimrocks, tableland rimrocks, and cliff habitats which are threatened by suburban homesite uses or other uses such as rock mining. The future status of these habitats with no action is expected to be further decline in quality and availability to wildlife.

Plant diversity: Oregon white oak groves. The oak forest component of ponderosa pine forest habitat is thought by local biologists to occur as mosaic or as isolated groves along the lower foothills of the Cascades from the town of Warm Springs north to The Dalles (Team 2003.) Some oak groves were also present in the Lower Eastside Deschutes AU historically, and remnant groves are still present in that area. Oak habitat is not shown in the IBIS data, but is thought by local biologists to be much reduced from historic levels, and is thought to be threatened by development for homesites and other future changes in land use (Calvin and Kohl p.c.) The future trend for the oak component of oak grove habitat with no action is thought to be a continued decline due to conversion to other land uses such as suburbanization or clearing for agricultural use.

Plant diversity: dwarf shrub-steppe. This habitat is considered by local biologists to be a valuable part of the structural diversity within the steppe habitat landscape. Since this habitat is not thought to be displayed accurately in the IBIS current habitat map, further work needs to be done to define this habitat in the subbasin, and the trend in the status of this habitat is unknown.

Plant diversity: aspen groves. This habitat occurs as smaller patches within other habitats in the subbasin, according to local biologists, and these smaller patches are referred to as aspen groves rather than forests for this reason. Although this habitat is described as a habitat type in the IBIS system, it is not thought to be represented accurately by mapped data, and no data is available to compare historic and current status. However, it is thought by local biologists that aspen groves are much reduced from historic times in the subbasin, and that this habitat is valuable to the species diversity in the subbasin. While no mapped data is available from IBIS, some map data of existing aspen groves in the subbasin is thought to exist in local US Forest Service and US Bureau of Land Management offices, since aspen groves have been identified as a habitat project item in some of these offices, and field activities to re-establish former aspen groves have been conducted out of some of these offices. Aspen forests and smaller groves are of concern among biologists and others in the Western states in general (Shepperd et al. 2001.) The future status of aspen groves in the subbasin with no action is thought to be continued loss as groves are harvested or lost for various reasons.

Plant diversity: cottonwood groves. Cottonwood groves once occurred along lower and middle reaches of streams and rivers in the subbasin, but are thought to be almost entirely gone from the subbasin, with only isolated groves remaining.

Ungulate Winter Ranges. Ungulate winter ranges occur over large areas of the subbasin, and are not necessarily defined by existing vegetation, but by elevation, aspect, and historic use by ungulates. Ungulate species such as mule deer, elk, pronghorn antelope, bighorn sheep, and mountain goats require winter range habitat areas. Ungulate winter ranges for mule deer southwest of Bend are thought by local biologists to have declined in productivity due to encroachment by suburban and other uses, and by changes in vegetation. Acreage data from some ungulate winter ranges in the subbasin were obtained, and analyzed to show the historic and current wildlife habitats which make up these areas. This is not a complete inventory of all winter ranges in the subbasin, but is a significant proportion, to provide an example of information that can be obtained and used for management of winter ranges. The current habitats represented in the highest acreages within ungulate winter ranges in the subbasin are juniper woodlands, shrub steppe and ponderosa pine woodland (Table 9.) Shrub-steppe and ponderosa pine woodlands make up the highest acreages of focal habitats in winter ranges (Table 9A.) Other acreages of habitats in winter ranges, including historic acreages, and also shown by AU, are presented in 9B, 9C, and 9D. More work needs to be done to obtain complete information for the subbasin on ungulate winter ranges, and to analyze the habitat information in more detail. The future status of ungulate winter ranges with no action is expected to be further declines in quality and availability to wintering animals.

Table 8. Acreages of all habitats within ungulate winter ranges, from current habitats map.

Habitat	Acres
Lower Eastside Deschutes (interior) grasslands	2990
Lodgepole pine forest and woodlands	8504
Montane mixed conifer forest	28026
Dwarf shrub-steppe	29003
Agriculture, pasture and mixed environs	43086
Lower Eastside Deschutes (interior) mixed conifer forest	200764
Ponderosa pine forest and woodlands	401652
Shrub-steppe	510439
Western juniper and mountain mahogany woodlands	703891
Grand Total	1928355

Table 9 Acreages of all habitats within ungulate winter ranges, from historic habitats map.

Habitat	Acres
Lower Eastside Deschutes (interior) grasslands	70230
Lower Eastside Deschutes (interior) mixed conifer forest	75944
Lodgepole pine forest and woodlands	55529
Ponderosa pine forest and woodlands	626710
Shrub-steppe	784424
Western juniper and mountain mahogany woodlands	319896
Grand Total	1932733

Table 9A. Acreages of focal habitats within winter ranges, from current habitats map.

Habitat	Acres
Ponderosa pine forest and woodlands	401652
Shrub-steppe	510439
Grand Total	912091

Table 9B Acreages of focal habitats within winter ranges, from historic habitats map.

Habitat	Acres
Lower Eastside Deschutes (interior) grasslands	70230
Lodgepole pine forest and woodlands	55529
Ponderosa pine forest and woodlands	626710
Shrub-steppe	784424
Grand Total	1536893

Habitat benefits from farmed land: Conservation Reserve Program (CRP) Agricultural Lands. This habitat is not shown in the IBIS database as a separate habitat, but is lumped in with agricultural lands. As an example, a map of CRP lands in the lower subbasin is presented in the Appendix. Acreages enrolled in CRP that are within historic focal wildlife habitat areas are shown in Table 9. This table shows nearly 32,000 acres of CRP lands enrolled within historic grasslands in the Lower Eastside Deschutes AU, which indicates potential acreage for grassland habitat if these CRP lands are managed with the goal of providing grassland habitat. Agricultural acreages enrolled under this federal program are usually planted to a mixture of grasses, and generally are left undisturbed without mowing or grazing, and therefore could be considered to be grasslands wildlife habitat. Although past CRP areas have been planted to domestic grass types, in recent years these acreages have been planted to a mixture of native grasses and legumes (Todd Peplin, p.c.) These agricultural lands, whether planted to propogated or native grasses, provide habitat for grassland wildlife species. While this acreage is not comparable to the 630,000 acres of grassland habitat formerly existing in the subbasin, there is some potential for future habitat. A sentence from recent literature on the decline of prairie grouse states: "Landscape-level habitat restoration through federal conservation programs may be the only option available to prevent several of these [prairie grouse] species from declining to dangerously low levels." (Riley 2004 p.83) The future status of these areas without action is unknown, however, since economic decisions by the landowners and government entities involved will influence the area under agreements.

Table 9C. CRP-enrolled acreages within historic wildlife habitats in the LOWER EASTSIDE DESCHUTES, Lower Westside Deschutes, and White River AUs (Wasco and Sherman Counties).

Assessment Unit	Habitat	Acres
LOWER EASTSIDE DESCHUTES		39625.47221
	Lower Eastside Deschutes (interior) grasslands	31977.98603
	Shrub-steppe	7647.486183
LOWER WESTSIDE DESCHUTES		12195.81758
	Desert playa and salt scrub shrublands	126.2443409
	Lower Eastside Deschutes (interior) grasslands	3496.669954
	Herbaceous wetlands	126.5704522
	Open water - lakes, rivers, streams	13.63975541
	Ponderosa pine forest and woodlands	77.55271489
	Shrub-steppe	8355.140358
WHITE RIVER		3151.487733
	Lower Eastside Deschutes (interior) grasslands	109.3763954
	Herbaceous wetlands	310.8456137
	Ponderosa pine forest and woodlands	155.647107
	Shrub-steppe	2575.618617

Table 9C. CRP-enrolled acreages within historic wildlife habitats in the LOWER EASTSIDE DESCHUTES, Lower Westside Deschutes, and White River AUs (Wasco and Sherman Counties).		
Grand Total		54972.77752

Original data from IBIS and U.S. Natural Resources Conservation Service offices. Summarized by Mark Garner, Natural Resources, Inc., Bend, Oregon.

3.3.8. Out of subbasin effects: out-of-subbasin harvest of managed species

Mule deer are subject to harvest during deer season when they migrate out of the subbasin. They are also susceptible to diseases. No out of subbasin harvest occurs on American beaver, the only other harvested focal species.

3.3.9. Basin-wide assumptions: effects on productivity and sustainability.

3.4. Environment/Population Relationships

3.4.1. Optimal characteristics of KECs and environmental potential for KECs

Important environmental factors for species survival by life stage are referred to as key environmental correlates (KECs.) KECs for the focal species, optimal characteristics of the KECs, and environmental potential for the KECs are presented in Appendix table L.

3.4.2. Long-term viability of focal species based on habitat availability and condition

Estimated long-term viability for focal species based on projected habitat availability and condition are presented in Table 10.

Table 10. Long-term viability of populations of focal species based on habitat availability and condition.

Species	Long-term viability
American beaver	Increasing in areas where riparian area is recovering. Decreasing in areas where riparian degradation continues.
Columbia spotted frog	Increasing in areas where riparian area is recovering. Decreasing in areas where riparian degradation continues.
White-headed woodpecker	Stable or increasing in areas where restoration projects occur and habitat is recovering. Stable or declining in areas with continued loss of large-diameter ponderosa pine trees and snags due to increasing human population and more intensive forest management.
Mule deer	Decreasing. Continued loss or fragmentation of winter range capability due to increasing human population.
Greater sage grouse	Decreasing. Continued vegetative succession is

Table 10. Long-term viability of populations of focal species based on habitat availability and condition.	
	expected to degrade shrub-steppe habitat in the absence of vegetative management options such as controlled burning.
Golden eagle	Decreasing. Loss of cliff and large tree nest sites will occur to due increasing human population, and other sources of mortality will increase.
Sharp-tailed grouse	(presently extirpated) Continued absence, unless action is taken by wildlife and habitat managers to restore populations.

3.4.3. Determination of key ecological functions (KEF's) and functional redundancy as a key indicator for ecological processes

The KEFs for the focal species are shown in Appendix table M, sorted by focal species to show functional redundancy. Functional redundancy refers to more than one species performing an ecological function; therefore, if two or more species are shown with the same KEF, functional redundancy is indicated. Functional redundancy would be shown at the most specific end of the KEF hierarchy. For example, both the Columbia spotted frog and the American beaver are heterotrophic consumers, but this would not show a high degree of functional redundancy until carried down the hierarchy to the lowest level where both species are shown to be aquatic herbivores. Another example of functional redundancy by two species from the table is the fact that both sage grouse and sharp-tailed grouse are bud and catkin feeders (KEF 1.1.1.10.)

3.4.4. Functional specialist species and critical functional link species.

Functional specialists are wildlife that perform very few ecological roles, and *critical functional link species* are wildlife that are the only species or are one of only a few species that perform a particular key ecological function in a particular wildlife habitat. Of the focal species, none were found to be functional specialists in the subbasin, and one, American beaver, was found to be a critical functional link species. The KEFs performed by the beaver are listed in Table 11.

Table 11. KEFs performed by American beaver, a critical functional link species, in habitats in the Deschutes Subbasin.

KEF Description	Wildlife Habitat	Other species that perform KEF
bark/cambium/bole feeder	Open water	Black bear
Creation of aquatic structures	Forest habitats	None
Impounds water by damming or diverting	Forests, wetlands, open water	None
Creation of ponds or wetlands by wallowing	Open water, forest habitats	Rocky Mountain elk

3.4.5. Wildlife Interspecies relationships

Inter-specific relationships between the focal species can be obtained by examining the KECs and KEFs lists, sorted by KECs and KEFs. These lists are shown as Appendix M indicating KEFs and redundancy, and Appendix N showing interdependence of focal species utilizing the same habitat correlates.

The first indication of inter-specific relationships might be shared KEFs or KECs between two or more species. For example, both sharp-tailed grouse and white-headed woodpeckers share a KEF in that they both disperse seeds through ingestion or caching. Similarly, both golden eagles and white-headed woodpeckers share the KEC of utilizing snags.

Other indications of relationships might be more difficult to recognize. For example, one KEF for the golden eagle is that this species is a vertebrate consumer or predator. What this actually means is that the golden eagle could (and would) prey on all other 6 focal wildlife species, which would indicate a type of inter-specific relationship. This is also shown by the KEC information that shows all 6 other focal species as “prey for secondary or tertiary consumer.”

3.4.6. Key relationships between fish and wildlife

Of the 7 focal species, beaver and the golden eagle are shown to interact with salmon. Beaver play an important role in maintaining functional riparian communities and floodplains. Golden eagle utilize salmon carcasses as food (Table 12.)

Table 12. Focal species interaction with salmonids.

Common Name	Salmonid-wildlife-Relationship Description*	Salmonid-wildlife Stages Description
Golden Eagle	Recurrent relationship	Carcasses
Golden Eagle	Recurrent relationship	Spawning - freshwater
Sage Grouse	No relationship	Not known or none
Sharp-tailed Grouse	No relationship	Not known or none
White-headed Woodpecker	No relationship	Not known or none
Mule Deer	No relationship	Not known or none
Columbia Spotted Frog	No known relationship	Not known or none
American Beaver	Recurrent relationship	Habitat diversity
SW-Relationship Description	Carcasses	Spawning - freshwater
Recurrent relationship	1	1

Table supplied by NHI, 2004.

3.5. Analysis of Limiting Factors

3.5.1. Limiting factors and opportunities for action inside the subbasin.

Disturbance factors limiting populations and ecological processes, with opportunities to have a beneficial effect or that can be corrected are shown in Table 12A.

Table 12A. Disturbance factors inside Deschutes subbasin limiting populations, and opportunites for action in assessment units.

Focal species or habitat/limiting factors	Assessment Unit(s)	Opportunties for action
American beaver	All	
Overharvest/eradication of local beaver populations (colonies)		Localized harvest regulation
No nearby local population to repopulate		Relocation of beaver to suitable habitat
Loss of riparian vegetation		Restore riparian vegetation
Loss of permanent water habitats due to other water uses		Restore permanent (year-around) water habitats
Columbia spotted frog	Upper Crooked only	
Competition/predation by exotics		Eradication of exotic plants, animals, fish in habitats
Loss of riparian vegetation		Restoration of riparian vegetation
Loss of oxbows, backwaters		Restoration of oxbows, backwaters
Spring development for livestock water		Restoration of springs habitats
Loss of permanent water habitat due to other water uses.		Restoration of permanent (year-around) water habitat.
White-headed woodpecker	All	
Lack of large-diameter ponderosa pine stands		Forest management for stands of large ponderosa pine.
Mule deer	All except Cascade Highlands	
Human disturbance on winter ranges		Controlled access on winter ranges
Poaching on winter ranges		Increased enforcement on winter ranges
Construction of dwellings, other development on winter ranges		Implement/develop protections
Reduced quality/quantity of forage on winter range		Management of plant communities on winter ranges to provide high quality/quantity forage.
Greater sage grouse	Upper Crooked and Lower Crooked	
Disturbance/destruction of lek sites		Implement/develop protections
Lack of knowledge of habitat requirements		Continued research

Table 12A. Disturbance factors inside Deschutes subbasin limiting populations, and opportunites for action in assessment units.

Focal species or habitat/limiting factors	Assessment Unit(s)	Opportunties for action
Lack of knowledge of plant community manipulation methods needed to produce suitable habitat		Plant community research/management experiments
Columbian sharp-tailed grouse	Lower Eastside Deschutes, Upper Crooked, Lower Crooked, Middle Deschutes	
Lack of grassland habitat		CRP management for grassland habitat
Lack of grassland habitat		Management of Crooked River Natl Grassland for grassland habitat.
Local populations extirpated		Relocation of grouse to suitable habitat from Washington or as available
Golden eagle	All except Cascade Highlands	
Illegal shooting		Regulatory measures
Electrocution on power lines		Power pole modifications
Construction of dwellings near cliff nest sites		Implement/develop protections
Riparian habitats (See American beaver, Columbia spotted frog)	All	1. Replant riparian plants 2. Reconstruct backwaters, oxbow sloughs, natural meander 3. Establish beaver colonies.
Grassland habitat (see sharp-tailed grouse)	Lower Lower Eastside Deschutes Deschutes, Upper and Lower Crooked, Middle Deschutes	1. Use fire to re-establish former grasslands. 2. Eradicate noxious weeds and exotic grasses in former grasslands. 3. Eradicate juniper, brush that has encroached in former grasslands.
Shrub steppe habitat (see greater sage grouse)	Upper Crooked River, Lower Crooked River, Lower Lower Eastside Deschutes Deschutes, Lower Westside Deschutes.	1. Eradicate noxious weeds and exotic grasses. 2. Use fire to restore early successional stages.
Ponderosa pine forests (see white-headed woodpecker)	All AU's.	1. Inventory functional large-tree (late seral) stands. 2. Manage late-seral stands to

Table 12A. Disturbance factors inside Deschutes subbasin limiting populations, and opportunites for action in assessment units.

Focal species or habitat/limiting factors	Assessment Unit(s)	Opportunties for action
		maintain connectivity.
Lodgepole pine forests	All	Inventory large-tree (late seral) stands.
Loss of large diameter lodgepole pine		Management for large diameter lodgepole.
Loss of insect irruption areas		Management of insect irruption areas for habitat.
Loss of fire-killed areas		Management of fire-killed areas for habitat.
Ungulate winter ranges (see mule deer also)	All	Inventory status of functional winter ranges.
Dwellings and other development in winter ranges.		Assess effectiveness of regulatory rules in place. Develop effective rules if needed.
Exotic ungulates and domestic livestock degrading vegetation on winter ranges.		Assess impacts of exotic and domestic livestock on winter range vegetation.
Exotic ungulates and domestic livestock communicating diseases to wild ungulates on winter ranges.		Assess impacts of disease on wild ungulate winter ranges. Example bighorn sheep are vulnerable to domestic sheep diseases, and wild elk are vulnerable to domestic livestock and exotic wild ungulate diseases.
Structure: rock cliffs, rimrocks (see also golden eagle).	Lower Eastside Deschutes, Lower Westside Deschutes, Upper Crooked and Lower Crooked, Upper Deschutes, Middle Deschutes	Inventory rimrock and cliff areas to assess impacts of development near cliffs and rimrocks
Structure: large diameter trees (late seral forest stages) (see white-headed woodpecker)	All	Inventory late-seral stage forest stands to assess connectivity.
CRP lands (see sharp-tailed grouse)	White River, Lower Eastside Deschutes, Lower Crooked River.	Inventory CRP lands where opportunity for grassland management exists.
Decadent CRP grass stands: invasion by brush		Restore grass areas
Mowing, grazing of CRP grass stands		Manage mowing or grazing to protect grassland habitat values
Vegetation species diversity:	All	Inventory aspen stands to assess

Table 12A. Disturbance factors inside Deschutes subbasin limiting populations, and opportunites for action in assessment units.		
Focal species or habitat/limiting factors	Assessment Unit(s)	Opportunties for action
aspen groves		connectivity.
Grazing: destruction of young aspen trees.		Protect young trees from grazing
Vegetation species diversity: cottonwood groves	All	Inventory cottonwood groves and seral stages to assess connectivity.
Grazing: destruction of young cottonwood trees		Protect young trees from grazing
Clearing of cottonwood groves		Replace groves in former areas
Cutting of large cottonwood trees/snags for firewood, other uses		Protect large trees/snags (late seral groves) from cutting for firewood or other uses.

3.5.2. Limiting factors outside the subbasin.

The only focal species that has been identified as being influenced by out-of-subbasin factors is a population of mule deer in the Middle Deschutes AU which migrates to summer range partly or entirely outside the subbasin. In the summer of 2003 a wildfire occurred on both the summer range (outside the subbasin) and winter range (inside the subbasin) of this herd, and this could have an effect on this population. Since this herd migrates between two different wildlife management units that are used to manage hunting seasons for deer, the hunting season on the out-of-subbasin summer range, that is in a different wildlife management unit than the winter range, could have an effect on this deer population.

Opportunities to have a beneficial effect, or conditions that can be corrected. Hunting seasons are monitored by the Oregon Department of Fish and Wildlife to make sure that overharvest does not occur on the migratory mule deer population in the Middle Deschutes AU. If overharvest or other impact to the mule deer population in the Middle Deschutes AU occurs, the hunting season can be modified.

3.6. Synthesis.

3.6.2. Working hypotheses.

Working hypotheses are presented in Table 13. Where no supporting evidence is indicated, no supporting data from IBIS sources or readily-available sources such as watershed assessments were found. A more complete listerature search for those items where no supporting evidence is indicated could produce evidence such as historic narratives supporting the hypotheses.

Table 13. Habitat hypotheses, species hypotheses, and supporting evidence.		
Number	Terrestrial working hypothesis	Evidence supporting hypothesis
1.	Large areas of riparian and wetland habitats have been lost or degraded since 1850.	No objective data were found. This is identified as a data gap.

Table 13. Habitat hypotheses, species hypotheses, and supporting evidence.

Number	Terrestrial working hypothesis	Evidence supporting hypothesis
2.	Nearly all grassland habitats have been lost since 1850	1. Comparison of historical and current wildlife habitat maps from IBIS indicates loss of 99 percent of interior grasslands.
3.	Shrub steppe habitat has been reduced in area since 1850.	1. Comparison of historic and current wildlife habitat maps from IBIS indicates a 14 percent loss in shrub steppe since 1850.
4.	Large areas of lodgepole pine forest have been lost since 1850.	1. Comparison of historic and current wildlife habitat maps from IBIS indicates a 60 percent loss in lodgepole pine forest since 1850.
5.	Large areas of ponderosa pine forest have been lost since 1850.	1. Comparison of historic and current habitat maps from IBIS indicate a 29 percent loss in ponderosa pine habitat since 1850.
6.	Habitat structure such as large tree structure and cliff/rimrock structure has been lost or degraded as golden eagle nesting habitat since 1850.	See golden eagle species account.
7.	Aspen, cottonwood, and white oak groves have been lost since 1850	See habitat discussion sections.
8.	Ungulate winter ranges have been degraded since 1850.	See discussion in winter range section.
9.	CRP lands provide potential grassland habitat for wildlife.	See discussion in Columbian sharp-tailed grouse species account.
10.	American beaver populations have been greatly reduced since 1850 due to loss of habitat.	See discussion in species account section.
11.	Columbia spotted frog populations have declined in the Upper Crooked River AU as a result of loss of habitat.	See discussion in species account section.
12.	White-headed woodpecker populations have been reduced or lost as a result of loss of large-ponderosa pine-tree breeding habitat.	See discussion in species account section. See discussion in ponderosa pine forest habitat section.
13.	Mule deer populations have been reduced or lost as a result of loss or degradation of winter range habitat (see ungulate winter range.)	See discussion in species account section.
14.	Greater sage grouse populations have been reduced or lost as a result of loss or degradation of shrub steppe habitats.	See discussion in species account section.
15.	Columbian sharp-tailed grouse populations have been lost as a result of the loss of grassland habitat.	See discussion in species account section.
16.	Golden eagle populations have been lost or are threatened as a result of loss or threatened loss of foraging habitat in	See discussion in species account section.

Table 13. Habitat hypotheses, species hypotheses, and supporting evidence.		
Number	Terrestrial working hypothesis	Evidence supporting hypothesis
	grasslands and shrub-steppe habitats and other factors such as shooting and electrocution, and as a result of disturbance of nesting sites in rimrock and cliff nesting habitat.	

3.6.2. Desired future conditions

Listed species recovery goals. Of the focal species, only the Columbia spotted frog is a priority 3 candidate for federal listing in the subbasin (see species account.) No recovery goals have been set for this species by the US Fish and Wildlife Service.

Desired future conditions for focal species and focal habitats in the subbasin are summarized in Table 14.

Table 14. Desired future conditions for focal species and focal habitats.	
Focal species or focal habitat	Desired future condition
Riparian habitat.	50 percent of former riparian habitat (1850) in functional condition.
Shrub steppe habitat	50 percent of habitat existing in 1850 in functional condition.
Grassland steppe habitat	10 percent of former habitat (1850) in functional condition, including CRP grasslands as functional habitat where applicable.
Ponderosa pine habitat	Late seral single-story large tree structure stands restored to functional condition across the ponderosa pine forest landscape, including adequate connectivity between late seral stands.
Lodgepole pine habitat	50 percent of habitat existing in 1999 restored to functional condition, including stands of bug-killed and fire-killed trees and late seral stands.
Habitat structure: large late seral trees, rimrocks, cliffs.	See lodgepole and ponderosa pine habitats. For rimrocks and cliffs, local protections should be installed to conserve remaining structures as functional habitat.
Plant diversity: aspen, oak, cottonwood groves	50 percent of historic groves restored to functional condition.
Ungulate winter range	100 percent of habitat existing in 1999 in functional condition.
American beaver	50 percent of adequate habitat in each AU occupied by beaver measured in colonies per mile of linear stream and riverine habitat.
Columbia spotted frog	Establish 10 genetically connected viable populations in the Upper Crooked River AU.

Table 14. Desired future conditions for focal species and focal habitats.	
Focal species or focal habitat	Desired future condition
	Establish populations in other AU’s which may be identified as areas of former occurrence.
White-headed woodpecker	100 percent of ponderosa pine forest existing in 1999 in adequate reproducing habitat condition which includes some large diameter tree stands for reproduction.
Mule deer	Five-year average population levels maintained at ODFW population management objective levels as measured on winter ranges annually.
Greater sage grouse	Five-year average population level maintained at 1990-1999 average as measured on leks annually.
Coumbian sharp-tailed grouse	Two viable populations established including at least two leks for each population on the Crooked River National Grasslands in the Lower Lower Eastside Deschutes Deschutes, Lower Crooked, and Middle Deschutes AUs.
Golden eagle	60 viable nest territories maintained in the subbasin.

3.6.3. Opportunities for conservation and restoration

All focal habitats and focal species are designated as high priority for protection or restoration in the subbasin. Findings, goals, some potential strategies, and priority areas at the AU level are presented in Table 15. This list of potential strategies should not be considered a complete list. More work needs to be done to discover additional strategies that may be most effective in local areas. Much more work needs to be done to formulate an overall plan for restoration and conservation work based on a more complete inventory of habitats such as riparian habitats, where no data is available to show linear miles or acres of habitat and the degree of functionality of the habitat.

Opportunities for conservation and restoration of both fish and wildlife habitats are shown at the HUC 6 level in the Appendix maps as colored stream reaches and indicated changes in wildlife habitat from historic estimates. On these maps (a group of 12 maps) priority stream reaches are color coded as candidates for conservation, restoration, or both. These priority stream reaches are overlain on each of four focal habitat maps that are color-coded to show decreases or increases in habitat levels in each HUC6 compared to historic levels. Also shown on one set of four maps are past and ongoing habitat projects, both aquatic and terrestrial. With this information, a proposed project can be evaluated, or a project strategy can be formulated for a HUC6 or larger geographic unit, using the aquatic and terrestrial priorities presented in this plan. As previously mentioned, wildlife habitat acreages and stream miles evaluated for functionality at the HUC6 level would be useful for designing future work in the subbasin.

Table 15. Key findings, goals, potential strategies, and priority areas for management of focal habitats and species.

Species or Habitat	Key findings	Goals	Potential Strategies	Priority Areas
Riparian habitats and herbaceous wetlands.	Many degraded areas, and converted to other uses.	Restore seasonal water regime	1. Purchase water rights.	All streams, all AUs.
Riparian habitats and herbaceous wetlands.	Large areas have been degraded or destroyed since historic times.	1. Restore riparian vegetation to functional status in 90 percent of stream reaches. 2. Restore 25 percent of former acreage of herbaceous wetlands in 25 percent of historic areas.	1. inventory non-functional riparian zones and former herbaceous wetland areas. 2. Purchase wetland areas and riparian zones or obtain natural resource easements.	All stream and river valleys and canyons. All AUs.
Lodgepole pine forests	Fragmented	Restore 4 large blocks of forest	1. Inventory remaining blocks. 2. Inform forest managers.	South half of Upper Deschutes AU.
Lodgepole pine forests	Lack of large trees, dead trees, late seral stage stands.	Restore tree size and snag diversity in 50 percent of remaining stands.	1. Inventory remaining diverse stands, assess connectivity values. 2. Inform forest managers.	South half of Upper Deschutes AU.
Ungulate winter range (mule deer, bighorn sheep, antelope, elk)	Degraded	Protect remaining habitat, restore degraded habitat.	1. Inventory winter ranges. 2. Purchase winter ranges or purchase easements. 3. Purchase grazing rights on winter ranges.	Designated areas in each AU, all AUs.
Sage grouse (shrub steppe)	Declining in numbers	Maintain minimum population of 1990-99 average as measured on leks.	1. Inventory populations. 2. Continue population management to prevent overharvest. 3. Release birds into old and new habitat	East half of Upper Crooked AU, east half of Lower Crooked, Lower Eastside Deschutes, Middle Deschutes..

Table 15. Key findings, goals, potential strategies, and priority areas for management of focal habitats and species.

Species or Habitat	Key findings	Goals	Potential Strategies	Priority Areas
			areas to diversify genetics. 4. Construct new habitat centers (leks.) 5. Identify potential habitat areas. 6. Inform land managers. 7. Purchase grazing rights, pay for fire management, scarification if needed.	
Dwarf shrub steppe	Declining in area, decadent stands	Protect remaining, restore to 50 percent of historic area.	1. Inventory remaining dwarf shrub habitats. 2. Manage grazing, fire, planting, scarification, if needed.	Historic area of habitat in the Lower Crooked AU, Upper Crooked, Lower Lower Eastside Deschutes Deschutes.
C. spotted frog	Loss in distribution in former range.	Restore or establish 10 populations. Restore connectivity of populations and habitats.	1. Inventory former springs and other habitats. 2. Restore habitats obtained through purchase or easement.	Upper Crooked AU.
Ponderosa pine forests (white-headed woodpecker)	Declining in area and large tree (late seral stage) component	Identified large tree stands maintained throughout ponderosa pine forests to allow connectivity between stands for species such as white-headed woodpecker.	1. Inventory late seral stands remaining, and evaluate functional status such as connectivity. 2. Inform forest mgrs.	Historic ponderosa pine forested areas in all AUs.
Grasslands.	Formerly 600,000 acres in subbasin, now 99 percent gone.	Restore functional blocks of grasslands in areas of AUs where grasslands	2. Add to small existing remaining areas, in Crooked River Natl Grasslands, or near	Lower Lower Eastside Deschutes Deschutes, Lower and Upper

Table 15. Key findings, goals, potential strategies, and priority areas for management of focal habitats and species.				
Species or Habitat	Key findings	Goals	Potential Strategies	Priority Areas
		formerly occurred..	CRP lands, for example, by informing managers or buying easements or land.	Crooked, Middle Deschutes AUs.
Aspen groves, cottonwood groves	Declining in numbers	Protect remaining groves, restore groves to 50 percent of historical locations and arcreages.	1. Inventory remaining groves, and areas of former groves. 2. Inform managers, buy easements or land.	Historic groves sites in all AUs.
White oak groves	Declining in numbers and area	Protect remaining groves, restore groves to 50 percent of historic acreages and areas.	1. Inventory historic areas and acreages. 2. Inform mgrs, buy easements or land.	Historic groves sites, Lower Westside and Lower Lower Eastside Deschutes Deschutes, White River AUs.
Cliffs, rimrocks	Threatened by future development	Protect remaining cliffs, rimrocks that are undeveloped.	1. Inventory cliffs and rimrocks. 2. Inform local govt 3. Buy easements or land.	Inventory may be needed. All AUs except Cascade Highlands.
Golden eagle	Threatened by shooting, disturbance at nest sites, loss of foraging habitat	Maintain at least 60 nesting territories (pairs) in the subbasin.	1. Inventory nesting territories. 2. Inform local govt. 3. Identify threats to each territory or pair.	Inventory may be needed. All AUs except Cascade Highlands.
C. sharp-tailed grouse	Extirpated	Establish two populations of at least 500 birds each.	1. Identify sources of proper race of birds to transplant. 2. Construct leks, water sources, inventory habitat attributes in release areas. 3. Monitor populations.	Suitable habitat in Lower Lower Eastside Deschutes Deschutes, Lower and Upper Crooked, Middle Deschutes AUs.

4. Inventory

Visual presentations of past and ongoing stream and upland restoration projects in the subbasin are shown with wildlife habitat information in the Appendix maps. Projects are displayed as points on each of four focal wildlife habitat maps showing color-coded changes in focal wildlife habitats from historic levels, by HUC6 geographical unit. Projects are also color-coded according to 11 categories of projects on these maps, e.g. instream habitat restoration, wetlands restoration, upland habitat restoration, and so on. Appendix maps are included on a CD in Adobe format, so they can be viewed in more detail. Since the restoration projects represent projects that are ongoing or were completed within the past 5 years, it is apparent that a significant number of projects have been completed or are ongoing in the subbasin.

A summary of past and ongoing projects in the subbasin is also presented in table form in the Management Plan section of the main document.

5. Management Plan

5.1.Vision for the subbasin.

The full spectrum of indigenous wildlife and wildlife habitats should be present in the subbasin, but some habitats and populations would be expected to be at lower levels than historically. Degraded habitats should be restored to functional status where not permanently committed to other uses, and existing functional habitats should be conserved and managed to insure that they remain viable into the future.

5.2. Biological and habitat objectives and key findings.

See main plan document for combined fish and wildlife biological and habitat objectives and key findings.

5.3. Prioritized strategies

See main plan document for combined fish and wildlife prioritized strategies.

5.4. Consistency with ESA Requirements

All proposals for action in this assessment are consistent with ESA requirements according to available literature information reviewed for this assessment.

5.5. Research, Monitoring and Evaluation

See Table 15 for summaries of research, monitoring, and evaluation opportunities, and main plan document for combined fish and wildlife monitoring and evaluation opportunities.

6. Appendices

6.1. Species Accounts.

6.2. List of appendix tables.	
Appendix table	Subject
A	List of historic wildlife species in the Deschutes subbasin.
B	List of current wildlife species in the Deschutes subbasin.
C	Comparison of historic and current species, and suggested additions and deletions.
D	Threatened, endangered, and sensitive wildlife species in the Deschutes Subbasin.
E	Wildlife species currently harvested by hunters in the Deschutes Subbasin.
F	HEP wildlife species in the Deschutes Subbasin.
G	Partners in Flight listed species in the Deschutes Subbasin.
H	Critical functional link species in the Deschutes Subbasin.
I	Changes in acreages within assessment units of wildlife habitats thought to occur historically (1860) and currently (1999.)
J	Acreages of focal habitats within ungulate winter ranges by Assessment Unit, from current habitats map.
K	Acreages of Focal Habitats within ungulate winter ranges by Assessment Unit, from historic habitats map.
L	Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.
M	Key ecological functions (KEFs) for focal species, sorted to show redundancy.
N	KECs sorted to show interspecific relationships.

6.3. List of appendix maps.
Map of historic wildlife habitats in the Deschutes Subbasin and assessment units.
Map of current wildlife habitats in the Deschutes Subbasin and assessment units.
Map of wildlife habitats thought to occur historically (1860) in the Columbia Plateau Ecoprovince
Map of wildlife habitats thought to occur currently (1999) in the Columbia Plateau Ecoprovince.
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in interior grasslands wildlife habitat in each subbasin, including the Deschutes Subbasin.
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in shrub steppe wildlife habitat in each subbasin, including the Deschutes Subbasin
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in ponderosa pine and oak wildlife habitat in each subbasin, including the Deschutes Subbasin.
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in lodgepole pine forest wildlife habitat in each subbasin, including the Deschutes Subbasin.
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in Western juniper wildlife habitat in each subbasin, including the Deschutes Subbasin.
Map of Columbia Plateau Ecoprovince, showing percent change from historic conditions in montane mixed conifer wildlife habitat in each subbasin, including the Deschutes Subbasin.
Map of CRP lands in the LOWER WESTSIDE DESCHUTES subbasin.
Map of some ungulate winter ranges in the Deschutes subbasin.
Maps (group of 12) of color-coded changes in each of the four focal wildlife habitats from historic levels by HUC6, with restoration project locations and priority stream reaches indicated.

7. Literature Cited

Anon. 2003. An Oregon Technical Guide for Developing Wildlife Elements of a Subbasin Plan. Dated April 16, 2003. 22 p. with flow charts.

Anon. 2003. Oregon Specific Guidance. Prepared by Oregon Subbasin Planning Coordination Group. Dated Sept. 15, 2003.79 p.

Ashley, Paul and Stacy Stoval. 2004. American Beaver. Species Account written for the Southeast Washington Ecoregional Assessment. 9 p.

___________. 2004a. Columbian Sharp-tailed Grouse. Species Account written for the Southeast Washington Ecoregional Assessment. 12 p.

__________. 2004b. Rocky Mountain Mule Deer. Species Account written for the Southeast Washington Ecoregional Assessment. 10 p.

__________. 2004c. White-headed Woodpecker. Species Account written for the Southeast Washington Ecoregional Assessment. 8 p.

Barrett, Charley. 2003. US Columbia River Basin Land Stewarship Status, 1st. Ed. Northwest Habitat Institute. *Online_Linkage:* <http://www.nwhi.org/ibis/mapping/gisdata/gisdata.asp>

Burt, Henry William. 1976. A Field Guide to the Mammals: North America north of Mexico. Houghton Mifflin Co. 299 p.

Carey, Chris. 2004. Pers. comm. Wildlife Biologist, Ore. Dept. Fish and Wildlife, Bend, Oregon.

Calvin, Doug 2004. Personal communication. Wildlife Biologist, Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, OR;

Clark, Jennifer Shannon and Karen Lamsen 2004. White River Watershed Assessment. Wasco County Soil and Water Conservation District, The Dalles, Oregon. 79 p. or CD.

Clowers, Gary. 2004. Pers. comm. Wildlife Biologist, consulting. Madras, Oregon.

Confederated Tribes of the Warm Springs Reservation of Oregon. 1999. Pelton Project Final License Application. Vol. 1 of 4.

Corkran, Charlotte C. and Chris Thoms. 1996. Amphibians of Oregon, Washington and British Columbia: A Field Identification Guide. Lone Pine Publishing. 175 p.

Csuti et al. 2001. Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History. Oregon State Univ. Press, Corvallis, Or. 525 p.

Deschutes Coordinating Group. 2004. Members from within the Deschutes Subbasin. Members served 2003-04 to provide technical and other stakeholder input during the process of assembling the Deschutes Subbasin Plan.

Deschutes Subbasin Wildlife Team. 2004. Team members served Nov. 2003-May, 2004, to provide technical input during construction of the wildlife assessment section of the Deschutes Subbasin Plan. Members: Glen Ardt, Watershed Habitat Biologist, Oregon Dept. of Fish and Wildlife, Bend, OR; Doug Calvin, Wildlife Biologist, Confederated Tribes of the Warm Springs Reservation of Oregon, Warm Springs, OR; Nancy Gilbert, Wildlife Biologist, US Fish and Wildlife Service, Bend, OR; Ellen Hammond, Ore. Dept. of Agriculture, Bend, OR; Jan Hanf, Wildlife Biologist, US Bureau of Land Management, Prineville, OR; Shane Jeffries, Wildlife Biologist, US Forest Service, Bend, OR; Clair Kunkel, Assistant Watershed Manager, Oregon Dept. of Fish and Wildlife, Bend, OR; Robert Marheine, Wildlife Biologist, Portland General Electric, Madras, OR; Carl Scheeler, Wildlife Biologist, Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR;

Gabrielson, Ira N. and Stanley G. Jewett. 1970 ed. Birds of the Pacific Northwest, With Special Reference to Oregon. (Formerly: Birds of Oregon.) Dover Publications, Inc. New York.650 p.

George, Steven 2003. Personal communication. District Wildlife Biologist, Oregon Dept. of Fish and Wildlife, Bend, Oregon.

Gilbert, Nancy. 2003. Personal communication. Wildlife biologist, US Fish and Wildlife Service, Bend, OR.

Hanf, Jan. 2003. Personal communication. Wildlife biologist, US Bureau of Land Management, Prineville, OR.

IBIS. 2004. Interactive Biological Information System. Northwest Habitat Institute, Corvallis, OR www.nhi.org

Johnson, David H. and Thomas A. O’Neil (managing directors). 2001.Wildlife-Habitat Relationships in Oregon and Washington.. Oregon State Univ. Press, Corvallis, Or. 768 p.

Kohl, Keith. District Wildlife Biologist, Ore. Dept. Fish and Wildlife The Dalles, Oregon.

Kunkel, Clair. 2003. Assistant Watershed Manager, Ore. Dept. Fish and Wildlife, Bend, Oregon.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR 768 Pp.

Nelson, Leslie and Clair Kunkel. 2001. Draft Deschutes River Subbasin Summary. Prepared for the Northwest Power Planning Council. Ore. Dept. of Fish and Wildlife. 167 p.

Northwest Power Planning Council. 2001. Technical Guide for Subbasin Planners. Council document 2001-20. 24 p.

Ore. Dept. of Fish and Wildlife. 1997. 1997 Big Game Statistics. Rev. Aug. 1997. 66 p.

_________________________. 2002. Oregon Furbearer Trapping and Hunting Regulations, July 1, 2002 throught June 30, 2004. 11p.

_________________________. 2003. Oregon's Mule Deer Management Plan. 29 p.

_________________________. 2003a. Oregon Big Game Regulations.103 p.

_________________________ 2003b. Oregon's Bighorn Sheep and Rocky Mountain Goat Management Plan. Dated December 2003. 80 p.

Paul, Keith. 2004. Columbia Spotted Frog Species Account. U.S. Fish and Wildlife Service, La Grande, Or. 19 p.

Peplin, Todd. 2004. Personal communication. District Conservationist, Natural Resources Conservation Service, Redmond, OR.

O'Neil, Thomas A., David H. Johnson, Charley Barrett, Marla Trevithick, Kelly A. Bettinger, Chris Kiilsgaard, Madeleine Vander Heyden, Eva L. Greda, Derek Stinson, Bruce G. Marcot, Patrick J. Doran, Susan Tank, and Laurie Wunder. 2001. Matrixes for Wildlife-Habitat Relationships in Oregon and Washington. [CD-ROM] in D. H. Johnson and T. A. O'Neil (managing directors). 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR 768 p.

Riley, Terry Z. 2004. Private-land habitat opportunities for prairie grouse through federal conservation programs. in Special prairie grouse coverage section, Wildlife Society Bulletin, spring 2004, 32(1).

Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1966. Birds of North America. Golden Press, New York. 340 p.

Scheeler, Carl A. and Paul Ashley, William Blosser, David H. Johnson, Jimmy Kagan, Catherine Macdonald, Bruce G. Marcot, Thomas A. O'Neil, Peter J. Paquet, Drew Parkin, Elizabeth Roderick, Phil Roger, Angela Sondenaa, Scot Soults. 2003. A technical Guide for Developing Wildlife Elements of a Subbasin Plan.20 p.

Shepperd, Wayne D., Dan Binkley, Dale L. Bartos, Thomas J. Stohlgren, Lane G. Squeskew, compilers. 2001. Sustaining Aspen in Western Landscapes: Symposium Proceedings 13-15 June 2000, Grand Junction, CO. Proceedings RMRS-P-18, US Dept. Agriculture Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 460 p.

Verts, B.J. and Leslie N. Carraway. 1998. Land Mammals of Oregon. Univ. of California Press. 668 p.

Wallmo, Olof C. Ed. 1981. Mule and Black-tailed Deer of North America. A Wildlife Mgt. Institute book. Developed in cooperation with U.S. Dept. of Agric., Forest Service. Univ. of Nebraska Press, Lincoln and London. 605 p.

End wildlife assessment

See attached appendices.

Appendix

Species Accounts

Appendix A. Focal wildlife species accounts, Deschutes subbasin, Oregon.

Contents

1. American Beaver.

Note: much of this account is abstracted from Ashley and Stovall, 2004.

Distribution

The beaver occurs throughout most of the U.S. and Canada and into northern Mexico, except for the Arctic northern fringe, southern Florida and California, and the southern half of Nevada (Burt 1976.) In Oregon, the beaver occurs throughout the state (Verts and Carraway 1998.) The subspecies *Castor Canadensis leucodontus*, a large chestnut-brown colored variation, occurs in the northern two-thirds of Oregon east of the Cascade Range, including the Deschutes Subbasin (Ibid p. 257.)

Historic and current populations, and population trends

No estimates of beaver populations are available for Oregon and, in the absence of systematic population estimates, harvest and damage complaint levels are considered to be indicative of the population levels in local areas and statewide (Ibid.) From 1981 to 1991, over 5,000 complaints of beaver damage were received by the Oregon Department of Fish and Wildlife (Ibid.) During the 1930s many beaver were transplanted in Oregon from areas of damage to areas of suitable habitat with no beaver (Ibid.) The range of reported annual beaver harvests for the counties within the Deschutes Subbasin for the years 1990-95 are shown in Table . If the harvest ranges in the Deschutes Subbasin counties are compared to Clatsop County, it can be inferred that the populations are much lower in the subbasin counties than in Clatsop County, which is smaller than all of the counties in the subbasin except for Hood River, which is smaller, and Sherman, which is about the same size as Clatsop. About 10,000 beaver a year are trapped in Oregon (Csuti 2001.) Special beaver harvest regulations in place within the subbasin for July 1, 2002 through June 30, 2004 were (ODFW 2002 p. 2):

1. Prineville Reservoir up to the high water line and the Ochoco National Forest were closed to beaver harvest.
2. That portion of Willow Creek and its tributaries within the Crooked River National Grassland was closed to beaver harvest.

Table 1. Range of Annual Beaver Harvest for the Years 1990-95 for counties in the Deschutes Subbasin . Clatsop County harvest range is shown for comparison.

County	Range of Numbers of Beaver Harvested Annually, 1990-95.
Clatsop	212-821
Deschutes	31-63
Crook	13-50
Hood River	18-40
Jefferson	4-31
Sherman	No numbers shown (previous 5 years: 0-8)
Wasco	24-86

Habitat

All wetland cover types (e.g., herbaceous wetland and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation in order to provide suitable beaver habitat (Slough and Sadleir 1977). Water provides cover for the feeding and reproductive activities of the beaver. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge (e.g., high spring runoff) or a stream channel gradient of 15 percent or more, will have little year-round value as beaver habitat. Assuming that there is an adequate food source available, small lakes [< 8 ha (20 acres) in surface area] are assumed to provide suitable habitat. Large lakes and reservoirs [> 8 ha (20 acres) in surface area] must have irregular shorelines (e.g., bays, coves, and inlets) in order to provide optimum habitat for beaver.(The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Beavers can usually control water depth and stability on small streams, ponds, and lakes; however, larger rivers and lakes where water depth and/or fluctuation cannot be controlled are often partially or wholly unsuitable for the species (Murray 1961; Slough and Sadleir 1977). Rivers or streams that are dry during some parts of the year are assumed to be unsuitable beaver habitat. Beavers are absent from sizable portions of rivers in Wyoming, due to swift water and an absence of suitable dwelling sites during periods of high and low water levels (Collins 1976b). (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

In riverine habitats, stream gradient is the major determinant of stream morphology and the most significant factor in determining the suitability of habitat for beavers (Slough and Sadleir 1977). Stream channel gradients of 6 percent or less have optimum value as beaver habitat. Retzer *et al.* (1956) reported that 68 percent of the beaver colonies recorded in Colorado were in valleys with a stream gradient of less than 6 percent, 28 percent were associated with stream gradients from 7 to 12 percent, and only 4 percent were located along streams with gradients of 13 to 14 percent. No beaver colonies were recorded in streams with a gradient of 15 percent or more. Valleys that were only as wide as the stream channel were unsuitable beaver habitat, while valleys wider than the stream channel were frequently occupied by beavers. Valley widths of 46 m (150 ft) or more were considered the most suitable. Marshes, ponds, and lakes were nearly always occupied by beavers when an adequate supply of food was available. (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Feeding

Beavers are generalized herbivores; however, they show strong preferences for particular plant species and size classes (Jenkins 1975; Collins 1975a; Jenkins 1979). The leaves, twigs, and bark of woody plants are eaten, as well as many species of aquatic and terrestrial herbaceous vegetation. Food preferences may vary seasonally, or from year to year, as a result of variation in the nutritional value of food sources (Jenkins 1979). (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

An adequate and accessible supply of food must be present for the establishment of a beaver colony (Slough and Sadleir 1977). The actual biomass of herbaceous vegetation will probably not limit the potential of an area to support a beaver colony (Boyce 1981). However, total biomass of winter food cache plants (woody plants) may be limiting. Low marshy areas and streams flowing in and out of lakes allow the channelization and damming of water, allowing access to, and transportation of, food materials. Steep topography prevents the establishment of a food transportation system (Williams 1965; Slough and Sadleir 1977). Trees and shrubs closest to the pond or stream periphery are generally utilized first (Brenner 1962; Rue 1964). Jenkins (1980) reported that most of the trees utilized by beaver in his Massachusetts study area were within 30 m (98.4 ft) of the water's edge. However, some foraging did extend up to 100 m (328 ft). Foraging distances of up to 200 m (656 ft) have been reported (Bradt 1938). In a California study, 90 percent of all cutting of woody material was within 30 m (98.4 ft) of the water's edge (Hall 1970). (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Woody stems cut by beavers are usually less than 7.6 to 10.1 cm (3 to 4 inches) DBH (Bradt 1947; Hodgdon and Hunt 1953; Longley and Moyle 1963; Nixon and Ely 1969). Jenkins (1980) reported a decrease in mean stem size cut and greater selectivity for size and species with increasing distance from the water's edge. Trees of all size classes were felled close to the water's edge, while only smaller diameter trees were felled farther from the shore. (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Beavers rely largely on herbaceous vegetation, or on the leaves and twigs of woody vegetation, during the summer (Bradt 1938, 1947; Brenner 1962; Longley and Moyle 1963; Brenner 1967; Aleksiuk 1970; Jenkins 1981). Forbs and grasses comprised 30 percent of the summer diet in Wyoming (Collins 1976a). Beavers appear to prefer herbaceous vegetation over woody vegetation during all seasons of the year, if it is available (Jenkins 1981). (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Reproduction

The basic composition of a beaver colony is the extended family, comprised of a monogamous pair of adults, subadults (young of the previous year), and young of the year (Svendsen 1980). Female beavers are sexually mature at 2.5 years old. Females normally produce litters of three to four young with most kits being born during May and June. Gestation is approximately 107 days (Linzey 1998). Kits are born with all of their fur, their eyes open, and their incisor teeth erupted. (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Dispersal of subadults occurs during the late winter or early spring of their second year and coincides with the increased runoff from snowmelt or spring rains. Subadult beavers have been reported to disperse as far as 236 stream km (147 mi) (Hibbard 1958), although average emigration distances range from 8 to 16 stream km (5 to 10 mi) (Hodgdon and Hunt 1953; Townsend 1953; Hibbard 1958; Leege 1968). The daily movement patterns of the beaver centers around the lodge or burrow and pond (Rutherford 1964). The density of colonies in favorable habitat ranges from 0.4 to 0.8/km2 (1 to 2/mi2) (Lawrence 1954; Aleksiuk 1968; Voigt *et al.* 1976; Bergerud and Miller 1977 cited by Jenkins and Busher 1979). (The foregoing paragraph was excerpted from Ashley and Stovall 2004.)

Limiting Factors

A primary predator of the beaver historically was the wolf, now extirpated in Oregon, but other predators known to take beaver in Oregon are coyotes, red foxes, mink, and river otter (Verts and Carraway 1998.) Water is a limiting factor for beaver. Beaver require a permanent source of water, preferably small ponds or slow streams meandering through low-gradient valleys (Ibid p. 257,) therefore, lack of water in a stream or pond during part of the year would render the stream or pond unusable for beaver. In addition, relatively stable water level is more favorable, thus river or streams with wide variation in levels during the year are not habitable. Due to the impact of beaver on their habitat, which may be a plus or minus depending on the point of view in each situation, beaver numbers are often controlled most importantly by humans.

Literature Cited

Ashley, Paul and Stacy Stoval. 2004. American Beaver. Species Account written for the Southeast Washington Ecoregional Assessment. 9 p.

Beer, J. R. 1942. Notes on the winter food of beavers in the Palouse Prairies, Washington. Journal of Mammalogy, 23:444-445.

Hill, E. P. 1982. Beaver: Castor Canadensis. Pp. 256-281, in Wild mammals of North America: biology, management, and economics (J. A. Chapman and G. A. Feldhamer, eds.). The Johns Hopkins University Press, Baltimore, 1147 pp.

Jenkins, S. H. 1979. Seasonal and year-to-year differences in food selection by beavers. Oecologia, 44:112-116.

Jenkins, S. H., and P. E. Busher. 1979. Castor Canadensis. Mammalian Species, 120:1-8.

Kindschy, R. R. 1985. Response of red willow to beaver use in southeastern Oregon. The Journal of Wildlife Management, 49:26-28.

Svendsen, G. E. 1980. Seasonal change in feeding patterns of beaver in southeastern Ohio. The Journal of Wildlife Management, 44:285-290.

Verts, B. J., and L. N. Carraway. 1998. Land Mammals of Oregon. University of California Press, 668 pp.

Additional references from Ashley and Stovall 2004

Aleksiuk, M. 1968. Scent-mound communication, territoriality and population regulation in beaver. J. Mammal. 49(4):759-762.

_____1970. The seasonal food regime of arctic beavers. Ecology. 51:264-270.

Allen, A. W. 1983. Habitat suitability index models: beaver. FWS/OBS-82/10.30 (Revised). Washingtion, DC: U.S. Department of the Interior, Fish and Wildlife Service. 20 p.

Bergerud, A. T., and D. R. Miller. 1977. Population dynamics of Newfoundland beaver. Can. J. Zool. 55(2):1480-1492. Cited by Jenkins and Busher 1979.

Boyce, M. S. 1981. Habitat ecology of an unexploited population of beavers in interior Alaska. Pages 155-186 in J. A. Chapman and D. Pursley, eds. - Worldwide Furbearer Conf. Proc. Vol. I.

Bradt, G. W. 1938. A study of beaver colonies in Michigan. J. Mammal. 19:139-162.
_____1947. Michigan beaver management. Mich. Dept. Conserv., Lansing. 56 pp.

Brenner F. J. 1962. Food consumed by beavers in Crawford County, Pennsylvania. 3. Wildl. Manage. 26(1):104-107.

_____. 1967. Spatial and energy requirements of beaver. Ohio J. Sci. 67(4):242-246.

Collins, T. C. 1976a. Population characteristics and habitat relationships of beaver in Northwest Wyoming. Ph.D. Diss., Univ. Wyoming, Laramie [Abstract only, from Diss. Abst. Int. B Sci. Eng. 37(11):5459, 19771.

_____. 1976b. Stream flow effects on beaver populations in Grand Teton National Park. Pages 349-352 in Proceedings of the First Conference - on Scientific Research in the National Parks, U.S. Dept. Int. Nat. Park Serv., Trans. Proc. Series 5. Vol. I.

Denney, R. N. 1952. A summary of North American beaver management. 1946-1948. Colo. Fish Game Dept. Rep. 28, Colo. Div. Wildl. 14 pp.

Findley, J.S. 1987. The Natural History of New Mexican Mammals. University of New Mexico Press, Albuquerque, p85-88.

Hall, J. G. 1970. Willow and aspen in the ecology of beaver in Sagehen Creek, California. Ecology 41(3):484-494.

Hammond, M. C. 1943. Beaver on the Lower Souris Refuge. J. Wildl. Manage. 7(3):316-321.

Hays, R. L., C. S. Summers, and W. Seitz. 1981. Estimating wildlife habitat variables. U.S. Dept. Int., Fish and Wildl. Serv. FWS/OBS-81/47. 111 pp.

Hibbard, E. A. 1958. Movements of beaver transplanted in North Dakota. J. Wildl. Manage. 22(2):209-211.
Hodgdon, H. W., and J. H. Hunt. 1953. Beaver management in Maine. Maine Dept. Inland Fish Game, Game Div. Bu 11. 3. 102 pp.

Hoffman, R. S., and D. L. Pattie. 1968. A guide to Montana mammals: identification, habitat, distribution and abundance. Univ. Montana Printing Services, Missoula. 333 pp.

Howard, R. J. 1982. Beaver habitat classification in Massachusetts. M.S. Thesis. Univ. Mass., Amherst. 67 pp.

Jenkins, S. H. 1975. Food selection by beavers: a multidimensional contingency table analysis. Oecologia 21:157-173.

_____. 1979. Seasonal and year-to-year differences in food selection by beavers. Oecologia. (Berl.) 44:112-116.

_____. 1980. A size-distance relation in food selection by beavers. Ecology 61(4):740-746.

_____. 1981. Problems, progress, and prospects in studies of food selection by beavers. Pages 559-579 in J. A. Chapman and D. Pursley, eds. Worldwide Furbearer Conf. Proc., Vol I.

_____. Personnal communication (letter dated 4 January 1982). University of Nevada, Reno, NV.

Jenkins, S. H., and P. E. Busher. 1979. Castor canadensis. Am. Sot. Mammal, New York. Mammalian Species 120:1-8.

Lawrence, W. H. 1954. Michigan beaver populations as influenced by fire and logging. Ph.D. Diss., Univ. Michigan, Ann Arbor. 219 pp. Cited by Jenkins and Busher 1979.

Leege, T. A. 1968. Natural movements of beavers in southeastern Idaho. J. Wildl. Manage. 32(4):973-976.

Linzey, D. W. 1998. The Mammals of Virginia. Blacksburg, Virginia: The McDonald & Wood ward Publishing Company, Inc.

Linzey, D. and C. Brecht. 2002. Website accessed on 26 June 2003. http://www.discoverlife.org/nh/tx/Vertebrata/Mammalia/Castoridae/Castor/canadensis/

Longley, W. H., and J. B. Moyle. 1963. The beaver in Minnesota. Minn. Dept. Conserv. Tech. Bull. 6. 87 pp.

Lowery, G. H., Jr. 1974. The mammals of Louisiana and its adjacent waters. Shreveport, LA: Louisiana State University Press. 565 p.

Merritt, J. F. 1987. Guide to the mammals of Pennsylvania. Pittsburg, PA: University of Pittsburgh Press. 408 p.

Murray, D. F. 1961. Some factors affecting the production and harvest of beaver in the upper Tanana River Valley, Alaska. M.S. Thesis, Univ. Alaska, Anchorage. 140 pp.

Nixon, C. M., and J. Ely. 1969. Foods eaten by a beaver colony in southeastern Ohio. Ohio J. Sci. 69(5):313-319.
Retzer, J. L., H. M. Swope, J. 0. Remington, and W. H. Rutherford. 1956. Suitability of physical factors for beaver management in the Rocky Mountains of Colorado. Colo. Dept. Game, Fish and Parks, Tech. Bull. 2:1-32.

Rue, L. E., III. 1964. The world of the beaver. J. B. Lippincott Co., Philadelphia and New York. 155 pp.

_____. 1967. Pictorial guide to the mammals of North America. New York: Thomas Y. Crowell Company. 299 p.

Rutherford, W. H. 1964. The beaver in Colorado. Colo. Dept. Game, Fish and Parks Dept., Tech. Publ. 17. 49 pp.

Slough, B. G., and R. M. F. S. Sadleir. 1977. A land capability classification system for beaver (Castor canadensis Kuhl). Can. J. Zool. 55(8):1324-1335.

Svendsen, G. E. 1980. Population parameters and colony composition of beaver (Castor canadensis) in southeast Ohio. Am. Midl. Nat. 104(1):47-56.

Townsend, J. E. 1953. Beaver ecology in western Montana with special reference to movements. J. Mammal. 34(1):459-479.

U.S. Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. 103 ESM. U.S. Dept. Int., Fish Wildl. Serv., Div. Ecol. Serv. n.p.

Van Gelden, R. G. 1982. Mammals of the National Parks. Baltimore, MD: Johns Hopkins University Press. 310 p.

Voigt, D. R., G. B. Kolenosky, and D. H. Pimlott. 1976. Changes in summer foods of wolves in central Ontario. J. Wildl. Manage. 40(4):663-668.

Williams, R. M. 1965. Beaver habitat and management. Idaho Wildl. Rev. 17(4):3-7.

Zeveloff, S. I. 1988. Mammals of the Intermountain West. Salt Lake City, UT: University of Utah Pres

2. Columbia Spotted Frog in the Deschutes Subbasin

Note: this account is mostly exerpted from an account written by Kieth Paul, US Fish and Wildlife Service, LaGrande, Oregon.

Identification

The adult Columbia spotted frog (*Rana luteiventris*) is about 4 in. long, not including the legs. The adult frogs are green to greenish-brown, with large black spots on the back. Eggs are deposited in a soft, orange-sized egg masses, sometimes several egg masses on top of one another, and the egg masses may separate and float on the top of the water in a frothy mass before hatching. Tadpoles are small, from 0.25 in. to 1.5 in. long (Corkran and Thoms 1996.).

Similar species

The Columbia spotted frog is similar in appearance to the Oregon spotted frog (*R. pretiosa*), which also occurs in the Deschutes Subbasin, but currently is only present in a small remnant population in the southern end of the subbasin (Csuti et al. 2001.) Also similar in appearance is the Cascades frog (R. cascadae) that occurs at higher elevations in the Cascade Mountains in the subbasin, and the Northern leopard frog (*R. pipiens*) that formerly occurred in the subbasin but is thought to be currently extirpated.

Distribution

This frog occurs from British Columbia south into Eastern Oregon and Northern Nevada and Utah in small isolated populations (Csuti et al. 2001.) In the Deschutes Subbasin, small areas of occurrence are Indicated in eastern Crook County in the upper Crooked River Valley (Ibid.)

Habitat and feeding behavior (this section was excerpted from Paul, 2004.)

This species is relatively aquatic and is rarely found far from water. It occupies a variety of still water habitats and can also be found in streams and creeks (Hallock and McAllister 2002). CSF's are found closely associated with clear, slow-moving or ponded surface waters, with little shade (Reaser 1997). CSF's are found in aquatic sites with a variety of vegetation types, from grasslands to forests (Csuti 1997). A deep silt or muck substrate may be required for hibernation and torpor (Morris and Tanner 1969). In colder portions of their range, CSF's will use areas where water does not freeze, such as spring heads and undercut streambanks with overhanging vegetation (IDFG et al. 1995). CSF's may disperse into forest, grassland, and brushland during wet weather (NatureServe 2003). They will use stream-side small mammal burrows as shelter. Overwintering sites in the Great Basin include undercut banks and spring heads (Blomquist and Tull 2002). The CSF eats a variety of food including arthropods (e.g., spiders, insects), earthworms and other invertebrate prey (Whitaker et al. 1982). Adult CSFs are opportunistic feeders and feed primarily on invertebrates (Nussbaum et al. 1983). Larval frogs feed on aquatic algae and vascular plants, and scavenged plant and animal materials (Morris and Tanner 1969).

Reproduction (this section was excerpted from Paul, 2004.)

Reproducing populations have been found in habitats characterized by springs, floating vegetation, and larger bodies of pooled water (e.g., oxbows, lakes, stock ponds, beaver-created ponds, seeps in wet meadows, backwaters) (IDFG et al. 1995; Reaser 1997). Breeding habitat is the temporarily flooded margins of wetlands, ponds, and lakes (Hallock and McAllister 2002). Breeding habitats include a variety of relatively exposed, shallow-water (<60 cm), emergent wetlands such as sedge fens, riverine over-bank pools, beaver ponds, and the wetland fringes of ponds and small lakes. Vegetation in the breeding pools generally is dominated by herbaceous species such as grasses, sedges (Cares spp.) and rushes (Juncus spp.) (Amphibia Web 2004).

Migration (this section was excerpted from Paul, 2004.)

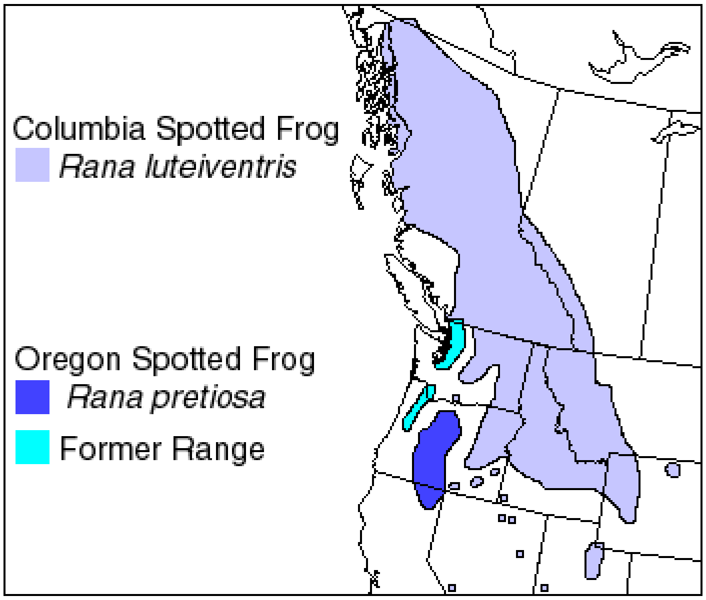
[Though movements exceeding 1 km (0.62 mi) and up 5 km (3.11 mi) have been recorded, these frogs generally stay in wetlands and along streams within 0.6 km (0.37 mi) of their breeding pond (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001). Frogs in isolated ponds may not leave those sites (Bull and Hayes 2001) (NatureServe 2003)].

Historic and current populations and population trends (This section was excerpted from Paul, 2004.)

[Surveys conducted in the Raft River and Goose Creek drainages in Idaho failed to relocate spotted frogs (Reaser 1997; Shipman and Anderson 1997; Turner 1962). In 1994 and 1995, the Bureau of Land Management (BLM) conducted surveys in the Jarbidge and Snake River Resource Areas in Twin Falls County, Idaho. These efforts were also unsuccessful in locating spotted frogs (McDonald 1996). Only six historical sites were known in the Owyhee Mountain range in Idaho, and only 11 sites were known in southeastern Oregon in Malheur County prior to 1995 (Munger et al. 1996) (USFWS 2002c)]. (The preceding paragraph was excerpted from Paul, 2004.)

Currently, Columbia spotted frogs appear to be widely distributed throughout southwestern Idaho (mainly in Owyhee County) and eastern Oregon, but local populations within this general area appear to be isolated from each other by either natural or human induced habitat disruptions. The largest local population of spotted frogs in Idaho occurs in Owyhee County in the Rock Creek drainage. The largest local population of spotted frogs in Oregon occurs in Malheur County in the Dry Creek Drainage (USFWS 2002c). (The preceding paragraph was excerpted from Paul, 2004.)

Figure . Current range of the Columbia and Oregon spotted frog.



USGS, Northern Prairie Wildlife Research Center; range acquired from Green et al. 1997. (map exerpted from Paul 2004)

Legal status

In 1989, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list the spotted frog (referred to as *Rana pretiosa*) under ESA (Federal Register 54[1989]:42529). The USFWS ruled on April 23, 1993, that the listing of the spotted frog was warranted and designated it a candidate for listing with a priority 3 for the Great Basin population, but was precluded from listing due to higher priority species (Federal Register 58[87]:27260). The major impetus behind the petition was the reduction in distribution apparently associated with impacts from water developments and the introduction of nonnative species. On September 19, 1997 (Federal Register 62[182]:49401), the USFWS downgraded the priority status for the Great Basin population of Columbia spotted frogs to a priority 9, thus relieving the pressure to list the population while efforts to develop and implement specific conservation measures were ongoing. As of January 8, 2001 (Federal Register 66[5]:1295- 1300), however, the priority ranking has been raised back to a priority 3 due to increased threats to the species. This includes the Great Basin DPS Columbia spotted frog populations. (The preceding paragraph was excerpted from Paul, 2004.)

Limiting factors (this entire section was excerpted from Paul, 2004.)

The present or threatened destruction, modification, or curtailment of its habitat or range

[Spotted frog habitat degradation and fragmentation is probably a combined result of past and current influences of heavy livestock grazing, spring development, agricultural development, urbanization, and mining activities. These activities eliminate vegetation necessary to protect frogs from predators and UV-B radiation; reduce soil moisture; create undesirable changes in water temperature, chemistry and water availability; and can cause restructuring of habitat zones through trampling, rechanneling, or degradation which in turn can negatively affect the available invertebrate food source (IDFG et al. 1995; Munger et al. 1997; Reaser 1997; Engle and Munger 2000; Engle 2002). Spotted frog habitat occurs in the same areas where these activities are likely to take place or where these activities occurred in the past and resulting habitat degradation has not improved over time. Natural fluctuations in environmental conditions tend to magnify the detrimental effects of these activities, just as the activities may also magnify the detrimental effects of natural environmental events (USFWS 2002c)].

[Springs provide a stable, permanent source of water for frog breeding, feeding, and winter refugia (IDFG et al. 1995). Springs provide deep, protected areas which serve as hibernacula for spotted frogs in cold climates. Springs also provide protection from predation through underground openings (IDFG et al. 1995; Patla and Peterson 1996). Most spring developments result in the installation of a pipe or box to fully capture the water source and direct water to another location such as a livestock watering trough. Loss of this permanent source of water in desert ecosystems can also lead to the loss of associated riparian habitats and wetlands used by spotted frogs. Developed spring pools could be functioning as attractive nuisances for frogs, concentrating them into isolated groups, increasing the risk of disease and predation (Engle 2001). Many of the springs in southern Idaho, eastern Oregon, and Nevada have been developed (USFWS 2002c)].

[The reduction of beaver populations has been noted as an important feature in the reduction of suitable habitat for spotted frogs. Beaver are important in the creation of small pools with slow-moving water that function as habitat for frog reproduction and create wet meadows that provide foraging habitat and protective vegetation cover, especially in the dry interior western United States (St. John 1994). Beaver trapping is still common in Idaho and harvest is unregulated in most areas (IDFG et al. 1995). In some areas, beavers are removed because of a perceived threat to water for agriculture or horticultural plantings. As indicated above, permanent ponded waters are important in maintaining spotted frog habitats during severe drought or winter periods. Removal of a beaver dam in Stoneman Creek in Idaho is believed to be directly related to the decline of a spotted frog subpopulation there. Intensive surveying of the historical site where frogs were known to have occurred has documented only one adult spotted frog (Engle 2000) (USFWS 2002c)].

[Fragmentation of habitat may be one of the most significant barriers to spotted frog recovery and population persistence. Recent studies in Idaho indicate that spotted frogs exhibit breeding site fidelity (Patla and Peterson 1996; Engle 2000; Munger and Engle 2000; J. Engle, IDFG, pers. comm., 2001). Movement of frogs from hibernation ponds to breeding ponds may be impeded by zones of unsuitable habitat. As movement corridors become more fragmented due to loss of flows within riparian or meadow habitats, local populations will become more isolated (Engle 2000; Engle 2001). Vegetation and surface water along movement corridors provide relief from high temperatures and arid environmental conditions, as well as protection from predators. Loss of vegetation and/or lowering of the water table as a result of the above mentioned activities can pose a significant threat to frogs moving from one area to another. Likewise, fragmentation and loss of habitat can prevent frogs from colonizing suitable sites elsewhere (USFWS 2002c)].

[Though direct correlation between spotted frog declines and livestock grazing has not been studied, the effects of heavy grazing on riparian areas are well documented (Kauffman et al. 1982; Kauffman and Kreuger 1984; Skovlin 1984; Kauffman et al. 1985; Schulz and Leininger 1990). Heavy grazing in riparian areas on state and private lands is a chronic problem throughout the Great Basin. Efforts to protect spotted frog habitat on state lands in Idaho have been largely unsuccessful because of lack of cooperation from the State. In northeast Nevada, the Forest Service has completed three riparian area protection projects in areas where spotted frogs occur. These projects include altering stocking rates or changing the grazing season in two allotments known to have frogs and constructing riparian fencing on one allotment. However, these three sites have not been monitored to determine whether efforts to protect riparian habitat and spotted frogs have been successful. In the Toiyabe Range, a proposal to fence 3.2 kilometers (km) (2 miles (mi)) of damaged riparian area along Cloverdale Creek to protect it from grazing is scheduled to occur in the summer of 2002. In addition to the riparian exclosure, BLM biologists located a diversion dam in 1998 on Cloverdale Creek which was completely de- watering approximately 1.6 km (1 mi) of stream. During the summer of 2000, this area was reclaimed and water was put back into the stream. This area of the stream is not currently occupied by spotted frogs but it is historical habitat (USFWS 2002c)].

[The effects of mining on Great Basin Columbia spotted frogs, specifically, have not been studied, but the adverse effects of mining activities on water quality and quantity, other wildlife species, and amphibians in particular have been addressed in professional scientific forums (Chang et al. 1974; Birge et al. 1975; Greenhouse 1976; Khangarot et al. 1985) (USFWS 2002c)].

Disease or predation

[Predation by fishes is likely an important threat to spotted frogs. The introduction of nonnative salmonid and bass species for recreational fishing may have negatively affected frog species throughout the United States. The negative effects of predation of this kind are difficult to document, particularly in stream systems. However, significant negative effects of predation on frog populations in lacustrine systems have been documented (Hayes and Jennings 1986; Pilliod et al. 1996, Knapp and Matthews 2000). One historic site in southern Idaho no longer supports spotted frog although suitable habitat is available. This may be related to the presence of introduced bass in the Owyhee River (IDCDC 2000). The stocking of nonnative fishes is common throughout waters of the Great Basin. The Nevada Division of Wildlife (NDOW) has committed to conducting stomach sampling of stocked nonnative and native species to determine the effects of predation on spotted frogs. However, this commitment will not be fulfilled until the spotted frog conservation agreements are signed. To date, NDOW has not altered fish stocking rates or locations in order to benefit spotted frogs (USFWS 2002c)].

[The bull frog (Rana catesbeiana), a nonnative ranid species, occurs within the range of the spotted frog in the Great Basin. Bullfrogs are known to prey on other frogs (Hayes and Jennings 1986). They are rarely found to co-occur with spotted frogs, but whether this is an artifact of competitive exclusion is unknown at this time (USFWS 2002c)].

[Although a diversity of microbial species is naturally associated with amphibians, it is generally accepted that they are rarely pathogenic to amphibians except under stressful environmental conditions. Chytridiomycosis (chytrid) is an emerging panzootic fungal disease in the United States (Fellers et al. 2001). Clinical signs of amphibian chytrid include abnormal posture, lethargy, and loss of righting reflex. Gross lesions, which are usually not apparent, consist of abnormal epidermal sloughing and ulceration; hemorrhages in the skin, muscle, or eye; hyperemia of digital and ventrum skin, and congestion of viscera. Diagnosis is by identification of characteristic intracellular flask-shaped sporangia and septate thalli within the epidermis. Chytrid can be identified in some species of frogs by examining the oral discs of tadpoles which may be abnormally formed or lacking pigment (Fellers et al. 2001) (USFWS 2002c)].

[Chytrid was confirmed in the Circle Pond site, Idaho, where long term monitoring since 1998 has indicated a general decline in the population (Engle 2002). It is unclear whether the presence of this disease will eventually result in the loss of this subpopulation. Two additional sites may have chytrid, but this has yet to be determined (J. Engle, pers. comm., 2001). Protocols to prevent further spread of the disease by researchers were instituted in 2001. Chytrid has also been found in the Wasatch Columbia spotted frog distinct population segment (K. Wilson, pers comm., 2002). Chytrid has not been found in Nevada populations of spotted frogs (USFWS 2002c)].

The inadequacy of existing regulatory mechanisms

[Spotted frog occurrence sites and potential habitats occur on both public and private lands. This species is included on the Forest Service sensitive species list; as such, its management must be considered during forest planning processes. However, little habitat restoration, monitoring or surveying has occurred on Forest Service lands (USFWS 2002c)].

[In the fall of 2000, 250 head of cattle were allowed to graze for 45 days on one pasture in the Indian Valley Creek drainage of the Humboldt-Toiyabe National Forest in central Nevada for the first time in 6 years (M. Croxen, pers. comm., 2002). Grazing was not allowed in this allotment in 2001. Recent mark-recapture data indicated that this drainage supports more frogs than previously presumed, potentially around 5,000 individuals (K. Hatch, pers. comm., 2000). Perceived improvements in the status of frog populations in the Indian Valley Creek area may be a result of past removal of livestock grazing. The reintroduction of grazing disturbance into this relatively dense area of frogs has yet to be determined (USFWS 2002c)].

[BLM policies direct management to consider candidate species on public lands under their jurisdiction. To date, BLM efforts to conserve spotted frogs and their habitat in Idaho, Oregon, and Nevada have not been adequate to address threats (USFWS 2002c)].

[The southernmost known population of spotted frogs can be found on the BLM San Antone Allotment south of Indian Valley Creek in the Toiyabe Range. Grazing is allowed in this area from November until June (L. Brown, pers. comm., 2002). The season of use is a very sensitive portion of the spotted frog annual life cycle which includes migration from winter hibernacula to breeding ponds, breeding, egg laying and hatching, and metamorphosing of young. Additionally, the riparian Standards and Guidelines were not met in 1996, the last time the allotment was evaluated (USFWS 2002c)].

[The status of local populations of spotted frogs on Yomba-Shoshone or Duck Valley Tribal lands is unknown. Tribal governments do not have regulatory or protective mechanisms in place to protect spotted frogs (USFWS 2002c)].

[The Nevada Division of Wildlife classifies the spotted frog as a protected species, but they are not afforded official protection and populations are not monitored. Though the spotted frog is on the sensitive species list for the State of Idaho, this species is not given any special protection by the State. Columbia spotted frogs are not on the sensitive species list for the State of Oregon. Protection of wetland habitat from loss of water to irrigation or spring development is difficult because most water in the Great Basin has been allocated to water rights applicants based on historical use and spring development has already occurred within much of the known habitat of spotted frogs. Federal lands may have water rights that are approved for wildlife use, but these rights are often superceded by historic rights upstream or downstream that do not provide for minimum flows. Also, most public lands are managed for multiple use and are subject to livestock grazing, silvicultural activities, and recreation uses that may be incompatible with spotted frog conservation without adequate mitigation measures (USFWS 2002c)].

Other natural or manmade factors affecting its continued existence

[Multiple consecutive years of less than average precipitation may result in a reduction in the number of suitable sites available to spotted frogs. Local extirpations eliminate source populations from habitats that in normal years are available as frog habitat (Lande and Barrowclough 1987; Schaffer 1987; Gotelli 1995). These climate events are likely to exacerbate the effects of other threats, thus increasing the possibility of stochastic extinction of subpopulations by reducing their size and connectedness to other subpopulations (see Factor A for additional information). As movement corridors become more fragmented, due to loss of flows within riparian or meadow habitats, local populations will become more isolated (Engle 2000). Increased fragmentation of the habitat can lead to greater loss of populations due to demographic and/or environmental stochasticity (USFWS 2002c)].

References (from Paul 2004)

AmphibiaWeb: Information on amphibian biology and conservation. [web application]. 2004. Berkeley, California: AmphibiaWeb. Available: http://amphibiaweb.org/. (Accessed: 2004).

Birge, W.J., J.J. Just, A.G. Westerman, J.A. Black, and O.W. Roberts. 1975. Sensitivity of Vertebrate Embryos to Heavy Metals as a Criterion of Water Quality. Phase II. Bioassay Procedures Using Developmental Stages As Test . Water Resour. Res. Inst., Kentucky Univ., Lexington, KY; U.S. NTIS PB-240 987: 36 pp.

Blomquist, S. M., and J. C. Tull. 2002. Rana luteiventris: burrow use. Herpetological Review 33:131.

Brown, L. 2002. Wildlife Biologist, Bureau of Land Management. Tonopah Field Station, Nevada, personal communication.

Bull, E. L., and M. P. Hayes. 2001. Post-breeding season movements of Columbia spotted frogs (RANA LUTEIVENTRIS) in northeastern Oregon. Western North American Naturalist 61:119-123.

Chang, L.W., K.R. Reuhl, and A.W. Dudley, Jr. 1974. Effects of Methylmercury Chloride on Rana pipiens tadpoles. Environ. Res. 8(1):82-91.

Croxen, M. 2002. Range Conservation Specialist, U.S. Forest Service. Tonopah Ranger District, Nevada, personal communication.

Csuti, B., A.J. Kimmerling, T.A. O’Neil, M.M. Shaughnessy, E.P. Gaines, and M.M.P. Huso. 1997. Atlas of Oregon Wildlife. Oregon State University Press. 492 pp.

Davidson C. 1995. Frog and Toad Calls of the Pacific Coast: Vanishing Voices. Ithaca, NY: Library of Natural Sounds, Cornell Laboratory of Ornithology. [Compact disc].

Engle, J.C. 2004. Fish and Wildlife Biologist. U.S. Fish and Wildlife Service, Snake River Fish and Wildlife Office, Boise, Idaho.

Engle, J.C. 2004. Columbia Spotted Frog, Great Basin Population. Species profile on USFWS website: http://idahoes.fws.gov/fact/spotfrog.html.

Engle, J.C. 2002. Columbia spotted frog Great Basin population (Owyhee subpopulation) longterm monitoring plan. Year 2001 results. Idaho Department of Fish and Game Report. Boise, Idaho. 64 pp.

Engle, J.C. 2001. Columbia spotted frog project: the translocation of 2 male Columbia spotted frogs between breeding sites within an element occurrence in the Owyhee subpopulation of the Great Basin population. Idaho Department of Fish and Game Report. Boise, Idaho. 19 pp.

Engle, J.C. 2001. Wildlife Research Biologist, Idaho Department of Fish and Game, Boise, Idaho, personal communication.

Engle, J.C. 2000. Columbia spotted frog Great Basin population (Owyhee Mountains subpopulation) long-term monitoring plan. Year 2000 Results. (draft). Boise, Idaho.

Engle, J.C. and J.C. Munger. 2000. Population fragmentation of spotted frogs in the Owyhee Mountains. Field Report from a cost share agreement between Boise State University and the Bureau of Land Management (DBP990048). Boise, Idaho.

Fellers, G.M., D.E. Green, and J.E. Longcore. 2001. Oral chytridiomycosis in the mountain yellow-legged frog (Rana muscosa). Copeia 2001:945-953.

Gotelli, N.J. 1995. A primer of ecology, Sinauer and Associates, Sunderland, Massachusetts. 206 pp.

Green, D.M., T.F. Sharbel, J. Kearsley, and H. Kaiser. 1996. Postglacial range fluctuation, genetic subdivision and speciation in the western North American spotted frog complex, Rana pretiosa. Evolution 50:(1):374-390.

Green, D.M., H. Kaiser, T.F. Sharbel, J. Kearsley, and K.R. McAllister. 1997. Cryptic species of spotted frogs, Rana pretiosa complex, in Western North America. Copeia 1997 (1): 1-8.

Greenhouse, G. 1976. Effects of Pollutants on Eggs, Embryos and Larvae of Amphibian Species University of California, Irvine, CA, Air Force Tech. Report AMRL-TR-76-31, U.S. NTIS AD-A025 403:24 p.

Hallock, L.A. and McAllister, K.R. 2002. Columbia Spotted Frog. Washington Herp Atlas. http://www.dnr.wa.gov/nhp/refdesk/herp/.

Hatch, K. 2000. Researcher, University of Nevada, Reno, personal communication.

Hatch, K. 2001. Researcher, University of Nevada, Reno, personal communication.

Hayes, M.P. and M.R. Jennings. 1986. Decline of ranid frog species in western North America: are bullfrogs responsible? Journal of Herpetology 20:490-509.

Hollenbeck, R. R. 1974. Growth rates and movements within a population of RANA PRETIOSA PRETIOSA Baird and Girard in south central Montana. M.A. thesis, Montana State University, Bozeman.

Hovingh, P. 1990. Investigations of aquatic resources in the Great Basin and adjacent regions with respect to amphibians, mollusks and leeches: a preliminary report for the tri-state region of Idaho, Nevada, and Utah. March 1990. 12 pp. + appendices.

Idaho Conservation Data Center. 2000. Spotted frog database. Idaho Department of Fish and Game, Boise, Idaho.

Idaho Department of Fish and Game, Idaho Department of Parks and Recreation, Bureau of Land Management, Regions 1 and 4 of U.S. Forest Service, and U.S. Fish and Wildlife Service. 1995. Habitat Conservation Assessment and Conservation Strategy: Spotted Frog (Rana pretiosa). (Draft) Idaho State Conservation Effort.

Kauffman, J.B., W.C. Krueger, and M. Vavra. 1985. Impacts of cattle on streambanks in northeastern Oregon. Journal of Range Management 36(6):683-685.

Kauffman, J.B. and W.C. Krueger. 1984. Livestock impacts on riparian plant communities and stream-side management implications, a review. Journal of Range Management 37(5):430-437.

Kauffman, J.B., W.L. Krueger, and M. Vavra. 1982. Effects of late season cattle grazing on riparian plant communities. Journal of Range Management 36(6):685-691.

Khangarot, B.S., A. Sehgal and M.K. Bhasin. 1985. Man and biosphere-studies on the Sikkim. Part 5: acute toxicity of selected heavy metals on the tadpoles of Rana hexadactyla. Acta Hydrochim. Hydrobiol. 13(2):259-263.

Knapp, R. A. and K. R. Matthews. 2000. Non-native fish introductions and the decline of the mountain yellow-legged frog from within protected areas. Conservation Biology 14(2):428-438.

Koch, E.D., G. Williams, C.R. Peterson, and P.S. Corn. 1997. A summary of the conference on declining and sensitive amphibians in the Rocky Mountains and Pacific Northwest. November 7-8, 1996, Boise Idaho. Meeting sponsored by U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Bureau of Land Management, Idaho Herpetological Society, Declining Amphibian Population Task Force Rocky Mountain Working Group, U.S. Geological Survey - Biological Resources Division, Idaho Museum of Natural History, Idaho State University.

Lande, R. and G.F. Barrowclough. 1987. Effective population size, genetic variation, and their use in population management, pages 87-124, in Viable Populations for Conservation, M. E. Soul (ed.), Cambridge University Press, Cambridge, Great Britain.
McDonald, M. 1996. Amphibian Inventory of the Jarbidge and Snake River Resource Areas. Idaho Bureau of Land Management Technical Bulletin No. 96-13. 23 pp.

Leonard, W.P., Brown H.A., Jones, L.L.C., McAllister, Storm R.M. 1993. Amphibians of Washington and Oregon. Seattle, WA: Seattle Audubon Society. 168 p.

Leonard, W.P., Leonard N.P., Storm R.M., and P.E. Petzel. 1996. *Rana pretiosa* (spotted frog). Behavior and reproduction. Herpetological Review, 27(4), 195.

Licht, L.E. 1975. Comparative life history features of the western spotted frog, *rana pretiosa*, from low- and high-elevation populations. Canadian Journal of Zoology 53: 1254-1257.

Mellison, C. 2004. Fish and Wildlife Biologist. U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office, Reno, Nevada.

Morris, R. L. and W. W. Tanner. 1969. The ecology of the western spotted frog, Rana pretiosa pretiosa Baird and Girard, a life history study. Great Basin Naturalist 2:45-81.

Munger, J.C., M. Gerber, M. Carroll, K. Madric, and C. Peterson. 1996. Status and habitat associations of the spotted frog (Rana pretiosa) in southwestern Idaho. Bureau of Land Management Technical Bulletin No. 96- 1. Boise, Idaho.

Munger, J.C., A. Ames, and B. Barnett. 1997. 1996 Survey for Columbia spotted frogs in the Owyhee Mountains of southwestern Idaho. Technical Bulletin No. 97-13. Idaho Bureau of Land Management. Boise, Idaho.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 2, 2004).

Nussbaum, R.A., E.D. Brodie Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press. Moscow, Idaho. pp. 183-187.

Patla, D.A. and C.R. Peterson. 1996. The effects of habitat modification on a spotted frog population in Yellowstone National Park in A summary of the conference on declining and sensitive amphibians in the Rocky Mountains and Pacific Northwest. Idaho Herpetological Society and U. S. Fish and Wildlife Service, Snake River Basin Office Report, Boise, Idaho. 96 pp.

Pearl, C.A. 2000. Amphibian survey and monitoring on the Baker District, Wallowa-Whitman National Forest: Summary of 1999 Findings. Prepared for the Wallowa-Whitman National Forest, Baker Ranger District.

Pilliod, D., C.R, Peterson, and P. Ritson. 1996. Impacts of introduced fish on spotted frog populations in high mountain lakes of central Idaho. A Summary of the Conference on Declining and Sensitive Amphibians in the Rocky Mountains and Pacific Northwest Idaho Herpetological Society and U.S. Fish and Wildlife Service, Snake River Basin Office Report, Boise, Idaho, November 7-8, 1996.

Reaser, J.K. 1996a. Conservation status of spotted frogs in Nevada: 1996 state-wide surveys. Cooperative Agreement between the U.S. Fish and Wildlife Service and the Center for Conservation Biology, Stanford University. Attachment A. August 9, 1996.
15 pp.

Reaser, J.K. 1996b. Conservation of the spotted frog (Rana pretiosa) in Nevada: Multi-scale population status and trends assessment. A Summary of the Conference on Declining and

Sensitive Amphibians in the Rocky Mountains and Pacific Northwest. Idaho Herpetological Society and U.S. Fish and Wildlife Service, Snake River Basin Office Report, Boise, Idaho, November 7-8, 1996.

Reaser, J.K. 1997. Amphibian declines: Conservation science and adaptive management. Doctoral Dissertation. Stanford University.

Reaser, J.K. 1998. Jamie K. Reaser, private consultant, Springfield, Virginia, personal communication.
Reaser, J. K. 2000. Demographic analyses of the Columbia spotted frog (Rana luteiventris): case study in spatiotemporal variation. Canadian Journal of Zoology 78:1158-1167.

Schulz, T.T. and W.C. Leininger. 1990. Differences in riparian vegetation structure between grazed areas and exclosures. Journal of Range Management 43(4):295-299.

Schaffer, M. 1987. Minimum viable populations: coping with uncertainty, pages 69-86, *in* Viable Populations for Conservation, M. E. Soul (ed.), Cambridge University Press, Cambridge, Great Britain.

Shipman, M. and S. Anderson. 1997. General survey of the Great Basin population of Columbia spotted frogs (Rana luteiventris) in the Jarbidge, Mountain City, and Santa Rosa Ranger Districts of Northern Nevada. Unpublished report prepared for the U.S. Forest Service, Humboldt-Toiyabe National Forest, September 1997.

Skovlin, J.M. 1984. Impacts of grazing on wetlands and riparian habitat: A review of our knowledge. Pages 1001- 1104, in Developing strategies for rangeland management-a report prepared by the committee on developing strategies for rangeland management. National Research Council/National Academy of Sciences. Westview Press, Boulder, Colorado.

St. John, A.D. 1994. The spotted frog in the Lakeview District of Oregon. Report to the Bureau of Land Management Lakeview District Office.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Co., Boston. 336 pp.

Tull, J. 1998. U.S. Forest Service, Ely Ranger District, Nevada, personal communication.

Turner, F.B. 1958. Life history of the western spotted frog in Yellowstone National Park. Herptelogica 14: 96-100.

Turner, F.B. 1960. Population structure and dynamics of the western spotted frog, *Rana pretiosa*. Baird and Girard, in Yellowstone Park, Wyoming. Ecological Monographs 30(3): 251-278.

Turner, F.B. 1962. An analysis of geographic variation and distribution of Rana pretiosa. American Philosophical Society Yearbook 1962. Pp. 325-328.

U.S. Fish and Wildlife Service. 2002a. Section 7 Guidelines: Columbia Spotted Frog – Great Basin Population. United States Department of the Interior, Snake River Basin Office, Boise, Idaho.

U.S. Fish and Wildlife Service. 2002b. Status Review for the Columbia Spotted Frog (Rana luteiventris) on the Wasatch Front, Utah. United States Department of the Interior
U.S. Fish and Wildlife Service Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service. 2002c. Candidate and Listing Priority Assignment Form: Columbia Spotted Frog. United States Department of the Interior, Nevada Fish and Wildlife Office, Reno, Nevada.

U.S. Geological Service. Northern Prairie Wildlife Research Center. Website: http://www.npwrc.usgs.gov/narcam/idguide/rpret.htm. Accessed 2/2004.

Utah Division of Wildlife Resources. 1998. Conservation Strategy for the spotted frog. January 22, 1998.

Whitaker, J.O., S.P. Cross, J.M. Skovlin, and C. Maser. 1982. Food habits of the spotted frog (*Rana pretiosa*) from managed sites in Grant County, Oregon. Northwest Science 57(2): 147-154.

Wilson, K. 2002. Wildlife Biologist, Utah Division of Wildlife Resources, Salt Lake City, Utah, personal communication.

End

3. White-headed Woodpecker.

Identification

The white-headed woodpecker (*Picoides albolarvatus*) is a robin-sized black woodpecker with white wing patches which are visible in flight, and is the only woodpecker in Oregon with a white head, although the acorn woodpecker (*Melanerpes formicivoris*) is somewhat similar with some white on the head (Robbins 1966.)

Distribution, historic and current populations and population trends.

This woodpecker is found from interior British Columbia south to Nevada and southern California. In Oregon, it is found in the Ochoco, Blue, and Wallowa mountains in Eastern Oregon, and also in some areas in the Siskiyou Mountains and on the "north part of the east slope of the Cascades" (Marshall et al. 2003.) The range in Oregon appears not to have changed from that reported by Gabrielson and Jewett in 1940, but "…seems to have become more patchy because of habitat deterioration (Ibid.) White-headed woodpecker density found in 1997 on five study areas in the Deschutes NF were calculated to be 0.03-1.54 birds per 100 acres, however, the population is thought to be declining in the Deschutes NF, in spite of the fact that some of the best remaining white-headed woodpecker habitat in Oregon is thought to exist in the Deschutes and Winema NFs (Ibid.)

Habitat

The white-headed woodpecker is referred to by Gabrielson and Jewett (1970) as "…a regular permanent Oregon resident wherever the yellow pine is found in good stands." Marshall et al. (2003) states that this bird occurs in "…open ponderosa pine or mixed-conifer forest dominated by ponderosa pine." It may occur in areas dominated by large-diameter ponderosa pine even if the stand has undergone silvicultural treatments such as thinning (Ibid.)

Feeding

Although the diet varies somewhat for this bird depending on local availability, ponderosa pine seeds, insects, and sap are main food items (Ibid.) In Oregon, ponderosa pine seeds are the most important plant item (Ibid p. 365.) Birds have been observed feeding on spruce budworms, larvae, ants and cicadas (Ibid.)

Reproduction

White-headed woodpeckers Excavate nests in large-diameter snags, stumps, leaning logs, and dead tops of live trees. Mean dbh of nest trees in the Deschutes National Forest was found to be 25.6 in. or 65 cm for 43 nests observed (Ibid p. 365.) Nesting activities occur in May and June, and young birds fledge in June and July.

Migration

This woodpecker is non-migratory. Some seasonal wandering outside the nesting territory occurs (Ibid. p. 366.)

Limiting Factors

Lack of large-diameter ponderosa pine trees in an open forest setting for nesting is apparently a limiting factor for this bird. Large-diameter ponderosa pine forests are thought to have been reduced by more than 90 percent in Oregon and Washington compared to what existed prior to pioneer settlement (Ibid.) Large-diameter ponderosa pine forests have been reduced by: timber harvest that has concentrated on large-diameter ponderosa pines; fire suppression that precludes natural thinning and results in replacement of ponderosa pines with firs; and livestock grazing that reduced grasses needed to carry ground fires; and shrub growth on the forest floor resulting from fire suppression that may have facilitated predation by avian and mammalian predators(Ibid.)

Literature Cited

Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1966. Birds of North America. Golden Press, New York. 340 p.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR 768 Pp.

Gabrielson, Ira N. and Stanley G. Jewett. 1970 ed. Birds of the Pacific Northwest, With Special Reference to Oregon. (Formerly: Birds of Oregon.) Dover Publications, Inc. New York.650 p.

4. Mule Deer.

Distribution and habitat

The Rocky Mountain Mule Deer (Odocoileus hemionus hemionus) is a native species to Oregon, and occurs generally east of the crest of the Cascade Mountains, including the entire Deschutes Subbasin (ODFW 2003.) Mule deer occupy all terrestrial habitats in the subbasin (IBIS 2004.)

Food Habits and Nutrition

Mule deer are ruminants, like cattle. Deer feed on a wide variety of grasses, small weedy plants, and leaves and twigs in a selective manner, choosing the best pieces of forage on the basis of smell, taste, appearance, and touch, and the physical form of their long nose and teeth are well suited to this selective feeding (Wallmo 1981 p. 99.) During critical winter months, new growth on the ends of twigs on shrubs and trees are important as food for mule deer. Sagebrush (Artemesia spp.), bitterbrush (Purshia tridentata), rabbitbrush (Chrysothamnos spp.), juniper

Juniperus occidentalis), and mountain mahogany (Cercocarpus spp.) are utilized during the winter (Verts and Carraway 1998.) Deer will also eat acorns, legume seeds, and fleshy fruits, and mushrooms and other fungi, all of which are highly digestible for the deer digestive system (Wallmo 1981 p. 114.) A diet that provides 15-16 percent protein during the summer when fawning and lactation occurs, and a diet providing 10 percent protein during winter maintenance periods “probably are adequate for deer.” (Ibid p. 110)

Mule deer are adapted to the cycle of food availability during the year, so that they are able to maintain functions during cold winters when food is scarce, and then are able to take advantage of food abundance in the summer for reproduction and for storing fat reserves for winter (Ibid p. 99.) During winter, mule deer utilize snow as a source of water, but require free water during other times of the year, especially nursing females and fawns (Ibid p. 111.) Supplemental winter feeding may or may not be effective in saving deer which are starving, depending on when the feeding is started and what feed is provided to the deer (Ibid p. 126.)

Reproduction

Breeding occurs in the fall and winter from October through early January, and 1-3 fawns are borne by each doe the following May through July (Verts and Carraway 1998.) A buck deer will seek out and mate with many females, and there is no pair fidelity. The female cares for the fawn (Ibid.)

Migration

Mule deer generally summer at higher elevations, then move to lower elevations for the winter (Ibid p. 474.) These lower elevation areas are referred to as winter ranges.

Population Limiting Factors

Mule deer numbers are limited by some combination of effects from weather, food supply, predation, hunting, parasites and diseases, and human activities in deer habitat (Wallmo 1981 p. 245.) Many managers believe that of these effects, the most important limiting factor generally is the food supply (Ibid p. 247.) Food supply evaluation for mule deer is complex, and generally methods satisfactory to most managers have not been developed (Ibid p. 421.)

Weather affects mule deer through the quantity and quality of the food supply, when rain or lack of rain affects growth, for example, or indirectly by covering up food supplies with snow or through extremely low temperatures for extended periods during the winter causing the deer to starve to death from lack of forage of adequate nutritive value and depleted body fat reserves (Ibid p.248.)

Hunting management is based on the premise that numbers of deer can be harvested each year without reducing the base population, and this is the goal of hunting season managers. This being said, it is known that hunting harvest changes the population size and composition of deer populations (Ibid p. 253.)

“Predators on many ranges kill substantial numbers of mule and black-tailed deer, but only by careful local study can it be determined whether such predation causes the deer to be less numerous than they would be in the absence of predation.” “In no case has predation by coyotes or mountain lions been documented as the principal cause of a mule deer population decline.” (Wallmo 1981 p.)

Diseases can be a primary mortality factor for deer, or can be the result of conditions such as overcrowding in the habitat or low nutrition, among many other causes (Ibid p.129.) “Mule deer populations that are relatively stable and that are found in good habitat rarely are in danger of disease epizootics [outbreaks].” (ODFW 2003.) This is not to say that disease outbreaks do not occur or that they will not reduce a population of mule deer. Diseases and parasites do impact deer populations, but the exact numbers of deer removed from a population is difficult to measure, and often all a manager can say is that an outbreak has occurred (Wallmo 1981.)

On the Warm Springs Reservation in the Deschutes Subbasin, a lack of quality winter range is thought to be a limiting factor to mule deer population (CTWSR 1999 p.E-III-71.) Degradation of designated big game winter range areas by development and changes in vegetation is thought to be a limiting factor for mule deer populations south and west of Bend (Team 2004.)

A wide array of changes to habitat and conflicts with human activities that are detrimental to deer have been documented (Wallmo 1981 p. 509-535.) Some of these detrimental changes and conflicts are: overgrazing; conversion of habitat to cropland, highways, subdivisions, reservoirs, subdivisions and homesites; mining; fencing; and free-roaming dogs (Ibid.)

Historic Populations and Trends

On his expedition through Eastern Oregon in 1826 and 1827, Peter Skene Ogden wrote in his journal that deer were scarce, and John Fremont saw few deer or other big game animals in Southeastern Oregon during the 1840’s. Mule deer were reported to be abundant in Eastern Oregon in the 1920’s and 30’s, and deer populations increased through the 30’s and 40’s until peaking in the mid-1950’s (ODFW 2003.) By the late 1960’s, however, mule deer populations throughout the west started to decline, and have remained at lower populations since then with some fluctuations (Wallmo 1981 p. 236) (ODFW 2003.)

Current Populations

Oregon Department of Fish and Wildlife biologists survey mule deer in Oregon each year to estimate the populations in each of the wildlife management units (wmu’s) that make up the

Eastern Oregon mule deer range. As can be seen from Figure 1, 9 wmu's take in the approximate area of the Deschutes Subbasin (checked,) along with the Warm Springs Reservation (WSR) which is managed by the Confederated Tribes of the Warm Springs Reservation (CTWSR.) The population objectives for each of these 9 wmu's established in 1990, a spring population estimate for the WSR calculated in 1998, and a total of 71,500 deer is shown in Table 1. This total could be considered an estimate of the current deer population in the Deschutes Subbasin.

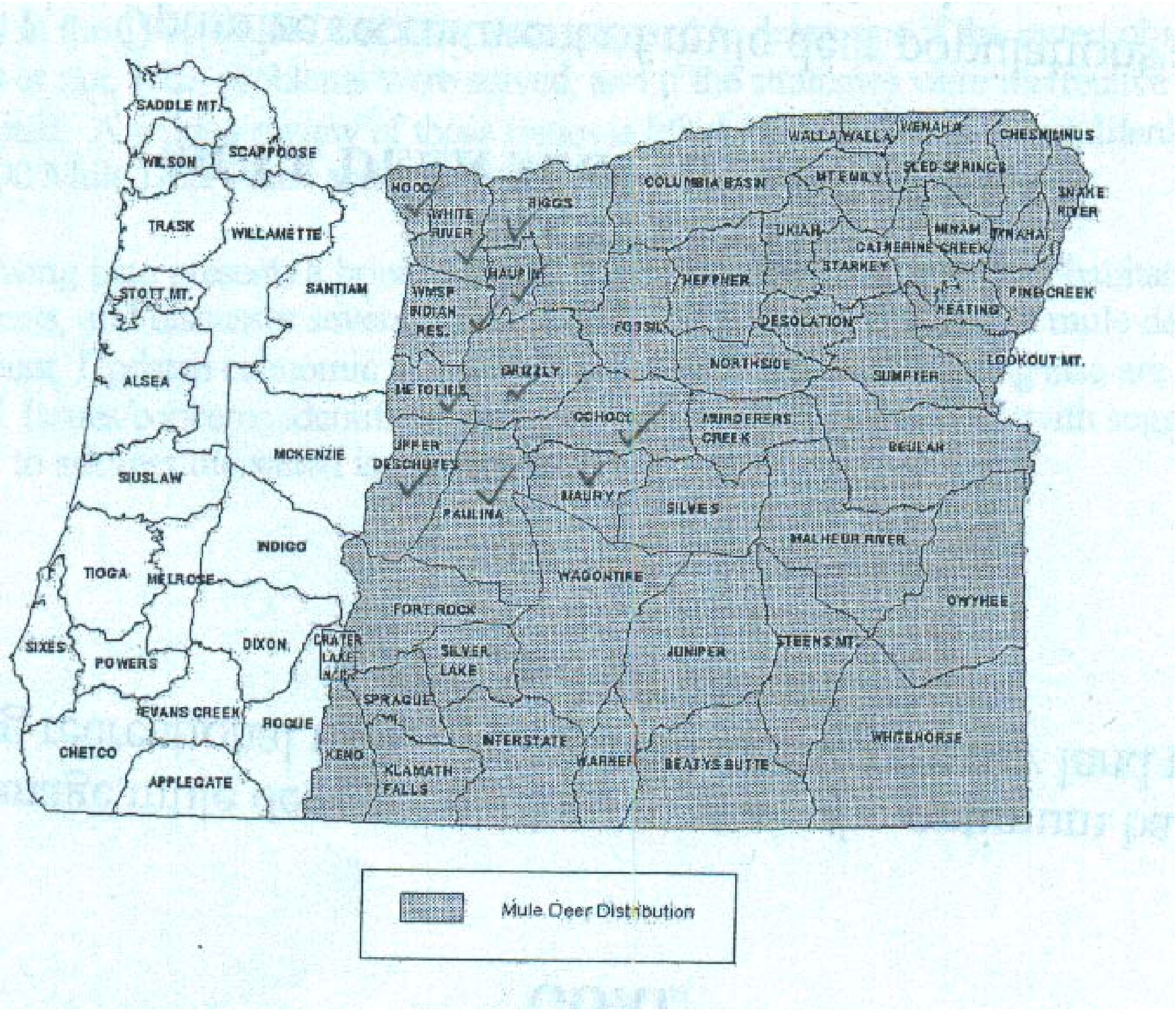


Figure 1. Range of mule deer in Oregon, with wildlife management units and the Warm Springs Reservation also indicated (ODFW 2003.)

Table 1. Population management objectives for mule deer for 9 wildlife management units that approximately make up the Deschutes Subbasin, Oregon; mule deer population estimate

for Warm Springs Reservation; and hunting tags issued, hunter-days expended, and deer harvest estimates for 1996 for the 9 wildlife management units and the Warm Springs Reservation.

Wildlife management unit	1996 Hunting Tags	1996 Hunter-days used	1996 Hunting Harvest	Population management objective (1990)
Ochoco	6324	34,959	1199	20,500
Grizzly	2843	15,823	810	8,500
Maury	1035	4,804	273	5,200
Maupin	355	1,167	198	3,000
White River	2920	12,977	826	9,000
Hood	641	2,923	118	400
Metolius	2307	11,420	581	6,200
Paulina	3425	20,088	705	16,500
Upper Deschutes	4425	26,971	679	2,200
Warm Springs Reservation	1300	--	455	7,100*
Total	25,575	131,132	5844	71,500

Table data in from ODFW (2003) and (1997.)

*Population estimate calculated by biologists in the spring of 1998 (Conf. Tribes of the WSR 1999 p.E-III-72.)

Population trends

Hunting Seasons and Harvest

Oregon’s first deer season was set in 1901 for a season running July 15-Oct. 31. Mule deer hunting seasons occur during the late summer and fall (ODFW 2003a.) As can be seen from Table , over 25 thousand persons hunted deer in the subbasin in 1996, harvesting nearly 6 thousand deer that represents approximately 8 percent of the population. An estimated 131 thousand hunter days were expended, not including the WSR.

Economic Impact of Mule Deer Hunting

In 1994, an estimate of the mean net economic value per day of deer hunting in Oregon was $59 (ODFW 2003.) If this number is applied to the number of hunter-days for 1996 in the subbasin, the result is an estimate of $7.7 million dollars net economic value to Oregon for deer hunting in the area approximating the Deschutes Subbasin.

end

5. Greater Sage Grouse.

Identification

The greater sage grouse is a pheasant-sized bird. The male has black markings on the belly and throat and neck, while the female appears uniformly gray (Robbins et al. 1966.)Of the three subspecies of sage grouse, the subspecies occupying areas in the Deschutes Subbasin is *Centrocercus urophasianus urophasianus* (Marshall et al. 2003.)

Distribution

Once found across most of the Western U.S. and into Canada, the sage grouse "…now has a local reduced population in the central part of western North America." "…from Eastern Washington to North Dakota." (Csuti et al, 2001.) Marshall (2003 p. 178) states that sage grouse had contracted in range in Oregon by 50 percent from previous population levels by the 1940's, and that populations were lost in the Blue Mountains and Columbia Plateau ecoregions of Oregon by that time. In the Deschutes Subbasin, sage grouse are currently found in eastern Crook and Deschutes counties (Ibid,) within the Upper Crooked and Lower Crooked AUs.

Migration

No regular migration occurs, but sage grouse may move several miles between feeding and brooding areas to find suitable forage, and will move several miles to areas where sage is not covered by snow to obtain forage in the winter (Marshall et al. 2003.)

Diet and feeding behavior

Sage grouse primarily eat the leaves of sagebrush throughout the year, but small weedy plants and insects are important during the nesting and brood seasons. Grasses are not eaten. (Marshall et al. 2003.)

Reproduction

Male sage grouse gather on display areas, or leks, in late February, and strut early in the mornings, beginning before dawn, to attract females. Females are attracted from surrounding habitat by the males displaying, and may choose a single male in a certain area of the lek as the primary breeding male. Leks are usually areas of sparse vegetation within sagebrush habitat. New leks have been established on recently burned sites. Nests are established as shallow depressions lined with grass, usually under a sagebrush, and usually in taller sagebrush habitat. Eggs are laid in May, and hatch in late May to mid-June. Nest success from an area near Prineville was 31 percent, with most unsuccessful nests the victims of predators. Hens may return to the lek and then renest after losing the first nest. Nest success in Oregon is lower than that reported from other areas states. (Marshall 2002.)

Historic and current populations, and population trends

The sage grouse range in in the Western U.S., and in states that it occupies, has become smaller (Marshall et al. 2003.) Formerly widespread in Eastern Oregon sagebrush prairies, by the 1940's sage grouse range had "contracted by about 50 percent" (Ibid.) "In Oregon, numbers of males counted at leks declined approximately 60% from the late 1950s to the early 1980s." (Ibid.)

Limiting factors

"Although the sage grouse is a game species in Oregon, the season is closed in much of the State." (Csuti et al. 2001.) Human disturbance at display leks can cause abandonment (Marshall et al. 2003.) The sage grouse is thought to require large areas of sagebrush with healthy native plant understory (Ibid.) Habitat loss primarily as a result of conversion to agriculture use is thought to be a major factor in the decline of sage grouse, as is encroachment by juniper into sagebrush prairies; fragmentation of habitat from roads and other changes; and changes in the composition of the sagebrush vegetation communities as a result of grazing, fire suppression or higher frequency of fires, and herbicide use (Ibid.)

Literature Cited

*Csuti et al. 2001. Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History. Oregon State Univ. Press, Corvallis, Or. 525 p.

*Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR 768 Pp.

*Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1966. Birds of North America. Golden Press, New York. 340 p.

6. Columbian Sharp-tailed Grouse.

Introduction

Sharp-tailed grouse were called prairie chickens by early Oregon residents, and these birds were abundant in grasslands and foothills in Eastern Oregon “prior to the late 1800s” (Marshall, 2003 p. 183.) Although sharp-tailed grouse have not been found in Eastern Oregon or the Deschutes Subbasin since the 1970s, it is thought by local biologists to be a good candidate for future re-introduction in the subbasin. An usuccessful re-introduction of the plains sharp-tailed grouse subspecies *Tympanuchus phasianellus jamesi* was conducted in Jefferson and Wasco counties in 1963 (Marshall et al. 2003.) Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus* are being re-introduced in an ongoing effort near Enterprise in Wallowa County, Oregon that was started in 1991, and some success seems to have occurred. The Oregon Department of Fish and Wildlife was reported to be considering areas for restoration of sharp-tailed grouse populations west of the Blue Mountains prior to 2003 (Ibid.)

Identification

The sharp-tailed grouse is a pheasant-sized bird with an overall light gray-brown coloration. Sexes are similar in appearance. When in flight, the narrow pointed tail is edged in white, distinguishing the sharp-tail from pheasants (Robbins et al. 1966.) Of six subspecies, only the Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) was found in Oregon (Marshall et al. 2003.)

Similar species

The greater sage grouse also occurs in the subbasin, and the habitats of sage grouse and sharp-tailed grouse probably overlapped in some areas in historic times.

Distribution

Found from Alaska and Canada south through the Great Plains states to New Mexico. In Oregon, the following status was described by Gabrielson and Jewett (1970) as existing in 1940: “ found over most of Eastern Oregon, but now, greatly reduced in numbers, and uncommon resident of a few counties. Recorded in recent years [prior to 1940] in Wasco, Sherman, Morrow, Unatilla, Wallowa, Union, Baker, and Harney Counties.”

Habitat and Nesting and Feeding Behavior

Sharp-tailed grouse inhabit grasslands or grass-shrublands and utilize deciduous shrubs and trees for wintering (Marshall et al. 2003.) Adult birds feed extensively on small weedy plants, and chicks require insects for feed (Ibid.) In the winter, when snow covers ground plants, birds feed on the buds of quaking aspen, chokecherry, black hawthorn, and willow (Ibid.) In Wallowa County, Oregon where Columbian sharp-tailed grouse are being released to establish new populations, birds can be seen in the winter perched in shrubs and small trees, presumably feeding on buds. Marshall (2003) reports that birds moved as far as 4 miles to deciduous shrub patches after a heavy snowfall. In Wallowa County, Oregon released birds used CRP program agricultural fields that were planted to perennial grasses and small weedy plants for lek sites and for late summer and fall feeding (Ibid p. 184.) In Wallowa County, native prairie was used by released birds for early spring feeding and nesting, and early summer brood rearing (Ibid p. 184.)

Reproduction

Male birds display on special openings in the grasslands or grass-shrubland called *leks* from early March through early June, attracting females for breeding. Nesting occurs in May and June. Two nests found near the mouth of the Deschutes in 1935 consisted of slight hollows in the ground of an agricultural grainfield lined with grasses, grains, stems, and feathers (Gabrielson and Jewett 1970.)

Migration

Columbian sharp-tailed grouse are non-migratory, but may move several miles away from the lek during the year (Csuti et al. 2001 p. 136.) The grouse form flocks during the winter (Ibid.)

Historic and current populations, and population trends

Although sharp-tailed grouse populations still exist in several midwest states, and remnant populations of the Columbian sharp-tailed grouse are present as close as Washington state (Ashley and Stoval 2004), sharp-tailed grouse are of concern in connection with disappearing habitat nationwide, and a recent publication states: “Prairie grouse [*Tympanuchus spp*] populations throughout North America have declined sharply in the last 3 decades.” Silvy and Hagen 2004 p. 2)

In Oregon, specimens of sharp-tailed grouse were taken by the Lewis and Clark expedition along the Columbia River and was described in documents written in 1815. In 1857 sharp-tailed grouse were reported as occurring “from the Deschutes to The Dalles” (Gabrielson and Jewett 1970.) However, as early as 1940 the status of the sharp-tail in Oregon was described as “precarious” due to “continual persecution and shooting.”(Ibid.) Sharp-tailed grouse were considered extirpated in Oregon by the 1970s (Marshall et al. 2003.)

Limiting factors

In 1940, Gabrielson and Jewett (1970) indicated that human encroachment on the breeding grounds was threatening populations of sharp-tailed grouse, along with “continual persecution and shooting.” In Wallowa County, Oregon predation has been a barrier to establishing new populations (Marshall et al. 2003.) Suitable habitat is apparently present in Wallowa County, Oregon where restoration of grassland and riparian areas has occurred, and where large grain fields have been replaced by CRP lands planted to permanent grasses and forbs (Marshall et al. 2003. p. 184.) (Gabrielson and Jewett 1970.)

Literature Cited

Ashley, Paul and Stacy Stoval. 2004. Columbian Sharp-tailed Grouse. Species Account written for the Southeast Washington Ecoregional Assessment. 12 p.

Csuti et al. 2001. Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History. Oregon State Univ. Press, Corvallis, Or. 525 p.

Gabrielson, Ira N. and Stanley G. Jewett. 1970 ed. Birds of the Pacific Northwest, With Special Reference to Oregon. (Formerly: Birds of Oregon.) Dover Publications, Inc. New York.650 p.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR 768 Pp.
*Riley, Terry Z. 2004. Private-land habitat opportunities for prairie grouse through federal conservation programs. in Special prairie grouse coverage section, Wildlife Society Bulletin, spring 2004, 32(1).

Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1966. Birds of North America. Golden Press, New York. 340 p.

Silva, Nova J. and Christian A. Hagen. 2004. Introduction: management of imperiled prairie grouse species and their habitat. *in* special prairie grouse coverage section, Wildlife Society Bulletin, spring 2004, 32(1).

7. Golden Eagle.

Introduction

Golden eagles are a native species to the subbasin. The first recorded listing of golden eagles in Oregon was in 1839 (Jewett and Gabrielson, 1970.) Since then observations on road surveys and other surveys have recorded substantial numbers of golden eagles in various areas of Eastern Oregon.

Identification

The golden eagle (Aquila Chrysaetos) is one of two eagles occurring in Oregon, the other being the bald eagle. The golden and bald eagle are the largest raptors currently occurring in Oregon, formerly being exceeded in size only by the condor. Adult golden eagles are colored a rich brown with lighter golden nape feathers, and the sexes are similarly colored. Adult and juvenile golden eagles are easily confused with immature bald eagles, all three birds being generally dark colored at a distance (Robbins 1966.)

Similar species

Bald eagle juveniles and golden eagle adults juveniles are easily confused. Vulture, red-tail hawk, rough-legged and ferruginous hawks appear similar (Wheeler 2003 p. 415.)

Distribution

The golden eagle occurs worldwide. In North America, it occurs in Alaska and Canada, and in western North American south to Mexico (Csuti et al. 2001.) Golden eagles occur most commonly east of the Cascades in Oregon, and have been noted from all Eastern Oregon counties, including all counties in the Deschutes Subbasin (Marshall et al. 2003.)

Migration

Generally golden eagles in Oregon are considered resident birds, but out-of-state migrant golden eagles from northern regions have been recorded passing through the State (Ibid.)

Diet and feeding behavior

Unlike the bald eagle, golden eagles are aggressive hunters. The black-tailed jackrabbit is considered to be historically a basic food item for golden eagles, but other animals such as marmots, ground squirrels, birds such as sage grouse and sharp-tailed grouse, and other species are taken. Golden eagles are known to kill deer and pronghorn fawns, wild and domestic lambs, and will eat fresh carrion and will steal prey from other raptors (Ibid.)

Reproduction

Nests are established most frequently in cliffs (65 percent of 506 occupied nests in Oregon in 1982), but nests are also built in large trees greater than 30 in. dbh, and occasionally on electric towers. Egg-laying occurs from late February to mid-April and young are fledged between Late June and early August. Breeding territories range in size between 10-40 sq. mi., and may include several habitat types. Alternate nest sites, consisting of partially-built or complete nests, within the same nesting territory may be maintained. Tolerance to human disturbance at nest sites varies widely among individual nesting pairs; some are very tolerant, others will abandon the nest if disturbed (Ibid.)

Historic and current populations, and population trends.

Numbers of golden eagles in Oregon were estimated to number 1,000-1,500 in 1982 (Marshall et al 2003.) Numbers of golden eagles observed during mid-winter bald eagle surveys in Oregon during 1992-2001 have averaged 97 (Ibid.) Number of observed active golden eagle nesting territories in the Deschutes Subbasin was 57 in 2000 (Clowers 2004.) Taking into account areas not inventoried by past surveys, a reasonable current estimate (2004) of nesting territories in the subbasin is considered to be 60 (Carey 2004.)

Golden eagle populations in the Northern Great Basin, especially Idaho and Northern Utah, have been reported to be declining (Marshall et al 2003.) The population trend of golden eagles in Oregon, or the Deschutes subbasin is basically unknown (Marshall et al. 2003, Clowers, 2004.)

Legal status

Golden eagles are protected by the Bald Eagle Protection Act through special provisions added in 1962 due to declining numbers of eagles and similarity of appearance between golden and bald eagle immature birds. It is unlawful to possess any part of any eagle except by federal permit. Four counties in the Deschutes subbasin have adopted ordinances designed to protect golden eagle nest sites by regulating development within a 0.25-mile zone around the nest: Deschutes, Jefferson, Crook, and Wasco counties. (Ibid.)

Limiting factors

It is reported that some nest territories in Central Oregon have been lost due to "…urban sprawl, residential developments, and disturbing recreational activities such as off-highway vehicles." (Ibid.) Other causes of mortality are electrocution on power line utility poles, poisoning from application of chemicals meant to kill other pests, collisions with wind-turbines, occasional shooting although this doesn't seem to be as much of a problem as before the bird became federally protected, and vehicle strikes when eagles land near highways to feed on road-kills (Wheeler 2003. p. 414-415.)

Literature Cited

Carey, Chris. 2004. Pers. comm. Wildlife Biologist, Ore. Dept. Fish and Wildlife, Bend, Oregon.

Clowers, Gary. 2004. Pers. comm. Wildlife Biologist, consulting. Madras, Oregon.

Gabrielson, Ira N. and Stanley G. Jewett. 1970 ed. Birds of the Pacific Northwest, With Special Reference to Oregon. (Formerly: Birds of Oregon.) Dover Publications, Inc. New York.650 p.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2003. Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR 768 Pp.

End Species Accounts

Appendix

Tables

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
Amphibians		
	Tiger Salamander	*Ambystoma tigrinum*
	Northwestern Salamander	*Ambystoma gracile*
	Long-toed Salamander	*Ambystoma macrodactylum*
	Cope's Giant Salamander	*Dicamptodon copei*
	Pacific Giant Salamander	*Dicamptodon tenebrosus*
	Southern Torrent Salamander	*Rhyacotriton variegatus*
	Cascade Torrent Salamander	*Rhyacotriton cascadae*
	Rough-skinned Newt	*Taricha granulosa*
	Dunn's Salamander	*Plethodon dunni*
	Larch Mountain Salamander	*Plethodon larselli*
	Western Red-backed Salamander	*Plethodon vehiculum*
	Del Norte Salamander	*Plethodon elongatus*
	Ensatina	*Ensatina eschscholtzii*
	Clouded Salamander	*Aneides ferreus*
	Oregon Slender Salamander	*Batrachoseps wrighti*
	Tailed Frog	*Ascaphus truei*
	Great Basin Spadefoot	*Scaphiopus intermontanus*
	Western Toad	*Bufo boreas*
	Pacific Chorus (Tree) Frog	*Pseudacris regilla*
	Red-legged Frog	*Rana aurora*
	Cascades Frog	*Rana cascadae*
	Columbia Spotted Frog	*Rana luteiventris*
	Foothill Yellow-legged Frog	*Rana boylii*
	Northern Leopard Frog	*Rana pipiens*
	Bullfrog	*Rana catesbeiana*
	Total Amphibians:	**25** **Total:**
Birds		
	Common Loon	*Gavia immer*
	Pied-billed Grebe	*Podilymbus podiceps*
	Horned Grebe	*Podiceps auritus*
	Red-necked Grebe	*Podiceps grisegena*
	Eared Grebe	*Podiceps nigricollis*
	Western Grebe	*Aechmophorus occidentalis*
	Clark's Grebe	*Aechmophorus clarkii*
	American White Pelican	*Pelecanus erythrorhynchos*
	Double-crested Cormorant	*Phalacrocorax auritus*
	American Bittern	*Botaurus lentiginosus*
	Least Bittern	*Ixobrychus exilis*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Great Blue Heron	*Ardea herodias*
	Great Egret	*Ardea alba*
	Snowy Egret	*Egretta thula*
	Cattle Egret	*Bubulcus ibis*
	Green Heron	*Butorides virescens*
	Black-crowned Night-heron	*Nycticorax nycticorax*
	White-faced Ibis	*Plegadis chihi*
	Turkey Vulture	*Cathartes aura*
	Greater White-fronted Goose	*Anser albifrons*
	Snow Goose	*Chen Ccaerulescens*
	Ross's Goose	*Chen rossii*
	Canada Goose	*Branta canadensis*
	Trumpeter Swan	*Cygnus buccinator*
	Tundra Swan	*Cygnus columbianus*
	Wood Duck	*Aix sponsa*
	Gadwall	*Anas strepera*
	Eurasian Wigeon	*Anas penelope*
	American Wigeon	*Anas americana*
	Mallard	*Anas platyrhynchos*
	Blue-winged Teal	*Anas discors*
	Cinnamon Teal	*Anas cyanoptera*
	Northern Shoveler	*Anas clypeata*
	Northern Pintail	*Anas acuta*
	Green-winged Teal	*Anas crecca*
	Canvasback	*Aythya valisineria*
	Redhead	*Aythya americana*
	Ring-necked Duck	*Aythya collaris*
	Greater Scaup	*Aythya marila*
	Lesser Scaup	*Aythya affinis*
	Harlequin Duck	*Histrionicus histrionicus*
	Surf Scoter	*Melanitta perspicillata*
	Bufflehead	*Bucephala albeola*
	Common Goldeneye	*Bucephala clangula*
	Barrow's Goldeneye	*Bucephala islandica*
	Hooded Merganser	*Lophodytes cucullatus*
	Common Merganser	*Mergus merganser*
	Red-breasted Merganser	*Mergus serrator*
	Ruddy Duck	*Oxyura jamaicensis*
	Osprey	*Pandion haliaetus*
	White-tailed Kite	*Elanus leucurus*
	Bald Eagle	*Haliaeetus leucocephalus*
	Northern Harrier	*Circus cyaneus*
	Sharp-shinned Hawk	*Accipiter striatus*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Cooper's Hawk	*Accipiter cooperii*
	Northern Goshawk	*Accipiter gentilis*
	Red-shouldered Hawk	*Buteo lineatus*
	Swainson's Hawk	*Buteo swainsoni*
	Red-tailed Hawk	*Buteo jamaicensis*
	Ferruginous Hawk	*Buteo regalis*
	Rough-legged Hawk	*Buteo lagopus*
	Golden Eagle	*Aquila chrysaetos*
	American Kestrel	*Falco sparverius*
	Merlin	*Falco columbarius*
	Gyrfalcon	*Falco rusticolus*
	Peregrine Falcon	*Falco peregrinus*
	Prairie Falcon	*Falco mexicanus*
	Chukar	*Alectoris chukar*
	Gray Partridge	*Perdix perdix*
	Ring-necked Pheasant	*Phasianus colchicus*
	Ruffed Grouse	*Bonasa umbellus*
	Sage Grouse	*Centrocercus urophasianus*
	Blue Grouse	*Dendragapus obscurus*
	Sharp-tailed Grouse	*Tympanuchus phasianellus*
	Wild Turkey	*Meleagris gallopavo*
	Mountain Quail	*Oreortyx pictus*
	California Quail	*Callipepla californica*
	Northern Bobwhite	*Colinus virginianus*
	Yellow Rail	*Coturnicops noveboracensis*
	Virginia Rail	*Rallus limicola*
	Sora	*Porzana carolina*
	American Coot	*Fulica americana*
	Sandhill Crane	*Grus canadensis*
	Black-bellied Plover	*Pluvialis squatarola*
	Pacific Golden-Plover	*Pluvialis fulva*
	Snowy Plover	*Charadrius alexandrinus*
	Semipalmated Plover	*Charadrius semipalmatus*
	Killdeer	*Charadrius vociferus*
	Black-necked Stilt	*Himantopus mexicanus*
	American Avocet	*Recurvirostra americana*
	Greater Yellowlegs	*Tringa melanoleuca*
	Lesser Yellowlegs	*Tringa flavipes*
	Solitary Sandpiper	*Tringa solitaria*
	Willet	*Catoptrophorus semipalmatus*
	Spotted Sandpiper	*Actitis macularia*
	Upland Sandpiper	*Bartramia longicauda*
	Long-billed Curlew	*Numenius americanus*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Marbled Godwit	*Limosa fedoa*
	Black Turnstone	*Arenaria melanocephala*
	Sanderling	*Calidris alba*
	Semipalmated Sandpiper	*Calidris pusilla*
	Western Sandpiper	*Calidris mauri*
	Least Sandpiper	*Calidris minutilla*
	Baird's Sandpiper	*Calidris bairdii*
	Pectoral Sandpiper	*Calidris melanotos*
	Dunlin	*Calidris alpina*
	Stilt Sandpiper	*Calidris himantopus*
	Ruff	*Philomachus pugnax*
	Short-billed Dowitcher	*Limnodromus griseus*
	Long-billed Dowitcher	*Limnodromus scolopaceus*
	Common Snipe	*Gallinago gallinago*
	Wilson's Phalarope	*Phalaropus tricolor*
	Red-necked Phalarope	*Phalaropus lobatus*
	Franklin's Gull	*Larus pipixcan*
	Bonaparte's Gull	*Larus philadelphia*
	Mew Gull	*Larus canus*
	Ring-billed Gull	*Larus delawarensis*
	California Gull	*Larus californicus*
	Herring Gull	*Larus argentatus*
	Thayer's Gull	*Larus thayeri*
	Western Gull	*Larus occidentalis*
	Glaucous-winged Gull	*Larus glaucescens*
	Glaucous Gull	*Larus hyperboreus*
	Caspian Tern	*Sterna caspia*
	Common Tern	*Sterna hirundo*
	Forster's Tern	*Sterna forsteri*
	Black Tern	*Chlidonias niger*
	Marbled Murrelet	*Brachyramphus marmoratus*
	Rock Dove	*Columba livia*
	Band-tailed Pigeon	*Columba fasciata*
	Mourning Dove	*Zenaida macroura*
	Yellow-billed Cuckoo	*Coccyzus americanus*
	Barn Owl	*Tyto alba*
	Flammulated Owl	*Otus flammeolus*
	Western Screech-owl	*Otus kennicottii*
	Great Horned Owl	*Bubo virginianus*
	Snowy Owl	*Nyctea scandiaca*
	Northern Pygmy-owl	*Glaucidium gnoma*
	Burrowing Owl	*Athene cunicularia*
	Spotted Owl	*Strix occidentalis*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Barred Owl	*Strix varia*
	Great Gray Owl	*Strix nebulosa*
	Long-eared Owl	*Asio otus*
	Short-eared Owl	*Asio flammeus*
	Boreal Owl	*Aegolius funereus*
	Northern Saw-whet Owl	*Aegolius acadicus*
	Common Nighthawk	*Chordeiles minor*
	Common Poorwill	*Phalaenoptilus nuttallii*
	Black Swift	*Cypseloides niger*
	Vaux's Swift	*Chaetura vauxi*
	White-throated Swift	*Aeronautes saxatalis*
	Black-chinned Hummingbird	*Archilochus alexandri*
	Anna's Hummingbird	*Calypte anna*
	Calliope Hummingbird	*Stellula calliope*
	Broad-tailed Hummingbird	*Selasphorus platycercus*
	Rufous Hummingbird	*Selasphorus rufus*
	Allen's Hummingbird	*Selasphorus sasin*
	Belted Kingfisher	*Ceryle alcyon*
	Lewis's Woodpecker	*Melanerpes lewis*
	Acorn Woodpecker	*Melanerpes formicivorus*
	Williamson's Sapsucker	*Sphyrapicus thyroideus*
	Red-naped Sapsucker	*Sphyrapicus nuchalis*
	Red-breasted Sapsucker	*Sphyrapicus ruber*
	Downy Woodpecker	*Picoides pubescens*
	Hairy Woodpecker	*Picoides villosus*
	White-headed Woodpecker	*Picoides albolarvatus*
	Three-toed Woodpecker	*Picoides tridactylus*
	Black-backed Woodpecker	*Picoides arcticus*
	Northern Flicker	*Colaptes auratus*
	Pileated Woodpecker	*Dryocopus pileatus*
	Olive-sided Flycatcher	*Contopus cooperi*
	Western Wood-pewee	*Contopus sordidulus*
	Willow Flycatcher	*Empidonax traillii*
	Least Flycatcher	*Empidonax minimus*
	Hammond's Flycatcher	*Empidonax hammondii*
	Gray Flycatcher	*Empidonax wrightii*
	Dusky Flycatcher	*Empidonax oberholseri*
	Pacific-slope Flycatcher	*Empidonax difficilis*
	Cordilleran Flycatcher	*Empidonax occidentalis*
	Black Phoebe	*Sayornis nigricans*
	Say's Phoebe	*Sayornis saya*
	Ash-throated Flycatcher	*Myiarchus cinerascens*
	Western Kingbird	*Tyrannus verticalis*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Eastern Kingbird	*Tyrannus tyrannus*
	Loggerhead Shrike	*Lanius ludovicianus*
	Northern Shrike	*Lanius excubitor*
	Cassin's Vireo	*Vireo cassinii*
	Hutton's Vireo	*Vireo huttoni*
	Warbling Vireo	*Vireo gilvus*
	Red-eyed Vireo	*Vireo olivaceus*
	Gray Jay	*Perisoreus canadensis*
	Steller's Jay	*Cyanocitta stelleri*
	Western Scrub-Jay	*Aphelocoma californica*
	Pinyon Jay	*Gymnorhinus cyanocephalus*
	Clark's Nutcracker	*Nucifraga columbiana*
	Black-billed Magpie	*Pica pica*
	American Crow	*Corvus brachyrhynchos*
	Common Raven	*Corvus corax*
	Horned Lark	*Eremophila alpestris*
	Purple Martin	*Progne subis*
	Tree Swallow	*Tachycineta bicolor*
	Violet-green Swallow	*Tachycineta thalassina*
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
	Bank Swallow	*Riparia riparia*
	Cliff Swallow	*Petrochelidon pyrrhonota*
	Barn Swallow	*Hirundo rustica*
	Black-capped Chickadee	*Poecile atricapillus*
	Mountain Chickadee	*Poecile gambeli*
	Chestnut-backed Chickadee	*Poecile rufescens*
	Oak Titmouse	*Baeolophus inornatus*
	Juniper Titmouse	*Baeolophus griseus*
	Bushtit	*Psaltriparus minimus*
	Red-breasted Nuthatch	*Sitta canadensis*
	White-breasted Nuthatch	*Sitta carolinensis*
	Pygmy Nuthatch	*Sitta pygmaea*
	Brown Creeper	*Certhia americana*
	Rock Wren	*Salpinctes obsoletus*
	Canyon Wren	*Catherpes mexicanus*
	Bewick's Wren	*Thryomanes bewickii*
	House Wren	*Troglodytes aedon*
	Winter Wren	*Troglodytes troglodytes*
	Marsh Wren	*Cistothorus palustris*
	American Dipper	*Cinclus mexicanus*
	Golden-crowned Kinglet	*Regulus satrapa*
	Ruby-crowned Kinglet	*Regulus calendula*
	Blue-gray Gnatcatcher	*Polioptila caerulea*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Western Bluebird	*Sialia mexicana*
	Mountain Bluebird	*Sialia currucoides*
	Townsend's Solitaire	*Myadestes townsendi*
	Veery	*Catharus fuscescens*
	Swainson's Thrush	*Catharus ustulatus*
	Hermit Thrush	*Catharus guttatus*
	American Robin	*Turdus migratorius*
	Varied Thrush	*Ixoreus naevius*
	Wrentit	*Chamaea fasciata*
	Gray Catbird	*Dumetella carolinensis*
	Northern Mockingbird	*Mimus polyglottos*
	Sage Thrasher	*Oreoscoptes montanus*
	European Starling	*Sturnus vulgaris*
	American Pipit	*Anthus rubescens*
	Bohemian Waxwing	*Bombycilla garrulus*
	Cedar Waxwing	*Bombycilla cedrorum*
	Orange-crowned Warbler	*Vermivora celata*
	Nashville Warbler	*Vermivora ruficapilla*
	Yellow Warbler	*Dendroica petechia*
	Yellow-rumped Warbler	*Dendroica coronata*
	Black-throated Gray Warbler	*Dendroica nigrescens*
	Townsend's Warbler	*Dendroica townsendi*
	Hermit Warbler	*Dendroica occidentalis*
	Palm Warbler	*Dendroica palmarum*
	American Redstart	*Setophaga ruticilla*
	Northern Waterthrush	*Seiurus noveboracensis*
	Macgillivray's Warbler	*Oporornis tolmiei*
	Common Yellowthroat	*Geothlypis trichas*
	Wilson's Warbler	*Wilsonia pusilla*
	Yellow-breasted Chat	*Icteria virens*
	Western Tanager	*Piranga ludoviciana*
	Green-tailed Towhee	*Pipilo chlorurus*
	Spotted Towhee	*Pipilo maculatus*
	California Towhee	*Pipilo crissalis*
	American Tree Sparrow	*Spizella arborea*
	Chipping Sparrow	*Spizella passerina*
	Clay-colored Sparrow	*Spizella pallida*
	Brewer's Sparrow	*Spizella breweri*
	Vesper Sparrow	*Pooecetes gramineus*
	Lark Sparrow	*Chondestes grammacus*
	Black-throated Sparrow	*Amphispiza bilineata*
	Sage Sparrow	*Amphispiza belli*
	Savannah Sparrow	*Passerculus sandwichensis*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**
	Grasshopper Sparrow	*Ammodramus savannarum*
	Fox Sparrow	*Passerella iliaca*
	Song Sparrow	*Melospiza melodia*
	Lincoln's Sparrow	*Melospiza lincolnii*
	Swamp Sparrow	*Melospiza georgiana*
	White-crowned Sparrow	*Zonotrichia leucophrys*
	Golden-crowned Sparrow	*Zonotrichia atricapilla*
	Dark-eyed Junco	*Junco hyemalis*
	Lapland Longspur	*Calcarius lapponicus*
	Snow Bunting	*Plectrophenax nivalis*
	Black-headed Grosbeak	*Pheucticus melanocephalus*
	Lazuli Bunting	*Passerina amoena*
	Bobolink	*Dolichonyx oryzivorus*
	Red-winged Blackbird	*Agelaius phoeniceus*
	Tricolored Blackbird	*Agelaius tricolor*
	Western Meadowlark	*Sturnella neglecta*
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
	Brewer's Blackbird	*Euphagus cyanocephalus*
	Brown-headed Cowbird	*Molothrus ater*
	Bullock's Oriole	*Icterus bullockii*
	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
	Black Rosy-finch	*Leucosticte atrata*
	Pine Grosbeak	*Pinicola enucleator*
	Purple Finch	*Carpodacus purpureus*
	Cassin's Finch	*Carpodacus cassinii*
	House Finch	*Carpodacus mexicanus*
	Red Crossbill	*Loxia curvirostra*
	White-winged Crossbill	*Loxia leucoptera*
	Common Redpoll	*Carduelis flammea*
	Pine Siskin	*Carduelis pinus*
	Lesser Goldfinch	*Carduelis psaltria*
	American Goldfinch	*Carduelis tristis*
	Evening Grosbeak	*Coccothraustes vespertinus*
	Total Birds:	**302** **:**
Mammals		
	Virginia Opossum	*Didelphis virginiana*
	Preble's Shrew	*Sorex preblei*
	Vagrant Shrew	*Sorex vagrans*
	Montane Shrew	*Sorex monticolus*
	Baird's Shrew	*Sorex bairdi*
	Fog Shrew	*Sorex sonomae*
	Pacific Shrew	*Sorex pacificus*
	Water Shrew	*Sorex palustris*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)		
	Common Name	**Scientific Name**
	Pacific Water Shrew	*Sorex bendirii*
	Trowbridge's Shrew	*Sorex trowbridgii*
	Merriam's Shrew	*Sorex merriami*
	Shrew-mole	*Neurotrichus gibbsii*
	Townsend's Mole	*Scapanus townsendii*
	Coast Mole	*Scapanus orarius*
	Broad-footed Mole	*Scapanus latimanus*
	California Myotis	*Myotis californicus*
	Western Small-footed Myotis	*Myotis ciliolabrum*
	Yuma Myotis	*Myotis yumanensis*
	Little Brown Myotis	*Myotis lucifugus*
	Long-legged Myotis	*Myotis volans*
	Fringed Myotis	*Myotis thysanodes*
	Long-eared Myotis	*Myotis evotis*
	Silver-haired Bat	*Lasionycteris noctivagans*
	Western Pipistrelle	*Pipistrellus hesperus*
	Big Brown Bat	*Eptesicus fuscus*
	Hoary Bat	*Lasiurus cinereus*
	Spotted Bat	*Euderma maculatum*
	Townsend's Big-eared Bat	*Corynorhinus townsendii*
	Pallid Bat	*Antrozous pallidus*
	Brazilian Free-tailed Bat	*Tadarida brasiliensis*
	American Pika	*Ochotona princeps*
	Pygmy Rabbit	*Brachylagus idahoensis*
	Brush Rabbit	*Sylvilagus bachmani*
	Eastern Cottontail	*Sylvilagus floridanus*
	Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*
	Snowshoe Hare	*Lepus americanus*
	White-tailed Jackrabbit	*Lepus townsendii*
	Black-tailed Jackrabbit	*Lepus californicus*
	Mountain Beaver	*Aplodontia rufa*
	Least Chipmunk	*Tamias minimus*
	Yellow-pine Chipmunk	*Tamias amoenus*
	Townsend's Chipmunk	*Tamias townsendii*
	Allen's Chipmunk	*Tamias senex*
	Siskiyou Chipmunk	*Tamias siskiyou*
	Yellow-bellied Marmot	*Marmota flaviventris*
	White-tailed Antelope Squirrel	*Ammospermophilus leucurus*
	Townsend's Ground Squirrel	*Spermophilus townsendii*
	Merriam's Ground Squirrel	*Spermophilus canus*
	Piute Ground Squirrel	*Spermophilus mollis*
	Belding's Ground Squirrel	*Spermophilus beldingi*
	Columbian Ground Squirrel	*Spermophilus columbianus*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	Scientific Name
	California Ground Squirrel	*Spermophilus beecheyi*
	Golden-mantled Ground Squirrel	*Spermophilus lateralis*
	Eastern Fox Squirrel	*Sciurus niger*
	Western Gray Squirrel	*Sciurus griseus*
	Red Squirrel	*Tamiasciurus hudsonicus*
	Douglas' Squirrel	*Tamiasciurus douglasii*
	Northern Flying Squirrel	*Glaucomys sabrinus*
	Northern Pocket Gopher	*Thomomys talpoides*
	Western Pocket Gopher	*Thomomys mazama*
	Townsend's Pocket Gopher	*Thomomys townsendii*
	Great Basin Pocket Mouse	*Perognathus parvus*
	Little Pocket Mouse	*Perognathus longimembris*
	Dark Kangaroo Mouse	*Microdipodops megacephalus*
	Ord's Kangaroo Rat	*Dipodomys ordii*
	Chisel-toothed Kangaroo Rat	*Dipodomys microps*
	California Kangaroo Rat	*Dipodomys californicus*
	American Beaver	*Castor canadensis*
	Western Harvest Mouse	*Reithrodontomys megalotis*
	Deer Mouse	*Peromyscus maniculatus*
	Canyon Mouse	*Peromyscus crinitus*
	Pinon Mouse	*Peromyscus truei*
	Northern Grasshopper Mouse	*Onychomys leucogaster*
	Desert Woodrat	*Neotoma lepida*
	Dusky-footed Woodrat	*Neotoma fuscipes*
	Bushy-tailed Woodrat	*Neotoma cinerea*
	Southern Red-backed Vole	*Clethrionomys gapperi*
	Western Red-backed Vole	*Clethrionomys californicus*
	Heather Vole	*Phenacomys intermedius*
	White-footed Vole	*Phenacomys albipes*
	Red Tree Vole	*Phenacomys longicaudus*
	Montane Vole	*Microtus montanus*
	California Vole	*Microtus californicus*
	Townsend's Vole	*Microtus townsendii*
	Long-tailed Vole	*Microtus longicaudus*
	Creeping Vole	*Microtus oregoni*
	Water Vole	*Microtus richardsoni*
	Sagebrush Vole	*Lemmiscus curtatus*
	Muskrat	*Ondatra zibethicus*
	Western Jumping Mouse	*Zapus princeps*
	Pacific Jumping Mouse	*Zapus trinotatus*
	Common Porcupine	*Erethizon dorsatum*
	Nutria	*Myocastor coypus*
	Coyote	*Canis latrans*

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**	
	Red Fox	*Vulpes vulpes*	
	Kit Fox	*Vulpes velox*	
	Gray Fox	*Urocyon cinereoargenteus*	
	Black Bear	*Ursus americanus*	
	Grizzly Bear	*Ursus arctos*	
	Ringtail	*Bassariscus astutus*	
	Raccoon	*Procyon lotor*	
	American Marten	*Martes americana*	
	Fisher	*Martes pennanti*	
	Ermine	*Mustela erminea*	
	Long-tailed Weasel	*Mustela frenata*	
	Mink	*Mustela vison*	
	Wolverine	*Gulo gulo*	
	American Badger	*Taxidea taxus*	
	Western Spotted Skunk	*Spilogale gracilis*	
	Striped Skunk	*Mephitis mephitis*	
	Northern River Otter	*Lutra canadensis*	
	Mountain Lion	*Puma concolor*	
	Lynx	*Lynx canadensis*	
	Bobcat	*Lynx rufus*	
	Feral Pig	*Sus scrofa*	
	Elk	*Cervus elaphus*	
	Mule Deer	*Odocoileus hemionus*	
	White-tailed Deer	*Odocoileus virginianus*	
	Pronghorn Antelope	*Antilocapra americana*	
	Mountain Goat	*Oreamnos americanus*	
	Bighorn Sheep	*Ovis canadensis*	
	Total Mammals:	**121**	**:**
Marine Mammals			
	Northern (Steller) Sea Lion	*Eumetopias jubatus*	
	Harbor Seal	*Phoca vitulina*	
	Total Marine Mammals:	**2**	
Reptiles			
	Snapping Turtle	*Chelydra serpentina*	
	Painted Turtle	*Chrysemys picta*	
	Western Pond Turtle	*Clemmys marmorata*	
	Northern Alligator Lizard	*Elgaria coerulea*	
	Southern Alligator Lizard	*Elgaria multicarinata*	
	Mojave Black-collared Lizard	*Crotaphytus bicinctores*	
	Long-nosed Leopard Lizard	*Gambelia wislizenii*	
	Short-horned Lizard	*Phrynosoma douglassii*	
	Desert Horned Lizard	*Phrynosoma platyrhinos*	
	Sagebrush Lizard	*Sceloporus graciosus*	

Appendix A. Wildlife species thought to occur in the Deschutes subbasin historically (1850.)

	Common Name	**Scientific Name**	
	Western Fence Lizard	*Sceloporus occidentalis*	
	Side-blotched Lizard	*Uta stansburiana*	
	Western Skink	*Eumeces skiltonianus*	
	Western Whiptail	*Cnemidophorus tigris*	
	Plateau Striped Whiptail	*Cnemidophorus velox*	
	Rubber Boa	*Charina bottae*	
	Racer	*Coluber constrictor*	
	Sharptail Snake	*Contia tenuis*	
	Ringneck Snake	*Diadophis punctatus*	
	Night Snake	*Hypsiglena torquata*	
	Common Kingsnake	*Lampropeltis getula*	
	California Mountain Kingsnake	*Lampropeltis zonata*	
	Striped Whipsnake	*Masticophis taeniatus*	
	Gopher Snake	*Pituophis catenifer*	
	Pacific Coast Aquatic Garter Snake	*Thamnophis atratus*	
	Western Terrestrial Garter Snake	*Thamnophis elegans*	
	Northwestern Garter Snake	*Thamnophis ordinoides*	
	Common Garter Snake	*Thamnophis sirtalis*	
	Western Rattlesnake	*Crotalus viridis*	
	Total Reptiles:	**29**	**:**
	Total Species:	**479**	
Subbasin Species Occurrences Generated by IBIS on 10/13/2003 12:00:16 PM.			
Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.			

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
Amphibians		
	Tiger Salamander	*Ambystoma tigrinum*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Northwestern Salamander	*Ambystoma gracile*
	Long-toed Salamander	*Ambystoma macrodactylum*
	Cope's Giant Salamander	*Dicamptodon copei*
	Pacific Giant Salamander	*Dicamptodon tenebrosus*
	Southern Torrent Salamander	*Rhyacotriton variegatus*
	Cascade Torrent Salamander	*Rhyacotriton cascadae*
	Rough-skinned Newt	*Taricha granulosa*
	Dunn's Salamander	*Plethodon dunni*
	Larch Mountain Salamander	*Plethodon larselli*
	Western Red-backed Salamander	*Plethodon vehiculum*
	Del Norte Salamander	*Plethodon elongatus*
	Ensatina	*Ensatina eschscholtzii*
	Clouded Salamander	*Aneides ferreus*
	Oregon Slender Salamander	*Batrachoseps wrighti*
	Tailed Frog	*Ascaphus truei*
	Great Basin Spadefoot	*Scaphiopus intermontanus*
	Western Toad	*Bufo boreas*
	Pacific Chorus (Tree) Frog	*Pseudacris regilla*
	Red-legged Frog	*Rana aurora*
	Cascades Frog	*Rana cascadae*
	Columbia Spotted Frog	*Rana luteiventris*
	Foothill Yellow-legged Frog	*Rana boylii*
	Northern Leopard Frog	*Rana pipiens*
	Bullfrog	*Rana catesbeiana*
	Total Amphibians:	**25**
Birds		
	Common Loon	*Gavia immer*
	Pied-billed Grebe	*Podilymbus podiceps*
	Horned Grebe	*Podiceps auritus*
	Red-necked Grebe	*Podiceps grisegena*
	Eared Grebe	*Podiceps nigricollis*
	Western Grebe	*Aechmophorus occidentalis*
	Clark's Grebe	*Aechmophorus clarkii*
	American White Pelican	*Pelecanus erythrorhynchos*
	Brown Pelican	*Pelecanus occidentalis*
	Double-crested Cormorant	*Phalacrocorax auritus*
	American Bittern	*Botaurus lentiginosus*
	Least Bittern	*Ixobrychus exilis*
	Great Blue Heron	*Ardea herodias*
	Great Egret	*Ardea alba*
	Snowy Egret	*Egretta thula*
	Cattle Egret	*Bubulcus ibis*
	Green Heron	*Butorides virescens*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)		
	Common Name	**Scientific Name**
	Black-crowned Night-heron	*Nycticorax nycticorax*
	White-faced Ibis	*Plegadis chihi*
	Turkey Vulture	*Cathartes aura*
	Greater White-fronted Goose	*Anser albifrons*
	Snow Goose	*Chen Ccaerulescens*
	Ross's Goose	*Chen rossii*
	Canada Goose	*Branta canadensis*
	Trumpeter Swan	*Cygnus buccinator*
	Tundra Swan	*Cygnus columbianus*
	Wood Duck	*Aix sponsa*
	Gadwall	*Anas strepera*
	Eurasian Wigeon	*Anas penelope*
	American Wigeon	*Anas americana*
	Mallard	*Anas platyrhynchos*
	Blue-winged Teal	*Anas discors*
	Cinnamon Teal	*Anas cyanoptera*
	Northern Shoveler	*Anas clypeata*
	Northern Pintail	*Anas acuta*
	Green-winged Teal	*Anas crecca*
	Canvasback	*Aythya valisineria*
	Redhead	*Aythya americana*
	Ring-necked Duck	*Aythya collaris*
	Greater Scaup	*Aythya marila*
	Lesser Scaup	*Aythya affinis*
	Harlequin Duck	*Histrionicus histrionicus*
	Surf Scoter	*Melanitta perspicillata*
	Bufflehead	*Bucephala albeola*
	Common Goldeneye	*Bucephala clangula*
	Barrow's Goldeneye	*Bucephala islandica*
	Hooded Merganser	*Lophodytes cucullatus*
	Common Merganser	*Mergus merganser*
	Red-breasted Merganser	*Mergus serrator*
	Ruddy Duck	*Oxyura jamaicensis*
	Osprey	*Pandion haliaetus*
	White-tailed Kite	*Elanus leucurus*
	Bald Eagle	*Haliaeetus leucocephalus*
	Northern Harrier	*Circus cyaneus*
	Sharp-shinned Hawk	*Accipiter striatus*
	Cooper's Hawk	*Accipiter cooperii*
	Northern Goshawk	*Accipiter gentilis*
	Red-shouldered Hawk	*Buteo lineatus*
	Swainson's Hawk	*Buteo swainsoni*
	Red-tailed Hawk	*Buteo jamaicensis*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Ferruginous Hawk	*Buteo regalis*
	Rough-legged Hawk	*Buteo lagopus*
	Golden Eagle	*Aquila chrysaetos*
	American Kestrel	*Falco sparverius*
	Merlin	*Falco columbarius*
	Gyrfalcon	*Falco rusticolus*
	Peregrine Falcon	*Falco peregrinus*
	Prairie Falcon	*Falco mexicanus*
	Chukar	*Alectoris chukar*
	Gray Partridge	*Perdix perdix*
	Ring-necked Pheasant	*Phasianus colchicus*
	Ruffed Grouse	*Bonasa umbellus*
	Sage Grouse	*Centrocercus urophasianus*
	Blue Grouse	*Dendragapus obscurus*
	Sharp-tailed Grouse	*Tympanuchus phasianellus*
	Wild Turkey	*Meleagris gallopavo*
	Mountain Quail	*Oreortyx pictus*
	California Quail	*Callipepla californica*
	Northern Bobwhite	*Colinus virginianus*
	Yellow Rail	*Coturnicops noveboracensis*
	Virginia Rail	*Rallus limicola*
	Sora	*Porzana carolina*
	American Coot	*Fulica americana*
	Sandhill Crane	*Grus canadensis*
	Black-bellied Plover	*Pluvialis squatarola*
	Pacific Golden-Plover	*Pluvialis fulva*
	Snowy Plover	*Charadrius alexandrinus*
	Semipalmated Plover	*Charadrius semipalmatus*
	Killdeer	*Charadrius vociferus*
	Black-necked Stilt	*Himantopus mexicanus*
	American Avocet	*Recurvirostra americana*
	Greater Yellowlegs	*Tringa melanoleuca*
	Lesser Yellowlegs	*Tringa flavipes*
	Solitary Sandpiper	*Tringa solitaria*
	Willet	*Catoptrophorus semipalmatus*
	Spotted Sandpiper	*Actitis macularia*
	Upland Sandpiper	*Bartramia longicauda*
	Whimbrel	*Numenius phaeopus*
	Long-billed Curlew	*Numenius americanus*
	Marbled Godwit	*Limosa fedoa*
	Black Turnstone	*Arenaria melanocephala*
	Red Knot	*Calidris canutus*
	Sanderling	*Calidris alba*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Semipalmated Sandpiper	*Calidris pusilla*
	Western Sandpiper	*Calidris mauri*
	Least Sandpiper	*Calidris minutilla*
	Baird's Sandpiper	*Calidris bairdii*
	Pectoral Sandpiper	*Calidris melanotos*
	Dunlin	*Calidris alpina*
	Stilt Sandpiper	*Calidris himantopus*
	Ruff	*Philomachus pugnax*
	Short-billed Dowitcher	*Limnodromus griseus*
	Long-billed Dowitcher	*Limnodromus scolopaceus*
	Common Snipe	*Gallinago gallinago*
	Wilson's Phalarope	*Phalaropus tricolor*
	Red-necked Phalarope	*Phalaropus lobatus*
	Franklin's Gull	*Larus pipixcan*
	Bonaparte's Gull	*Larus philadelphia*
	Heermann's Gull	*Larus heermanni*
	Mew Gull	*Larus canus*
	Ring-billed Gull	*Larus delawarensis*
	California Gull	*Larus californicus*
	Herring Gull	*Larus argentatus*
	Thayer's Gull	*Larus thayeri*
	Western Gull	*Larus occidentalis*
	Glaucous-winged Gull	*Larus glaucescens*
	Glaucous Gull	*Larus hyperboreus*
	Caspian Tern	*Sterna caspia*
	Common Tern	*Sterna hirundo*
	Forster's Tern	*Sterna forsteri*
	Black Tern	*Chlidonias niger*
	Marbled Murrelet	*Brachyramphus marmoratus*
	Rock Dove	*Columba livia*
	Band-tailed Pigeon	*Columba fasciata*
	Mourning Dove	*Zenaida macroura*
	Yellow-billed Cuckoo	*Coccyzus americanus*
	Barn Owl	*Tyto alba*
	Flammulated Owl	*Otus flammeolus*
	Western Screech-owl	*Otus kennicottii*
	Great Horned Owl	*Bubo virginianus*
	Snowy Owl	*Nyctea scandiaca*
	Northern Pygmy-owl	*Glaucidium gnoma*
	Burrowing Owl	*Athene cunicularia*
	Spotted Owl	*Strix occidentalis*
	Barred Owl	*Strix varia*
	Great Gray Owl	*Strix nebulosa*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Long-eared Owl	*Asio otus*
	Short-eared Owl	*Asio flammeus*
	Boreal Owl	*Aegolius funereus*
	Northern Saw-whet Owl	*Aegolius acadicus*
	Common Nighthawk	*Chordeiles minor*
	Common Poorwill	*Phalaenoptilus nuttallii*
	Black Swift	*Cypseloides niger*
	Vaux's Swift	*Chaetura vauxi*
	White-throated Swift	*Aeronautes saxatalis*
	Black-chinned Hummingbird	*Archilochus alexandri*
	Anna's Hummingbird	*Calypte anna*
	Calliope Hummingbird	*Stellula calliope*
	Broad-tailed Hummingbird	*Selasphorus platycercus*
	Rufous Hummingbird	*Selasphorus rufus*
	Allen's Hummingbird	*Selasphorus sasin*
	Belted Kingfisher	*Ceryle alcyon*
	Lewis's Woodpecker	*Melanerpes lewis*
	Acorn Woodpecker	*Melanerpes formicivorus*
	Williamson's Sapsucker	*Sphyrapicus thyroideus*
	Red-naped Sapsucker	*Sphyrapicus nuchalis*
	Red-breasted Sapsucker	*Sphyrapicus ruber*
	Downy Woodpecker	*Picoides pubescens*
	Hairy Woodpecker	*Picoides villosus*
	White-headed Woodpecker	*Picoides albolarvatus*
	Three-toed Woodpecker	*Picoides tridactylus*
	Black-backed Woodpecker	*Picoides arcticus*
	Northern Flicker	*Colaptes auratus*
	Pileated Woodpecker	*Dryocopus pileatus*
	Olive-sided Flycatcher	*Contopus cooperi*
	Western Wood-pewee	*Contopus sordidulus*
	Willow Flycatcher	*Empidonax traillii*
	Least Flycatcher	*Empidonax minimus*
	Hammond's Flycatcher	*Empidonax hammondii*
	Gray Flycatcher	*Empidonax wrightii*
	Dusky Flycatcher	*Empidonax oberholseri*
	Pacific-slope Flycatcher	*Empidonax difficilis*
	Cordilleran Flycatcher	*Empidonax occidentalis*
	Black Phoebe	*Sayornis nigricans*
	Say's Phoebe	*Sayornis saya*
	Ash-throated Flycatcher	*Myiarchus cinerascens*
	Western Kingbird	*Tyrannus verticalis*
	Eastern Kingbird	*Tyrannus tyrannus*
	Loggerhead Shrike	*Lanius ludovicianus*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Northern Shrike	*Lanius excubitor*
	Cassin's Vireo	*Vireo cassinii*
	Hutton's Vireo	*Vireo huttoni*
	Warbling Vireo	*Vireo gilvus*
	Red-eyed Vireo	*Vireo olivaceus*
	Gray Jay	*Perisoreus canadensis*
	Steller's Jay	*Cyanocitta stelleri*
	Western Scrub-Jay	*Aphelocoma californica*
	Pinyon Jay	*Gymnorhinus cyanocephalus*
	Clark's Nutcracker	*Nucifraga columbiana*
	Black-billed Magpie	*Pica pica*
	American Crow	*Corvus brachyrhynchos*
	Common Raven	*Corvus corax*
	Horned Lark	*Eremophila alpestris*
	Purple Martin	*Progne subis*
	Tree Swallow	*Tachycineta bicolor*
	Violet-green Swallow	*Tachycineta thalassina*
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
	Bank Swallow	*Riparia riparia*
	Cliff Swallow	*Petrochelidon pyrrhonota*
	Barn Swallow	*Hirundo rustica*
	Black-capped Chickadee	*Poecile atricapillus*
	Mountain Chickadee	*Poecile gambeli*
	Chestnut-backed Chickadee	*Poecile rufescens*
	Oak Titmouse	*Baeolophus inornatus*
	Juniper Titmouse	*Baeolophus griseus*
	Bushtit	*Psaltriparus minimus*
	Red-breasted Nuthatch	*Sitta canadensis*
	White-breasted Nuthatch	*Sitta carolinensis*
	Pygmy Nuthatch	*Sitta pygmaea*
	Brown Creeper	*Certhia americana*
	Rock Wren	*Salpinctes obsoletus*
	Canyon Wren	*Catherpes mexicanus*
	Bewick's Wren	*Thryomanes bewickii*
	House Wren	*Troglodytes aedon*
	Winter Wren	*Troglodytes troglodytes*
	Marsh Wren	*Cistothorus palustris*
	American Dipper	*Cinclus mexicanus*
	Golden-crowned Kinglet	*Regulus satrapa*
	Ruby-crowned Kinglet	*Regulus calendula*
	Blue-gray Gnatcatcher	*Polioptila caerulea*
	Western Bluebird	*Sialia mexicana*
	Mountain Bluebird	*Sialia currucoides*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Townsend's Solitaire	*Myadestes townsendi*
	Veery	*Catharus fuscescens*
	Swainson's Thrush	*Catharus ustulatus*
	Hermit Thrush	*Catharus guttatus*
	American Robin	*Turdus migratorius*
	Varied Thrush	*Ixoreus naevius*
	Wrentit	*Chamaea fasciata*
	Gray Catbird	*Dumetella carolinensis*
	Northern Mockingbird	*Mimus polyglottos*
	Sage Thrasher	*Oreoscoptes montanus*
	European Starling	*Sturnus vulgaris*
	American Pipit	*Anthus rubescens*
	Bohemian Waxwing	*Bombycilla garrulus*
	Cedar Waxwing	*Bombycilla cedrorum*
	Orange-crowned Warbler	*Vermivora celata*
	Nashville Warbler	*Vermivora ruficapilla*
	Yellow Warbler	*Dendroica petechia*
	Yellow-rumped Warbler	*Dendroica coronata*
	Black-throated Gray Warbler	*Dendroica nigrescens*
	Townsend's Warbler	*Dendroica townsendi*
	Hermit Warbler	*Dendroica occidentalis*
	Palm Warbler	*Dendroica palmarum*
	American Redstart	*Setophaga ruticilla*
	Northern Waterthrush	*Seiurus noveboracensis*
	Macgillivray's Warbler	*Oporornis tolmiei*
	Common Yellowthroat	*Geothlypis trichas*
	Wilson's Warbler	*Wilsonia pusilla*
	Yellow-breasted Chat	*Icteria virens*
	Western Tanager	*Piranga ludoviciana*
	Green-tailed Towhee	*Pipilo chlorurus*
	Spotted Towhee	*Pipilo maculatus*
	California Towhee	*Pipilo crissalis*
	American Tree Sparrow	*Spizella arborea*
	Chipping Sparrow	*Spizella passerina*
	Clay-colored Sparrow	*Spizella pallida*
	Brewer's Sparrow	*Spizella breweri*
	Vesper Sparrow	*Pooecetes gramineus*
	Lark Sparrow	*Chondestes grammacus*
	Black-throated Sparrow	*Amphispiza bilineata*
	Sage Sparrow	*Amphispiza belli*
	Savannah Sparrow	*Passerculus sandwichensis*
	Grasshopper Sparrow	*Ammodramus savannarum*
	Fox Sparrow	*Passerella iliaca*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Song Sparrow	*Melospiza melodia*
	Lincoln's Sparrow	*Melospiza lincolnii*
	Swamp Sparrow	*Melospiza georgiana*
	White-throated Sparrow	*Zonotrichia albicollis*
	Harris's Sparrow	*Zonotrichia querula*
	White-crowned Sparrow	*Zonotrichia leucophrys*
	Golden-crowned Sparrow	*Zonotrichia atricapilla*
	Dark-eyed Junco	*Junco hyemalis*
	Lapland Longspur	*Calcarius lapponicus*
	Snow Bunting	*Plectrophenax nivalis*
	Black-headed Grosbeak	*Pheucticus melanocephalus*
	Lazuli Bunting	*Passerina amoena*
	Bobolink	*Dolichonyx oryzivorus*
	Red-winged Blackbird	*Agelaius phoeniceus*
	Tricolored Blackbird	*Agelaius tricolor*
	Western Meadowlark	*Sturnella neglecta*
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
	Brewer's Blackbird	*Euphagus cyanocephalus*
	Brown-headed Cowbird	*Molothrus ater*
	Bullock's Oriole	*Icterus bullockii*
	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
	Black Rosy-finch	*Leucosticte atrata*
	Pine Grosbeak	*Pinicola enucleator*
	Purple Finch	*Carpodacus purpureus*
	Cassin's Finch	*Carpodacus cassinii*
	House Finch	*Carpodacus mexicanus*
	Red Crossbill	*Loxia curvirostra*
	White-winged Crossbill	*Loxia leucoptera*
	Common Redpoll	*Carduelis flammea*
	Pine Siskin	*Carduelis pinus*
	Lesser Goldfinch	*Carduelis psaltria*
	American Goldfinch	*Carduelis tristis*
	Evening Grosbeak	*Coccothraustes vespertinus*
	House Sparrow	*Passer domesticus*
	Total Birds:	**309**
Mammals		
	Virginia Opossum	*Didelphis virginiana*
	Preble's Shrew	*Sorex preblei*
	Vagrant Shrew	*Sorex vagrans*
	Montane Shrew	*Sorex monticolus*
	Baird's Shrew	*Sorex bairdi*
	Fog Shrew	*Sorex sonomae*
	Pacific Shrew	*Sorex pacificus*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Water Shrew	*Sorex palustris*
	Pacific Water Shrew	*Sorex bendirii*
	Trowbridge's Shrew	*Sorex trowbridgii*
	Merriam's Shrew	*Sorex merriami*
	Shrew-mole	*Neurotrichus gibbsii*
	Townsend's Mole	*Scapanus townsendii*
	Coast Mole	*Scapanus orarius*
	Broad-footed Mole	*Scapanus latimanus*
	California Myotis	*Myotis californicus*
	Western Small-footed Myotis	*Myotis ciliolabrum*
	Yuma Myotis	*Myotis yumanensis*
	Little Brown Myotis	*Myotis lucifugus*
	Long-legged Myotis	*Myotis volans*
	Fringed Myotis	*Myotis thysanodes*
	Long-eared Myotis	*Myotis evotis*
	Silver-haired Bat	*Lasionycteris noctivagans*
	Western Pipistrelle	*Pipistrellus hesperus*
	Big Brown Bat	*Eptesicus fuscus*
	Hoary Bat	*Lasiurus cinereus*
	Spotted Bat	*Euderma maculatum*
	Townsend's Big-eared Bat	*Corynorhinus townsendii*
	Pallid Bat	*Antrozous pallidus*
	Brazilian Free-tailed Bat	*Tadarida brasiliensis*
	American Pika	*Ochotona princeps*
	Pygmy Rabbit	*Brachylagus idahoensis*
	Brush Rabbit	*Sylvilagus bachmani*
	Eastern Cottontail	*Sylvilagus floridanus*
	Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*
	Snowshoe Hare	*Lepus americanus*
	White-tailed Jackrabbit	*Lepus townsendii*
	Black-tailed Jackrabbit	*Lepus californicus*
	Mountain Beaver	*Aplodontia rufa*
	Least Chipmunk	*Tamias minimus*
	Yellow-pine Chipmunk	*Tamias amoenus*
	Townsend's Chipmunk	*Tamias townsendii*
	Allen's Chipmunk	*Tamias senex*
	Siskiyou Chipmunk	*Tamias siskiyou*
	Yellow-bellied Marmot	*Marmota flaviventris*
	White-tailed Antelope Squirrel	*Ammospermophilus leucurus*
	Townsend's Ground Squirrel	*Spermophilus townsendii*
	Merriam's Ground Squirrel	*Spermophilus canus*
	Piute Ground Squirrel	*Spermophilus mollis*
	Belding's Ground Squirrel	*Spermophilus beldingi*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Columbian Ground Squirrel	*Spermophilus columbianus*
	California Ground Squirrel	*Spermophilus beecheyi*
	Golden-mantled Ground Squirrel	*Spermophilus lateralis*
	Eastern Gray Squirrel	*Sciurus carolinensis*
	Eastern Fox Squirrel	*Sciurus niger*
	Western Gray Squirrel	*Sciurus griseus*
	Red Squirrel	*Tamiasciurus hudsonicus*
	Douglas' Squirrel	*Tamiasciurus douglasii*
	Northern Flying Squirrel	*Glaucomys sabrinus*
	Northern Pocket Gopher	*Thomomys talpoides*
	Western Pocket Gopher	*Thomomys mazama*
	Camas Pocket Gopher	*Thomomys bulbivorus*
	Botta's (Pistol River) Pocket Gopher	*Thomomys bottae*
	Townsend's Pocket Gopher	*Thomomys townsendii*
	Great Basin Pocket Mouse	*Perognathus parvus*
	Little Pocket Mouse	*Perognathus longimembris*
	Dark Kangaroo Mouse	*Microdipodops megacephalus*
	Ord's Kangaroo Rat	*Dipodomys ordii*
	Chisel-toothed Kangaroo Rat	*Dipodomys microps*
	California Kangaroo Rat	*Dipodomys californicus*
	American Beaver	*Castor canadensis*
	Western Harvest Mouse	*Reithrodontomys megalotis*
	Deer Mouse	*Peromyscus maniculatus*
	Canyon Mouse	*Peromyscus crinitus*
	Pinon Mouse	*Peromyscus truei*
	Northern Grasshopper Mouse	*Onychomys leucogaster*
	Desert Woodrat	*Neotoma lepida*
	Dusky-footed Woodrat	*Neotoma fuscipes*
	Bushy-tailed Woodrat	*Neotoma cinerea*
	Southern Red-backed Vole	*Clethrionomys gapperi*
	Western Red-backed Vole	*Clethrionomys californicus*
	Heather Vole	*Phenacomys intermedius*
	White-footed Vole	*Phenacomys albipes*
	Red Tree Vole	*Phenacomys longicaudus*
	Montane Vole	*Microtus montanus*
	Gray-tailed Vole	*Microtus canicaudus*
	California Vole	*Microtus californicus*
	Townsend's Vole	*Microtus townsendii*
	Long-tailed Vole	*Microtus longicaudus*
	Creeping Vole	*Microtus oregoni*
	Water Vole	*Microtus richardsoni*
	Sagebrush Vole	*Lemmiscus curtatus*
	Muskrat	*Ondatra zibethicus*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**
	Black Rat	*Rattus rattus*
	Norway Rat	*Rattus norvegicus*
	House Mouse	*Mus musculus*
	Western Jumping Mouse	*Zapus princeps*
	Pacific Jumping Mouse	*Zapus trinotatus*
	Common Porcupine	*Erethizon dorsatum*
	Nutria	*Myocastor coypus*
	Coyote	*Canis latrans*
	Red Fox	*Vulpes vulpes*
	Kit Fox	*Vulpes velox*
	Gray Fox	*Urocyon cinereoargenteus*
	Black Bear	*Ursus americanus*
	Grizzly Bear	*Ursus arctos*
	Ringtail	*Bassariscus astutus*
	Raccoon	*Procyon lotor*
	American Marten	*Martes americana*
	Fisher	*Martes pennanti*
	Ermine	*Mustela erminea*
	Long-tailed Weasel	*Mustela frenata*
	Mink	*Mustela vison*
	Wolverine	*Gulo gulo*
	American Badger	*Taxidea taxus*
	Western Spotted Skunk	*Spilogale gracilis*
	Striped Skunk	*Mephitis mephitis*
	Northern River Otter	*Lutra canadensis*
	Mountain Lion	*Puma concolor*
	Lynx	*Lynx canadensis*
	Bobcat	*Lynx rufus*
	Feral Pig	*Sus scrofa*
	Elk	*Cervus elaphus*
	Mule Deer	*Odocoileus hemionus*
	White-tailed Deer	*Odocoileus virginianus*
	Pronghorn Antelope	*Antilocapra americana*
	Mountain Goat	*Oreamnos americanus*
	Bighorn Sheep	*Ovis canadensis*
	Total Mammals:	**128**
Marine Mammals		
	Northern (Steller) Sea Lion	*Eumetopias jubatus*
	Harbor Seal	*Phoca vitulina*
	Total Marine Mammals:	**2**
Reptiles		
	Snapping Turtle	*Chelydra serpentina*
	Painted Turtle	*Chrysemys picta*

Appendix B. Wildlife thought to occur in the Deschutes subbasin currently (1999.)

	Common Name	**Scientific Name**	
	Western Pond Turtle	*Clemmys marmorata*	
	Northern Alligator Lizard	*Elgaria coerulea*	
	Southern Alligator Lizard	*Elgaria multicarinata*	
	Mojave Black-collared Lizard	*Crotaphytus bicinctores*	
	Long-nosed Leopard Lizard	*Gambelia wislizenii*	
	Short-horned Lizard	*Phrynosoma douglassii*	
	Desert Horned Lizard	*Phrynosoma platyrhinos*	
	Sagebrush Lizard	*Sceloporus graciosus*	
	Western Fence Lizard	*Sceloporus occidentalis*	
	Side-blotched Lizard	*Uta stansburiana*	
	Western Skink	*Eumeces skiltonianus*	
	Western Whiptail	*Cnemidophorus tigris*	
	Plateau Striped Whiptail	*Cnemidophorus velox*	
	Rubber Boa	*Charina bottae*	
	Racer	*Coluber constrictor*	
	Sharptail Snake	*Contia tenuis*	
	Ringneck Snake	*Diadophis punctatus*	
	Night Snake	*Hypsiglena torquata*	
	Common Kingsnake	*Lampropeltis getula*	
	California Mountain Kingsnake	*Lampropeltis zonata*	
	Striped Whipsnake	*Masticophis taeniatus*	
	Gopher Snake	*Pituophis catenifer*	
	Pacific Coast Aquatic Garter Snake	*Thamnophis atratus*	
	Western Terrestrial Garter Snake	*Thamnophis elegans*	
	Northwestern Garter Snake	*Thamnophis ordinoides*	
	Common Garter Snake	*Thamnophis sirtalis*	
	Western Rattlesnake	*Crotalus viridis*	
	Total Reptiles:	**29**	
	Total Species:	**493**	
Subbasin Species Occurrences Generated by IBIS on 10/10/2003 4:56:56 PM.			
Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.			

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
Tiger Salamander	Tiger Salamander
Northwestern Salamander	Northwestern Salamander
Long-toed Salamander	Long-toed Salamander
Cope's Giant Salamander	Cope's Giant Salamander
Pacific Giant Salamander	Pacific Giant Salamander
Southern Torrent Salamander	Southern Torrent Salamander
Cascade Torrent Salamander	Cascade Torrent Salamander
Rough-skinned Newt	Rough-skinned Newt
Dunn's Salamander	Dunn's Salamander
Larch Mountain Salamander	Larch Mountain Salamander
Western Red-backed Salamander	Western Red-backed Salamander
Del Norte Salamander	Del Norte Salamander
Ensatina	Ensatina
Clouded Salamander	Clouded Salamander
Oregon Slender Salamander	Oregon Slender Salamander
Tailed Frog	Tailed Frog
Great Basin Spadefoot	Great Basin Spadefoot
Western Toad	Western Toad
Pacific Chorus (Tree) Frog	Pacific Chorus (Tree) Frog
Red-legged Frog	Red-legged Frog
Cascades Frog	Cascades Frog
Columbia Spotted Frog	
Oregon spotted frog	Oregon spotted frog
Foothill yellow-legged frog	Foothill Yellow-legged Frog
Northern Leopard Frog	
	Bullfrog
Common Loon	Common Loon
Pied-billed Grebe	Pied-billed Grebe
Horned Grebe	Horned Grebe
Red-necked Grebe	Red-necked Grebe
Eared Grebe	Eared Grebe
Western Grebe	Western Grebe
Clark's Grebe	Clark's Grebe

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
American White Pelican	American White Pelican
	Brown Pelican
Double-crested Cormorant	Double-crested Cormorant
American Bittern	American Bittern
Least Bittern	Least Bittern
Great Blue Heron	Great Blue Heron
Great Egret	Great Egret
Snowy Egret	Snowy Egret
Cattle Egret	Cattle Egret
Green Heron	Green Heron
Black-crowned Night-heron	Black-crowned Night-heron
White-faced Ibis	White-faced Ibis
Turkey Vulture	Turkey Vulture
Greater White-fronted Goose	Greater White-fronted Goose
Snow Goose	Snow Goose
Ross's Goose	Ross's Goose
Canada Goose	Canada Goose
Trumpeter Swan	Trumpeter Swan
Tundra Swan	Tundra Swan
Wood Duck	Wood Duck
Gadwall	Gadwall
Eurasian Wigeon	Eurasian Wigeon
American Wigeon	American Wigeon
Mallard	Mallard
Blue-winged Teal	Blue-winged Teal
Cinnamon Teal	Cinnamon Teal
Northern Shoveler	Northern Shoveler
Northern Pintail	Northern Pintail
Green-winged Teal	Green-winged Teal
Canvasback	Canvasback
Redhead	Redhead
Ring-necked Duck	Ring-necked Duck
Greater Scaup	Greater Scaup
Lesser Scaup	Lesser Scaup
Harlequin Duck	Harlequin Duck
Surf Scoter	Surf Scoter

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Bufflehead	Bufflehead
Common Goldeneye	Common Goldeneye
Barrow's Goldeneye	Barrow's Goldeneye
Hooded Merganser	Hooded Merganser
Common Merganser	Common Merganser
Red-breasted Merganser	Red-breasted Merganser
Ruddy Duck	Ruddy Duck
Osprey	Osprey
White-tailed Kite	White-tailed Kite
Bald Eagle	Bald Eagle
Northern Harrier	Northern Harrier
Sharp-shinned Hawk	Sharp-shinned Hawk
Cooper's Hawk	Cooper's Hawk
Northern Goshawk	Northern Goshawk
Red-shouldered Hawk	Red-shouldered Hawk
Swainson's Hawk	Swainson's Hawk
Red-tailed Hawk	Red-tailed Hawk
Ferruginous Hawk	Ferruginous Hawk
Rough-legged Hawk	Rough-legged Hawk
Golden Eagle	Golden Eagle
American Kestrel	American Kestrel
Merlin	Merlin
Gyrfalcon	Gyrfalcon
Peregrine Falcon	Peregrine Falcon
Prairie Falcon	Prairie Falcon
	Chukar
	Gray Partridge
	Ring-necked Pheasant
Ruffed Grouse	Ruffed Grouse
Sage Grouse	Sage Grouse
Blue Grouse	Blue Grouse
Sharp-tailed Grouse	
	Wild Turkey
Mountain Quail	Mountain Quail
California Quail	California Quail
	Northern Bobwhite

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Yellow Rail	Yellow Rail
Virginia Rail	Virginia Rail
Sora	Sora
American Coot	American Coot
Sandhill Crane	Sandhill Crane
Black-bellied Plover	Black-bellied Plover
Pacific Golden-Plover	Pacific Golden-Plover
Snowy Plover	Snowy Plover
Semipalmated Plover	Semipalmated Plover
Killdeer	Killdeer
Black-necked Stilt	Black-necked Stilt
American Avocet	American Avocet
Greater Yellowlegs	Greater Yellowlegs
Lesser Yellowlegs	Lesser Yellowlegs
Solitary Sandpiper	Solitary Sandpiper
Willet	Willet
Spotted Sandpiper	Spotted Sandpiper
Upland Sandpiper	Upland Sandpiper
	Whimbrel
Long-billed Curlew	Long-billed Curlew
Marbled Godwit	Marbled Godwit
Black Turnstone	Black Turnstone
	Red Knot
Sanderling	Sanderling
Semipalmated Sandpiper	Semipalmated Sandpiper
Western Sandpiper	Western Sandpiper
Least Sandpiper	Least Sandpiper
Baird's Sandpiper	Baird's Sandpiper
Pectoral Sandpiper	Pectoral Sandpiper
Dunlin	Dunlin
Stilt Sandpiper	Stilt Sandpiper
Ruff	Ruff
Short-billed Dowitcher	Short-billed Dowitcher
Long-billed Dowitcher	Long-billed Dowitcher
Common Snipe	Common Snipe
Wilson's Phalarope	Wilson's Phalarope

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
Red-necked Phalarope	Red-necked Phalarope
Franklin's Gull	Franklin's Gull
Bonaparte's Gull	Bonaparte's Gull
	Heermann's Gull
Mew Gull	Mew Gull
Ring-billed Gull	Ring-billed Gull
California Gull	California Gull
Herring Gull	Herring Gull
Thayer's Gull	Thayer's Gull
Western Gull	Western Gull
Glaucous-winged Gull	Glaucous-winged Gull
Glaucous Gull	Glaucous Gull
Caspian Tern	Caspian Tern
Common Tern	Common Tern
Forster's Tern	Forster's Tern
Black Tern	Black Tern
Marbled Murrelet	Marbled Murrelet
	Rock Dove
Band-tailed Pigeon	Band-tailed Pigeon
Mourning Dove	Mourning Dove
Yellow-billed Cuckoo	Yellow-billed Cuckoo
Barn Owl	Barn Owl
Flammulated Owl	Flammulated Owl
Western Screech-owl	Western Screech-owl
Great Horned Owl	Great Horned Owl
Snowy Owl	Snowy Owl
Northern Pygmy-owl	Northern Pygmy-owl
Burrowing Owl	Burrowing Owl
Spotted Owl	Spotted Owl
Barred Owl	Barred Owl
Great Gray Owl	Great Gray Owl
Long-eared Owl	Long-eared Owl
Short-eared Owl	Short-eared Owl
Boreal Owl	Boreal Owl
Northern Saw-whet Owl	Northern Saw-whet Owl
Common Nighthawk	Common Nighthawk

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Common Poorwill	Common Poorwill
Black Swift	Black Swift
Vaux's Swift	Vaux's Swift
White-throated Swift	White-throated Swift
Black-chinned Hummingbird	Black-chinned Hummingbird
Anna's Hummingbird	Anna's Hummingbird
Calliope Hummingbird	Calliope Hummingbird
Broad-tailed Hummingbird	Broad-tailed Hummingbird
Rufous Hummingbird	Rufous Hummingbird
Allen's Hummingbird	Allen's Hummingbird
Belted Kingfisher	Belted Kingfisher
Lewis's Woodpecker	Lewis's Woodpecker
Acorn Woodpecker	Acorn Woodpecker
Williamson's Sapsucker	Williamson's Sapsucker
Red-naped Sapsucker	Red-naped Sapsucker
Red-breasted Sapsucker	Red-breasted Sapsucker
Downy Woodpecker	Downy Woodpecker
Hairy Woodpecker	Hairy Woodpecker
White-headed Woodpecker	White-headed Woodpecker
Three-toed Woodpecker	Three-toed Woodpecker
Black-backed Woodpecker	Black-backed Woodpecker
Northern Flicker	Northern Flicker
Pileated Woodpecker	Pileated Woodpecker
Olive-sided Flycatcher	Olive-sided Flycatcher
Western Wood-pewee	Western Wood-pewee
Willow Flycatcher	Willow Flycatcher
Least Flycatcher	Least Flycatcher
Hammond's Flycatcher	Hammond's Flycatcher
Gray Flycatcher	Gray Flycatcher
Dusky Flycatcher	Dusky Flycatcher
Pacific-slope Flycatcher	Pacific-slope Flycatcher
Cordilleran Flycatcher	Cordilleran Flycatcher
Black Phoebe	Black Phoebe
Say's Phoebe	Say's Phoebe
Ash-throated Flycatcher	Ash-throated Flycatcher
Western Kingbird	Western Kingbird

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
Eastern Kingbird	Eastern Kingbird
Loggerhead Shrike	Loggerhead Shrike
Northern Shrike	Northern Shrike
Cassin's Vireo	Cassin's Vireo
Hutton's Vireo	Hutton's Vireo
Warbling Vireo	Warbling Vireo
Red-eyed Vireo	Red-eyed Vireo
Gray Jay	Gray Jay
Steller's Jay	Steller's Jay
Western Scrub-Jay	Western Scrub-Jay
Pinyon Jay	Pinyon Jay
Clark's Nutcracker	Clark's Nutcracker
Black-billed Magpie	Black-billed Magpie
American Crow	American Crow
Common Raven	Common Raven
Horned Lark	Horned Lark
Purple Martin	Purple Martin
Tree Swallow	Tree Swallow
Violet-green Swallow	Violet-green Swallow
Northern Rough-winged Swallow	Northern Rough-winged Swallow
Bank Swallow	Bank Swallow
Cliff Swallow	Cliff Swallow
Barn Swallow	Barn Swallow
Black-capped Chickadee	Black-capped Chickadee
Mountain Chickadee	Mountain Chickadee
Chestnut-backed Chickadee	Chestnut-backed Chickadee
Oak Titmouse	Oak Titmouse
Juniper Titmouse	Juniper Titmouse
Bushtit	Bushtit
Red-breasted Nuthatch	Red-breasted Nuthatch
White-breasted Nuthatch	White-breasted Nuthatch
Pygmy Nuthatch	Pygmy Nuthatch
Brown Creeper	Brown Creeper
Rock Wren	Rock Wren
Canyon Wren	Canyon Wren
Bewick's Wren	Bewick's Wren

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
House Wren	House Wren
Winter Wren	Winter Wren
Marsh Wren	Marsh Wren
American Dipper	American Dipper
Golden-crowned Kinglet	Golden-crowned Kinglet
Ruby-crowned Kinglet	Ruby-crowned Kinglet
Blue-gray Gnatcatcher	Blue-gray Gnatcatcher
Western Bluebird	Western Bluebird
Mountain Bluebird	Mountain Bluebird
Townsend's Solitaire	Townsend's Solitaire
Veery	Veery
Swainson's Thrush	Swainson's Thrush
Hermit Thrush	Hermit Thrush
American Robin	American Robin
Varied Thrush	Varied Thrush
Wrentit	Wrentit
Gray Catbird	Gray Catbird
Northern Mockingbird	Northern Mockingbird
Sage Thrasher	Sage Thrasher
European Starling	European Starling
American Pipit	American Pipit
Bohemian Waxwing	Bohemian Waxwing
Cedar Waxwing	Cedar Waxwing
Orange-crowned Warbler	Orange-crowned Warbler
Nashville Warbler	Nashville Warbler
Yellow Warbler	Yellow Warbler
Yellow-rumped Warbler	Yellow-rumped Warbler
Black-throated Gray Warbler	Black-throated Gray Warbler
Townsend's Warbler	Townsend's Warbler
Hermit Warbler	Hermit Warbler
Palm Warbler	Palm Warbler
American Redstart	American Redstart
Northern Waterthrush	Northern Waterthrush
Macgillivray's Warbler	Macgillivray's Warbler
Common Yellowthroat	Common Yellowthroat
Wilson's Warbler	Wilson's Warbler

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Yellow-breasted Chat	Yellow-breasted Chat
Western Tanager	Western Tanager
Green-tailed Towhee	Green-tailed Towhee
Spotted Towhee	Spotted Towhee
California Towhee	California Towhee
American Tree Sparrow	American Tree Sparrow
Chipping Sparrow	Chipping Sparrow
Clay-colored Sparrow	Clay-colored Sparrow
Brewer's Sparrow	Brewer's Sparrow
Vesper Sparrow	Vesper Sparrow
Lark Sparrow	Lark Sparrow
Black-throated Sparrow	Black-throated Sparrow
Sage Sparrow	Sage Sparrow
Savannah Sparrow	Savannah Sparrow
Grasshopper Sparrow	Grasshopper Sparrow
Fox Sparrow	Fox Sparrow
Song Sparrow	Song Sparrow
Lincoln's Sparrow	Lincoln's Sparrow
Swamp Sparrow	Swamp Sparrow
White-crowned Sparrow	White-throated Sparrow
	Harris's Sparrow
	White-crowned Sparrow
Golden-crowned Sparrow	Golden-crowned Sparrow
Dark-eyed Junco	Dark-eyed Junco
Lapland Longspur	Lapland Longspur
Snow Bunting	Snow Bunting
Black-headed Grosbeak	Black-headed Grosbeak
Lazuli Bunting	Lazuli Bunting
Bobolink	Bobolink
Red-winged Blackbird	Red-winged Blackbird
Tricolored Blackbird	Tricolored Blackbird
Western Meadowlark	Western Meadowlark
Yellow-headed Blackbird	Yellow-headed Blackbird
Brewer's Blackbird	Brewer's Blackbird
Brown-headed Cowbird	Brown-headed Cowbird
Bullock's Oriole	Bullock's Oriole

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
Gray-crowned Rosy-Finch	Gray-crowned Rosy-Finch
Black Rosy-finch	Black Rosy-finch
Pine Grosbeak	Pine Grosbeak
Purple Finch	Purple Finch
Cassin's Finch	Cassin's Finch
House Finch	House Finch
Red Crossbill	Red Crossbill
White-winged Crossbill	White-winged Crossbill
Common Redpoll	Common Redpoll
Pine Siskin	Pine Siskin
Lesser Goldfinch	Lesser Goldfinch
American Goldfinch	American Goldfinch
Evening Grosbeak	Evening Grosbeak
	House Sparrow
	Virginia Opossum
Preble's Shrew	Preble's Shrew
Vagrant Shrew	Vagrant Shrew
Montane Shrew	Montane Shrew
Baird's Shrew	Baird's Shrew
Fog Shrew	Fog Shrew
Pacific Shrew	Pacific Shrew
Water Shrew	Water Shrew
Pacific Water Shrew	Pacific Water Shrew
Trowbridge's Shrew	Trowbridge's Shrew
Merriam's Shrew	Merriam's Shrew
Shrew-mole	Shrew-mole
Townsend's Mole	Townsend's Mole
Coast Mole	Coast Mole
Broad-footed Mole	Broad-footed Mole
California Myotis	California Myotis
Western Small-footed Myotis	Western Small-footed Myotis
Yuma Myotis	Yuma Myotis
Little Brown Myotis	Little Brown Myotis
Long-legged Myotis	Long-legged Myotis
Fringed Myotis	Fringed Myotis
Long-eared Myotis	Long-eared Myotis

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Silver-haired Bat	Silver-haired Bat
Western Pipistrelle	Western Pipistrelle
Big Brown Bat	Big Brown Bat
Hoary Bat	Hoary Bat
Spotted Bat	Spotted Bat
Townsend's Big-eared Bat	Townsend's Big-eared Bat
Pallid Bat	Pallid Bat
Brazilian Free-tailed Bat	Brazilian Free-tailed Bat
American Pika	American Pika
Pygmy Rabbit	Pygmy Rabbit
Brush Rabbit	Brush Rabbit
Eastern Cottontail	Eastern Cottontail
Nuttall's (Mountain) Cottontail	Nuttall's (Mountain) Cottontail
Snowshoe Hare	Snowshoe Hare
White-tailed Jackrabbit	White-tailed Jackrabbit
Black-tailed Jackrabbit	Black-tailed Jackrabbit
Mountain Beaver	Mountain Beaver
Least Chipmunk	Least Chipmunk
Yellow-pine Chipmunk	Yellow-pine Chipmunk
Townsend's Chipmunk	Townsend's Chipmunk
Allen's Chipmunk	Allen's Chipmunk
Siskiyou Chipmunk	Siskiyou Chipmunk
Yellow-bellied Marmot	Yellow-bellied Marmot
White-tailed Antelope Squirrel	White-tailed Antelope Squirrel
Townsend's Ground Squirrel	Townsend's Ground Squirrel
Merriam's Ground Squirrel	Merriam's Ground Squirrel
Piute Ground Squirrel	Piute Ground Squirrel
Belding's Ground Squirrel	Belding's Ground Squirrel
Columbian Ground Squirrel	Columbian Ground Squirrel
California Ground Squirrel	California Ground Squirrel
Golden-mantled Ground Squirrel	Golden-mantled Ground Squirrel
	Eastern Gray Squirrel
	Eastern Fox Squirrel
Western Gray Squirrel	Western Gray Squirrel
Red Squirrel	Red Squirrel
Douglas' Squirrel	Douglas' Squirrel

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Northern Flying Squirrel	Northern Flying Squirrel
Northern Pocket Gopher	Northern Pocket Gopher
Western Pocket Gopher	Western Pocket Gopher
	Camas Pocket Gopher
	Botta's (Pistol River) Pocket Gopher
Townsend's Pocket Gopher	Townsend's Pocket Gopher
Great Basin Pocket Mouse	Great Basin Pocket Mouse
Little Pocket Mouse	Little Pocket Mouse
Dark Kangaroo Mouse	Dark Kangaroo Mouse
Ord's Kangaroo Rat	Ord's Kangaroo Rat
Chisel-toothed Kangaroo Rat	Chisel-toothed Kangaroo Rat
California Kangaroo Rat	California Kangaroo Rat
American Beaver	American Beaver
Western Harvest Mouse	Western Harvest Mouse
Deer Mouse	Deer Mouse
Canyon Mouse	Canyon Mouse
Pinon Mouse	Pinon Mouse
Northern Grasshopper Mouse	Northern Grasshopper Mouse
Desert Woodrat	Desert Woodrat
Dusky-footed Woodrat	Dusky-footed Woodrat
Bushy-tailed Woodrat	Bushy-tailed Woodrat
Southern Red-backed Vole	Southern Red-backed Vole
Western Red-backed Vole	Western Red-backed Vole
Heather Vole	Heather Vole
White-footed Vole	White-footed Vole
Red Tree Vole	Red Tree Vole
Montane Vole	Montane Vole
	Gray-tailed Vole
California Vole	California Vole
Townsend's Vole	Townsend's Vole
Long-tailed Vole	Long-tailed Vole
Creeping Vole	Creeping Vole
Water Vole	Water Vole
Sagebrush Vole	Sagebrush Vole
Muskrat	Muskrat
	Black Rat

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
	Norway Rat
	House Mouse
Western Jumping Mouse	Western Jumping Mouse
Pacific Jumping Mouse	Pacific Jumping Mouse
Common Porcupine	Common Porcupine
	Nutria
Coyote	Coyote
Gray wolf	
Red Fox	Red Fox
Kit Fox	Kit Fox
Gray Fox	Gray Fox
Black Bear	Black Bear
Grizzly Bear	
Ringtail	Ringtail
Raccoon	Raccoon
American Marten	American Marten
Fisher	Fisher
Ermine	Ermine
Long-tailed Weasel	Long-tailed Weasel
Mink	Mink
Wolverine	Wolverine
American Badger	American Badger
Western Spotted Skunk	Western Spotted Skunk
Striped Skunk	Striped Skunk
Northern River Otter	Northern River Otter
Mountain Lion	Mountain Lion
Lynx	Lynx
Bobcat	Bobcat
	Feral Pig
Elk	Elk
Mule Deer	Mule Deer
White-tailed Deer	
Pronghorn Antelope	Pronghorn Antelope
Mountain Goat	
Bighorn Sheep	Bighorn Sheep
Northern (Steller) Sea Lion	Northern (Steller) Sea Lion

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)	
Historic spp	Current spp
Harbor Seal	Harbor Seal
	Snapping Turtle
Painted Turtle	Painted Turtle
Western Pond Turtle	Western Pond Turtle
Northern Alligator Lizard	Northern Alligator Lizard
Southern Alligator Lizard	Southern Alligator Lizard
Mojave Black-collared Lizard	Mojave Black-collared Lizard
Long-nosed Leopard Lizard	Long-nosed Leopard Lizard
Short-horned Lizard	Short-horned Lizard
Desert Horned Lizard	Desert Horned Lizard
Sagebrush Lizard	Sagebrush Lizard
Western Fence Lizard	Western Fence Lizard
Side-blotched Lizard	Side-blotched Lizard
Western Skink	Western Skink
Western Whiptail	Western Whiptail
	Plateau Striped Whiptail
Rubber Boa	Rubber Boa
Racer	Racer
Sharptail Snake	Sharptail Snake
Ringneck Snake	Ringneck Snake
Night Snake	Night Snake
Common Kingsnake	Common Kingsnake
California Mountain Kingsnake	California Mountain Kingsnake
Striped Whipsnake	Striped Whipsnake
Gopher Snake	Gopher Snake
Pacific Coast Aquatic Garter Snake	Pacific Coast Aquatic Garter Snake
Western Terrestrial Garter Snake	Western Terrestrial Garter Snake
Northwestern Garter Snake	Northwestern Garter Snake
Common Garter Snake	Common Garter Snake
Western Rattlesnake	Western Rattlesnake
	Species added from historic: 27
	Species lost from historic: 7

Appendix C. Comparison of historic and current species occurrence in the Deschutes subbasin, and suggested additions and deletions (already added or deleted in table.)

Historic spp	Current spp
Suggested deletions *:	**Suggested deletions*:**
Bullfrog	Columbia spotted frog
Chukar	Northern leopard frog
Gray partridge	White-tailed deer
Ring-necked pheasant	Grizzly bear
Wild turkey	Sharp-tailed grouse
Northern bobwhite	Mountain goat
Rock dove	
Virginia opossum	T
Eastern cottontail	
Eastern fox squirrel	
Nutria	
Feral pig	
Snapping turtle	
Plateau striped whiptail	
Suggested additions*:	
Oregon spotted frog	**Suggested additions*:**
Gray wolf	Oregon spotted frog

Original tables supplied by IBIS, 2003.

* Csuti, et. al. 2001. Atlas of Oregon Wildlife.

Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.

Common Name	**Scientific Name**	**State Status**		**Federal Status**
Cope's Giant Salamander	*Dicamptodon copei*	**OR**	Unclear Status	

Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.

Common Name	**Scientific Name**	**State Status**		**Federal Status**
Columbia Torrent Salamander	*Rhyacotriton kezeri*	**OR**	Candidate Species	
Southern Torrent Salamander	*Rhyacotriton variegatus*	**OR**	Species listing avoidable	
Cascade Torrent Salamander	*Rhyacotriton cascadae*	**OR**	Species listing avoidable	
Larch Mountain Salamander	*Plethodon larselli*	**OR**	Species listing avoidable	
Del Norte Salamander	*Plethodon elongatus*	**OR**	Species listing avoidable	
Clouded Salamander	*Aneides ferreus*	**OR**	Unclear Status	
Oregon Slender Salamander	*Batrachoseps wrighti*	**OR**	Unclear Status	
Tailed Frog	*Ascaphus truei*	**OR**	Species listing avoidable	
Western Toad	*Bufo boreas*	**OR**	Species listing avoidable	
Red-legged Frog	*Rana aurora*	**OR**	combined status S-V and S-US	
Cascades Frog	*Rana cascadae*	**OR**	Species listing avoidable	
Oregon Spotted Frog	*Rana pretiosa*	**OR**	Candidate Species	Anticipated Candidate
Columbia Spotted Frog	*Rana luteiventris*	**OR**	Unclear Status	Anticipated Candidate
Foothill Yellow-legged Frog	*Rana boylii*	**OR**	Species listing avoidable	
Northern Leopard Frog	*Rana pipiens*	**OR**	Candidate Species	
Horned Grebe	*Podiceps auritus*	**OR**	Peripheral and Naturally Rare	
Red-necked Grebe	*Podiceps grisegena*	**OR**	Candidate Species	
American White Pelican	*Pelecanus erythrorhynchos*	**OR**	Species listing avoidable	
Brown Pelican	*Pelecanus occidentalis*	**OR**	Endangered	Endangered
Least Bittern	*Ixobrychus exilis*	**OR**	Peripheral and Naturally Rare	
Snowy Egret	*Egretta thula*	**OR**	Species listing avoidable	

Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.

Common Name	**Scientific Name**	**State Status**		**Federal Status**
Harlequin Duck	*Histrionicus histrionicus*	**OR**	Unclear Status	
Bufflehead	*Bucephala albeola*	**OR**	Unclear Status	
Barrow's Goldeneye	*Bucephala islandica*	**OR**	Unclear Status	
Bald Eagle	*Haliaeetus leucocephalus*	**OR**	Threatened	Threatened
Northern Goshawk	*Accipiter gentilis*	**OR**	Candidate Species	
Swainson's Hawk	*Buteo swainsoni*	**OR**	Species listing avoidable	
Ferruginous Hawk	*Buteo regalis*	**OR**	Candidate Species	
Peregrine Falcon	*Falco peregrinus*	**OR**	Endangered	
Sage Grouse	*Centrocercus urophasianus*	**OR**	Species listing avoidable	
Mountain Quail	*Oreortyx pictus*	**OR**	Unclear Status	
Yellow Rail	*Coturnicops noveboracensis*	**OR**	Candidate Species	
Sandhill Crane	*Grus canadensis*	**OR**	Species listing avoidable	
Snowy Plover	*Charadrius alexandrinus*	**OR**	Threatened	Threatened
Upland Sandpiper	*Bartramia longicauda*	**OR**	Candidate Species	
Long-billed Curlew	*Numenius americanus*	**OR**	Species listing avoidable	
Franklin's Gull	*Larus pipixcan*	**OR**	Peripheral and Naturally Rare	
Marbled Murrelet	*Brachyramphus marmoratus*	**OR**	Threatened	Threatened
Yellow-billed Cuckoo	*Coccyzus americanus*	**OR**	Candidate Species	Anticipated Candidate
Flammulated Owl	*Otus flammeolus*	**OR**	Candidate Species	
Northern Pygmy-owl	*Glaucidium gnoma*	**OR**	Candidate Species	
Burrowing Owl	*Athene cunicularia*	**OR**	Candidate Species	
Spotted Owl	*Strix occidentalis*	**OR**	Threatened	Threatened
Great Gray Owl	*Strix nebulosa*	**OR**	Species listing avoidable	
Boreal Owl	*Aegolius funereus*	**OR**	Unclear Status	
Common Nighthawk	*Chordeiles minor*	**OR**	Candidate Species	
Black Swift	*Cypseloides niger*	**OR**	Peripheral and Naturally Rare	
Lewis's Woodpecker	*Melanerpes lewis*	**OR**	Candidate Species	

Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.

Common Name	**Scientific Name**	**State Status**		**Federal Status**
Williamson's Sapsucker	*Sphyrapicus thyroideus*	**OR**	Unclear Status	
White-headed Woodpecker	*Picoides albolarvatus*	**OR**	Candidate Species	
Three-toed Woodpecker	*Picoides tridactylus*	**OR**	Candidate Species	
Black-backed Woodpecker	*Picoides arcticus*	**OR**	Candidate Species	
Pileated Woodpecker	*Dryocopus pileatus*	**OR**	Species listing avoidable	
Olive-sided Flycatcher	*Contopus cooperi*	**OR**	Species listing avoidable	
Willow Flycatcher	*Empidonax traillii*	**OR**	combined status S-V and S-US	
Loggerhead Shrike	*Lanius ludovicianus*	**OR**	Species listing avoidable	
Purple Martin	*Progne subis*	**OR**	Candidate Species	
Bank Swallow	*Riparia riparia*	**OR**	Unclear Status	
Pygmy Nuthatch	*Sitta pygmaea*	**OR**	Species listing avoidable	
Western Bluebird	*Sialia mexicana*	**OR**	Species listing avoidable	
Yellow-breasted Chat	*Icteria virens*	**OR**	Candidate Species	
Vesper Sparrow	*Pooecetes gramineus*	**OR**	Candidate Species	
Black-throated Sparrow	*Amphispiza bilineata*	**OR**	Peripheral and Naturally Rare	
Sage Sparrow	*Amphispiza belli*	**OR**	Candidate Species	
Grasshopper Sparrow	*Ammodramus savannarum*	**OR**	combined status S-V and S-PN	
Bobolink	*Dolichonyx oryzivorus*	**OR**	Species listing avoidable	
Tricolored Blackbird	*Agelaius tricolor*	**OR**	Peripheral and Naturally Rare	
Western Meadowlark	*Sturnella neglecta*	**OR**	Candidate Species	
Black Rosy-finch	*Leucosticte atrata*	**OR**	Peripheral and Naturally Rare	
Western Small-footed Myotis	*Myotis ciliolabrum*	**OR**	Unclear Status	
Long-legged Myotis	*Myotis volans*	**OR**	Unclear Status	
Fringed Myotis	*Myotis thysanodes*	**OR**	Species listing	

Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.

Common Name	**Scientific Name**	**State Status**		**Federal Status**
			avoidable	
Long-eared Myotis	*Myotis evotis*	**OR**	Unclear Status	
Silver-haired Bat	*Lasionycteris noctivagans*	**OR**	Unclear Status	
Townsend's Big-eared Bat	*Corynorhinus townsendii*	**OR**	Candidate Species	
Pallid Bat	*Antrozous pallidus*	**OR**	Species listing avoidable	
Pygmy Rabbit	*Brachylagus idahoensis*	**OR**	Species listing avoidable	
White-tailed Jackrabbit	*Lepus townsendii*	**OR**	Unclear Status	
White-tailed Antelope Squirrel	*Ammospermophilus leucurus*	**OR**	Unclear Status	
Washington Ground Squirrel	*Spermophilus washingtoni*	**OR**	Endangered	Anticipated Candidate
Western Gray Squirrel	*Sciurus griseus*	**OR**	Unclear Status	
White-footed Vole	*Phenacomys albipes*	**OR**	Unclear Status	
Gray Wolf	*Canis lupus*	**OR**	Endangered	
Kit Fox	*Vulpes velox*	**OR**	Threatened	
Ringtail	*Bassariscus astutus*	**OR**	Unclear Status	
American Marten	*Martes americana*	**OR**	Species listing avoidable	
Fisher	*Martes pennanti*	**OR**	Candidate Species	
Wolverine	*Gulo gulo*	**OR**	Threatened	
Lynx	*Lynx canadensis*	**OR**		Threatened
Northern (Steller) Sea Lion	*Eumetopias jubatus*	**OR**	Species listing avoidable	Threatened
Painted Turtle	*Chrysemys picta*	**OR**	Candidate Species	
Mojave Black-collared Lizard	*Crotaphytus bicinctores*	**OR**	Species listing avoidable	
Long-nosed Leopard Lizard	*Gambelia wislizenii*	**OR**	Unclear Status	
Sharptail Snake	*Contia tenuis*	**OR**	Species listing avoidable	
Common Kingsnake	*Lampropeltis getula*	**OR**	Species listing avoidable	
California Mountain Kingsnake	*Lampropeltis zonata*	**OR**	Species listing avoidable	
Western Rattlesnake	*Crotalus viridis*	**OR**	Species listing	

<table>
<tr><td colspan="5">Appendix Table D. Threatened, endangered, and Oregon-listed wildlife species thought to occur currently or historically in the Deschutes Subbasin.</td></tr>
<tr><th>Common Name</th><th>Scientific Name</th><th colspan="2">State Status</th><th>Federal Status</th></tr>
<tr><td></td><td></td><td></td><td>avoidable</td><td></td></tr>
<tr><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="5">Threatened and Endangered Species Status for the Columbia Plateau Ecological Province. Generated by IBIS on 11/12/2003 4:05:53 PM.</td></tr>
<tr><td colspan="5">Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.</td></tr>
</table>

Appendix E. Wildlife species currently harvested by hunters in the Deschutes subbasin.

No.	Common Name	Scientific Name	OR
1.	Greater White-fronted Goose	*Anser albifrons*	Game Bird
2.	Snow Goose	*Chen Ccaerulescens*	Game Bird
3.	Ross's Goose	*Chen rossii*	Game Bird
4.	Canada Goose	*Branta canadensis*	Game Bird
5.	Wood Duck	*Aix sponsa*	Game Bird
6.	Gadwall	*Anas strepera*	Game Bird
7.	Eurasian Wigeon	*Anas penelope*	Game Bird
8.	American Wigeon	*Anas americana*	Game Bird
9.	Mallard	*Anas platyrhynchos*	Game Bird
10.	Blue-winged Teal	*Anas discors*	Game Bird
11.	Cinnamon Teal	*Anas cyanoptera*	Game Bird
12.	Northern Shoveler	*Anas clypeata*	Game Bird
13.	Northern Pintail	*Anas acuta*	Game Bird
14.	Green-winged Teal	*Anas crecca*	Game Bird
15.	Canvasback	*Aythya valisineria*	Game Bird
16.	Redhead	*Aythya americana*	Game Bird
17.	Ring-necked Duck	*Aythya collaris*	Game Bird
18.	Greater Scaup	*Aythya marila*	Game Bird
19.	Lesser Scaup	*Aythya affinis*	Game Bird
20.	Harlequin Duck	*Histrionicus histrionicus*	Game Bird
21.	Surf Scoter	*Melanitta perspicillata*	Game Bird
22.	Bufflehead	*Bucephala albeola*	Game Bird
23.	Common Goldeneye	*Bucephala clangula*	Game Bird
24.	Barrow's Goldeneye	*Bucephala islandica*	Game Bird
25.	Hooded Merganser	*Lophodytes cucullatus*	Game Bird
26.	Common Merganser	*Mergus merganser*	Game Bird

Appendix E. Wildlife species currently harvested by hunters in the Deschutes subbasin.			
No.	Common Name	Scientific Name	OR
27.	Red-breasted Merganser	*Mergus serrator*	Game Bird
28.	Ruddy Duck	*Oxyura jamaicensis*	Game Bird
29.	Chukar	*Alectoris chukar*	Game Bird
30.	Gray Partridge	*Perdix perdix*	Game Bird
31.	Ring-necked Pheasant	*Phasianus colchicus*	Game Bird
32.	Ruffed Grouse	*Bonasa umbellus*	Game Bird
33.	Sage Grouse	*Centrocercus urophasianus*	Game Bird
34.	Spruce Grouse	*Falcipennis canadensis*	Game Bird
35.	Blue Grouse	*Dendragapus obscurus*	Game Bird
36.	Wild Turkey	*Meleagris gallopavo*	Game Bird
37.	Mountain Quail	*Oreortyx pictus*	Game Bird
38.	California Quail	*Callipepla californica*	Game Bird
39.	Northern Bobwhite	*Colinus virginianus*	Game Bird
40.	American Coot	*Fulica americana*	Game Bird
41.	Common Snipe	*Gallinago gallinago*	Game Bird
42.	Band-tailed Pigeon	*Columba fasciata*	Game Bird
43.	Mourning Dove	*Zenaida macroura*	Game Bird
44.	American Crow	*Corvus brachyrhynchos*	Game Bird
45.	American Beaver	*Castor canadensis*	Furbearer
46.	Muskrat	*Ondatra zibethicus*	Furbearer
47.	Nutria	*Myocastor coypus*	Furbearer
48.	Coyote	*Canis latrans*	Hunted
49.	Red Fox	*Vulpes vulpes*	Furbearer
50.	Gray Fox	*Urocyon cinereoargenteus*	Furbearer
51.	Raccoon	*Procyon lotor*	Furbearer
52.	American Marten	*Martes americana*	Furbearer
53.	Mink	*Mustela vison*	Furbearer
54.	Ermine	*Mustela erminea*	Furbearer
55.	Long-tailed Weasel	*Mustela frenata*	Furbearer
56.	American Badger	*Taxidea taxus*	Furbearer
57.	Western Spotted Skunk	*Spilogale gracilis*	Furbearer
58.	Striped Skunk	*Mephitis mephitis*	Furbearer
59.	Northern River Otter	*Lutra canadensis*	Furbearer
60.	Bobcat	*Lynx rufus*	Furbearer
61.	Western Gray Squirrel	*Sciurus griseus*	Game Mammal
62.	Feral Pig	*Sus scrofa*	Hunted
63.	Black Bear	*Ursus americanus*	Game Mammal
64.	Mountain Lion	*Puma concolor*	Game Mammal
65.	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Game Mammal
66.	Black-tailed Deer	*O. hemionus columbianus*	Game Mammal

Appendix E. Wildlife species currently harvested by hunters in the Deschutes subbasin.			
No.	Common Name	Scientific Name	OR
67.	Mule Deer	*O. hemionus*	Game Mammal
68.	Pronghorn Antelope	*Antilocapra americana*	Game Mammal

Sources for data:

1. Game Species Listing for the Columbia Plateau Ecological Province. Generated by IBIS on 2/9/2004 5:25:42 PM. Copyright 1998-2003. Please visit the IBIS web site (www.nwhi.org/ibis) for Copyright and Terms of Use limitations. This data is continually updated and therefore subject to change.
2. Oregon Dept. of Fish and Wildlife. Big Game, Game Bird, and Furbearer hunting Rgulations, and Trapping Regulations. 2003.

Appendix F. HEP wildlife species thought to occur currently in the Deschutes subbasin.			
No.	Common Name	Scientific Name	Comments
1.	Spotted sandpiper	*Actitis macularia*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
2.	Lesser scaup	*Aytha affinis*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
3.	Canada goose	*Branta Canadensis*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
4.	Great blue heron	*Ardea herodias*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
5.	Yellow warbler	*Dendroica petechia*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
6.	Black-capped chickadee	*Parus atricopillus*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.

Appendix F. HEP wildlife species thought to occur currently in the Deschutes subbasin.

No.	Common Name	Scientific Name	Comments
7.	Mink	*Mustella vison*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
8.	Western meadow lark	*Sturnella neglecta*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
9.	California quail	*Lophortyx californicus*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
10.	Mallard	*Anas platyrhynchos*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
11.	Downy woodpecker	*Picoides puescens*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
12.	Greater Sage Grouse	*Centrocercus urophasianus*	Use at Grand Coulie/Chief Joe
13.	Ruffed grouse	*Bonasa umbellus*	Use at Grand Coulie/Chief Joe
14.	Mourning Dove	*Zenaida macroura*	Use at Grand Coulie/Chief Joe
15.	Bald eagle	*Haliaeetus leucocephalus*	Use at Grand Coulie/Chief Joe
16.	Long-eared owl	*Asio otus*	Use at Grand Coulie/Chief Joe
17.	Northern Flicker	*Colaptes auratus*	Use at Grand Coulie/Chief Joe
18.	Beaver	*Castor canadensis*	Use at Grand Coulie/Chief Joe
19.	Ring-necked pheasant	*Phasianus colchicus*	Use at Grand Coulie/Chief Joe
20.	Lewis woodpecker	*Melanerpes lewis*	Use at Grand Coulie/Chief Joe
21.	Bobcat	*Lynx rufus*	Use at Grand Coulie/Chief Joe
22.	River Otter	*Lutra Canadensis*	Use for Minidoka Dam
23.	Mule deer	*Dendragapus obscurus*	Use by CTUIR for McNary/John Day and at other selected sites.
24.	Blue grouse	*Dendragapus obscurus*	Use by CTUIR for McNary/John Day and at other selected sites.

Basic table supplied by IBIS, 2003.

Appendix G. Partners in Flight listed species thought to occur in the Deschutes Subbasin.

No.	Common Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	OR PIF Priority & Focal Species
1.	Ross's Goose	Yes		
2.	Trumpeter Swan	Yes		
3.	Northern Harrier			Yes
4.	Swainson's Hawk		MO (Intermountain West, Prairies)	Yes
5.	Ferruginous Hawk			Yes
6.	American Kestrel			Yes
7.	Sage Grouse		MA (Intermountain West, Prairies)	
8.	Blue Grouse		MA (Pacific, Intermountain West)	
9.	Sharp-tailed Grouse		MO (Prairies)	Yes
10	Mountain Quail		MO (Pacific)	
11	Yellow Rail	Yes		
12	Snowy Plover	Yes		
13	Willet	Yes		
14	Long-billed Curlew	Yes		
15	Black Turnstone	Yes		
16	Red Knot	Yes		
17	Stilt Sandpiper	Yes		
18	Short-billed Dowitcher	Yes		
19	Franklin's Gull	Yes		
20	Heermann's Gull	Yes		
21	Band-tailed Pigeon	Yes	MA (Pacific)	Yes
22	Yellow-billed Cuckoo			Yes
23	Flammulated Owl		MO (Pacific, Intermountain West, Southwest)	Yes
24	Northern Pygmy-owl		PR (Pacific)	
25	Burrowing Owl			Yes
26	Spotted Owl		IM (Pacific, Intermountain West, Southwest)	
27	Great Gray Owl			Yes
28	Short-eared Owl	Yes	MA (Arctic, Northern Forests, Intermountain West, Prairies)	Yes
29	Common Poorwill			Yes
30	Black Swift	Yes	IM (Pacific, Intermountain West)	Yes

Appendix G. Partners in Flight listed species thought to occur in the Deschutes Subbasin.

No.	Common Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	OR PIF Priority & Focal Species
31	Vaux's Swift			Yes
32	White-throated Swift		MA (Intermountain West, Southwest)	Yes
33	Calliope Hummingbird		MO (Intermountain West)	Yes
34	Rufous Hummingbird	Yes	MA (Pacific, Intermountain West)	Yes
35	Allen's Hummingbird	Yes	MO (Pacific)	
36	Lewis's Woodpecker	Yes	MO (Intermountain West, Prairies)	Yes
37	Acorn Woodpecker			Yes
38	Williamson's Sapsucker		MO (Intermountain West)	Yes
39	Red-naped Sapsucker		MO (Intermountain West)	Yes
40	Red-breasted Sapsucker		MO (Pacific)	Yes
41	Downy Woodpecker			Yes
42	White-headed Woodpecker	Yes	PR (Pacific, Intermountain West)	Yes
43	Black-backed Woodpecker		PR (Northern Forests)	Yes
44	Pileated Woodpecker			Yes
45	Olive-sided Flycatcher		MA (Pacific, Northern Forests, Intermountain West)	Yes
46	Western Wood-pewee			Yes
47	Willow Flycatcher		MA (Prairies, East)	Yes
48	Hammond's Flycatcher			Yes
49	Gray Flycatcher		PR (Intermountain West)	Yes
50	Dusky Flycatcher		MA (Intermountain West)	Yes
51	Pacific-slope Flycatcher		PR (Pacific)	Yes
52	Ash-throated Flycatcher			Yes
53	Loggerhead Shrike			Yes
54	Hutton's Vireo			Yes
55	Warbling Vireo			Yes
56	Red-eyed Vireo			Yes
57	Pinyon Jay		MA (Intermountain West)	
58	Clark's Nutcracker		PR (Intermountain West)	Yes
59	Horned Lark			Yes
60	Purple Martin			Yes
61	Bank Swallow			Yes
62	Chestnut-backed Chickadee		PR (Pacific)	
63	Oak Titmouse	Yes	MA (Pacific)	Yes
64	Bushtit			Yes
65	White-breasted Nuthatch			Yes

Appendix G. Partners in Flight listed species thought to occur in the Deschutes Subbasin.

No.	Common Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	OR PIF Priority & Focal Species
66	House Wren			Yes
67	Winter Wren			Yes
68	American Dipper			Yes
69	Blue-gray Gnatcatcher			Yes
70	Western Bluebird			Yes
71	Mountain Bluebird		PR (Intermountain West)	
72	Townsend's Solitaire			Yes
73	Veery			Yes
74	Swainson's Thrush			Yes
75	Hermit Thrush			Yes
76	Varied Thrush			Yes
77	Wrentit		MA (Pacific)	Yes
78	Sage Thrasher		PR (Intermountain West)	Yes
79	American Pipit		PR (Arctic)	Yes
80	Orange-crowned Warbler			Yes
81	Nashville Warbler		PR (Northern Forests)	Yes
82	Yellow Warbler			Yes
83	Yellow-rumped Warbler			Yes
84	Black-throated Gray Warbler		MO (Pacific)	Yes
85	Townsend's Warbler			Yes
86	Hermit Warbler	Yes	MO (Pacific)	Yes
87	Macgillivray's Warbler			Yes
88	Wilson's Warbler			Yes
89	Yellow-breasted Chat			Yes
90	Western Tanager			Yes
91	Green-tailed Towhee		MO (Intermountain West)	Yes
92	Chipping Sparrow			Yes
93	Brewer's Sparrow	Yes	MA (Intermountain West)	Yes
94	Vesper Sparrow			Yes
95	Lark Sparrow			Yes
96	Black-throated Sparrow			Yes
97	Sage Sparrow	Yes	PR (Intermountain West)	Yes
98	Grasshopper Sparrow		MA (Prairies)	Yes
99	Fox Sparrow			Yes
10	Lincoln's Sparrow		PR (Northern Forests)	Yes
10	Harris's Sparrow	Yes	MA (Arctic, Northern Forests)	
10	Black-headed Grosbeak			Yes
10	Bobolink	Yes		
10	Tricolored Blackbird		MO (Pacific)	
10	Western Meadowlark			Yes

Appendix G. Partners in Flight listed species thought to occur in the Deschutes Subbasin.

No.	Common Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	OR PIF Priority & Focal Species
10	Bullock's Oriole			Yes
10	Black Rosy-finch		IM (Intermountain West)	
10	Purple Finch			Yes
10	Cassin's Finch		MA (Intermountain West)	
11	Red Crossbill			Yes
11	Lesser Goldfinch			Yes

Basic table supplied by IBIS, 2003.

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
1_1_1_13	Trophic relationships:	American Beaver	Open Water - Lakes, Rivers, and Streams
	Heterotrophic consumer:		
	Primary consumer (herbivore):		
	Bark/cambium/bole feeder		
1_1_1_13	Trophic relationships:	Black Bear	Alpine Grasslands and Shrublands
	Heterotrophic consumer:		Interior Grasslands
	Primary consumer (herbivore):		Dwarf Shrub-steppe
	Bark/cambium/bole feeder		
1_1_1_7	Trophic relationships:	Northern Pocket Gopher	Desert Playa and Salt Scrub Shrublands
	Heterotrophic consumer:		
	Primary consumer (herbivore):		
	Root feeders		
1_1_1_8	Trophic relationships:	Black-chinned Hummingbird	Shrub-steppe
	Heterotrophic consumer:		Dwarf Shrub-steppe
	Primary consumer (herbivore):		Desert Playa and Salt Scrub Shrublands
	Nectivore (nectar feeder)		
1_1_2_1_3	Trophic relationships:	Long-toed Salamander	Alpine Grasslands and Shrublands
	Heterotrophic consumer		Interior Canyon Shrublands
	Secondary consumer		
	Invertebrate eater		
	Freshwater or marine zooplankton		
1_1_2_1_3	Trophic relationships:	Rough-skinned	Ceanothus-Manzanita

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
	Heterotrophic consumer Secondary consumer Invertebrate eater Freshwater or marine zooplankton	Newt	Shrublands
	Heterotrophic consumer: Cannibalistic		Desert Playa and Salt Scrub Shrublands
1_1_6	Trophic relationships: Heterotrophic consumer: Coprophagous (feeds on fecal material)	American Pika	Alpine Grasslands and Shrublands
1_1_6	Trophic relationships: Heterotrophic consumer: Coprophagous (feeds on fecal material)	Brush Rabbit	Ceanothus-Manzanita Shrublands
1_1_6	Trophic relationships: Heterotrophic consumer: Coprophagous (feeds on fecal material)	Nuttall's (Mountain) Cottontail	Western Juniper and Mountain Mahogany Woodlands
1_1_6	Trophic relationships:	Snowshoe Hare	Lodgepole Pine Forest and Woodlands
	Heterotrophic consumer:		Ponderosa Pine & Interior White Oak Forest and Woodlands
	Coprophagous (feeds on fecal material)		Montane Coniferous Wetlands
1_1_7	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse	Mew Gull	Open Water - Lakes, Rivers, and Streams
1_1_7_1	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse: Aquatic (e.g. offal and bycatch of fishing boats)	Mew Gull	Open Water - Lakes, Rivers, and Streams
3_3	Organismal relationships: Pollination vector	Rufous Hummingbird	Alpine Grasslands and Shrublands
3_4_1	Organismal relationships: Transportation of viable seeds, spores, plants or animals: Disperses fungi	Deer Mouse	Ceanothus-Manzanita Shrublands
3_4_4	Organismal relationships:	Golden-mantled Ground Squirrel	Lodgepole Pine Forest and Woodlands

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
	Transportation of viable seeds, spores, plants or animals:		Ceanothus-Manzanita Shrublands
	Disperses insects and other invertebrates		Interior Canyon Shrublands
3_4_6	Organismal relationships:	Golden-mantled Ground Squirrel	Ceanothus-Manzanita Shrublands
	Transportation of viable seeds, spores, plants or animals:		Western Juniper and Mountain Mahogany Woodlands
	Disperses vascular plants		Interior Canyon Shrublands
3_5	Organismal relationships:	Great Blue Heron	Open Water - Lakes, Rivers, and Streams
	Creates feeding, roosting, denning, or nesting opportunities for other organisms		
3_5	Organismal relationships:	Grizzly Bear	Interior Grasslands
	Creates feeding, roosting, denning, or nesting opportunities for other organisms		
3_5	Organismal relationships:	Mountain Lion	Ceanothus-Manzanita Shrublands
	Creates feeding, roosting, denning, or nesting opportunities for other organisms		
3_5_1	Organismal relationships:	Great Blue Heron	Open Water - Lakes, Rivers, and Streams
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		
	Creates feeding opportunities (other than direct prey relations)		
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		
	Creates feeding opportunities (other than direct prey relations)		
3_5_1	Organismal relationships:	Mountain Lion	Ceanothus-Manzanita Shrublands
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		
	Creates feeding opportunities (other than direct prey relations)		
3_5_1_1	Organismal relationships:	Williamson's Sapsucker	Western Juniper and Mountain Mahogany Woodlands
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		Interior Canyon Shrublands

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
	Creates feeding opportunities:		
	Creates sapwells in trees		
3_5_1_1	Organismal relationships:	Red-breasted Sapsucker	Mesic Lowlands Conifer-Hardwood Forest
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		Southwest Oregon Mixed Conifer-Hardwood Forest
	Creates feeding opportunities:		
	Creates sapwells in trees		
3_5_2	Organismal relationships:	Great Blue Heron	Mesic Lowlands Conifer-Hardwood Forest
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		Open Water - Lakes, Rivers, and Streams
	Creates roosting, denning, or nesting opportunities		Herbaceous Wetlands
			Interior Riparian-Wetlands
3_5_2	Organismal relationships:	Red Squirrel	Montane Mixed Conifer Forest
	Creates feeding, roosting, denning, or nesting opportunities for other organisms:		Interior Mixed Conifer Forest
	Creates roosting, denning, or nesting opportunities		Lodgepole Pine Forest and Woodlands
			Ponderosa Pine & Interior White Oak Forest and Woodlands
3_6_2	Organismal relationships:	Dusky-footed Woodrat	Ceanothus-Manzanita Shrublands
	Primary creation of structures (possibly used by other organisms):		
	Ground structures		
3_6_2	Organismal relationships:	Bushy-tailed Woodrat	Montane Coniferous Wetlands
	Primary creation of structures (possibly used by other organisms):		Interior Riparian-Wetlands
	Ground structures		
3_6_3	Organismal relationships:	American Beaver	Mesic Lowlands Conifer-Hardwood Forest
	Primary creation of structures (possibly used by other organisms):		Southwest Oregon Mixed Conifer-Hardwood Forest
	Aquatic structures		Montane Mixed Conifer Forest
			Interior Mixed Conifer Forest
			Lodgepole Pine Forest and Woodlands

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
			Ponderosa Pine & Interior White Oak Forest and Woodlands
			Subalpine Parkland
			Western Juniper and Mountain Mahogany Woodlands
			Montane Coniferous Wetlands
3_7_1	Organismal relationships:	Black Tern	Open Water - Lakes, Rivers, and Streams
	User of structures created by other species:		
	Aerial structures		
3_7_1	Organismal relationships:	Great Horned Owl	Ceanothus-Manzanita Shrublands
	User of structures created by other species:		Desert Playa and Salt Scrub Shrublands
	Aerial structures		
3_7_2	Organismal relationships:	Deer Mouse	Alpine Grasslands and Shrublands
	User of structures created by other species:		Desert Playa and Salt Scrub Shrublands
	Ground structures		
3_7_3	Organismal relationships:	Fisher	Subalpine Parkland
	User of structures created by other species:		
	Aquatic structures		
3_7_3	Organismal relationships:	Mink	Lodgepole Pine Forest and Woodlands
	User of structures created by other species:		Ceanothus-Manzanita Shrublands
	Aquatic structures		Western Juniper and Mountain Mahogany Woodlands
			Interior Canyon Shrublands
			Interior Grasslands
			Shrub-steppe
			Desert Playa and Salt Scrub Shrublands
3_8_1	Organismal relationships:	Redhead	Open Water - Lakes, Rivers, and Streams
	Nest parasite:		
	Interspecies parasite		
3_8_1	Organismal relationships:	Brown-headed Cowbird	Mesic Lowlands Conifer-Hardwood Forest

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
	Nest parasite:		Southwest Oregon Mixed Conifer-Hardwood Forest
	Interspecies parasite		Montane Mixed Conifer Forest
			Interior Mixed Conifer Forest
			Lodgepole Pine Forest and Woodlands
			Ponderosa Pine & Interior White Oak Forest and Woodlands
			Subalpine Parkland
			Ceanothus-Manzanita Shrublands
			Western Juniper and Mountain Mahogany Woodlands
			Interior Canyon Shrublands
			Interior Grasslands
			Shrub-steppe
			Dwarf Shrub-steppe
			Desert Playa and Salt Scrub Shrublands
			Montane Coniferous Wetlands
3_8_2	Organismal relationships:	Greater Scaup	Open Water - Lakes, Rivers, and Streams
	Nest parasite:		
	Common interspecific host		
3_9	Organismal relationships:	Black Bear	Interior Grasslands
	Primary cavity excavator in snags or live trees		Dwarf Shrub-steppe
			Herbaceous Wetlands
4_2	Carrier, transmitter, or reservoir of vertebrate diseases:	Double-crested Cormorant	Open Water - Lakes, Rivers, and Streams
	Diseases that affect domestic animals		Herbaceous Wetlands
			Interior Riparian-Wetlands
4_3	Carrier, transmitter, or reservoir of vertebrate diseases:	Common Porcupine	Ceanothus-Manzanita Shrublands
	Diseases that affect other wildlife species		Montane Coniferous Wetlands
6_2	Wood structure relationships (either living or dead wood):	Black Bear	Alpine Grasslands and Shrublands
	Physically fragments standing wood		Dwarf Shrub-steppe

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
			Herbaceous Wetlands
7_1	Water relationships:	American Beaver	Mesic Lowlands Conifer-Hardwood Forest
	Impounds water by creating diversions or dams		Southwest Oregon Mixed Conifer-Hardwood Forest
			Montane Mixed Conifer Forest
			Interior Mixed Conifer Forest
			Lodgepole Pine Forest and Woodlands
			Ponderosa Pine & Interior White Oak Forest and Woodlands
			Subalpine Parkland
			Western Juniper and Mountain Mahogany Woodlands
			Open Water - Lakes, Rivers, and Streams
			Herbaceous Wetlands
			Montane Coniferous Wetlands
			Interior Riparian-Wetlands
7_2	Water relationships:	American Beaver	Southwest Oregon Mixed Conifer-Hardwood Forest
	Creates ponds or wetlands through wallowing		Open Water - Lakes, Rivers, and Streams
7_2	Water relationships:	Rocky Mountain Elk	Alpine Grasslands and Shrublands
	Creates ponds or wetlands through wallowing		Interior Canyon Shrublands
			Interior Grasslands
			Shrub-steppe
			Dwarf Shrub-steppe
8_1	Vegetation structure and composition relationships:	Black Bear	Alpine Grasslands and Shrublands
	Creates standing dead trees (snags)		Interior Grasslands
			Dwarf Shrub-steppe
	Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)		
8_3	Vegetation structure and composition relationships:	Canada Goose	Open Water - Lakes, Rivers, and Streams

Appendix H. Critical functional link species thought to occur in the Deschutes subbasin.

KEF* Code	KEF Description	Species Common Name	Wildlife-Habitat Type
	Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)		
8_3	Vegetation structure and composition relationships:	Rocky Mountain Elk	Mesic Lowlands Conifer-Hardwood Forest
	Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)		

Table supplied by NHI, 2004.
*Key Ecological Function

Appendix table I. Changes in acreages of wildlife habitats thought to occur historically (1860) and currently (1999) in Deschutes Subbasin Assessment Units.

ASSESSMENT UNIT/HABITAT ID AND DESCRIPTION	HIST ACRES	CURR ACRES	% CHANGE	ACRES CHANGE
CASCADE HIGHLANDS				
15. Eastside (interior) grasslands	1963.85	0.00	-100%	-1963.85
25. Eastside (interior) riparian wetlands	247.02	0.00	-100%	-247.02
13. Western juniper and mountain mahogany woodlands	494.03	0.00	-100%	-494.03
1. Mesic lowlands conifer-hardwood forest	11855.62	0.00	-100%	-11855.62
7. Ponderosa pine forest and woodlands	92226.92	18100.19	-80%	-74126.73
6. Lodgepole pine forest and woodlands	31870.05	6370.06	-80%	-25499.99
21. Open water - lakes, rivers, streams	27690.06	26757.11	-3%	-932.95
5. Eastside (interior) mixed conifer forest	25865.13	31984.14	24%	6119.01
10. Alpine grassland and shrublands	4136.47	5804.31	40%	1667.84
4. Montane mixed conifer forest	96883.45	192829.77	99%	95946.32
9. Subalpine parkland	2809.62	10252.80	265%	7443.18
22. Herbaceous wetlands	0.00	2947.99	#DIV/0!	2947.99
24. Montane coniferous wetlands	0.00	995.97	#DIV/0!	995.97
TOTAL ACRES CASCADE HIGHLANDS AU	296042.22	296042.34		
LOWER EASTSIDE DESCHUTES				
6. Lodgepole pine forest and woodlands	3353.23	0.00	-100%	-3353.23
15. Eastside (interior) grasslands	371137.92	150.98	-100%	-370986.94
25. Eastside (interior) riparian wetlands	401.64	41.84	-90%	-359.80
7. Ponderosa pine forest and woodlands	67896.20	47702.59	-30%	-20193.61
21. Open water - lakes, rivers, streams	1162.29	924.79	-20%	-237.50
16. Shrub-steppe	305061.13	429084.68	41%	124023.55
13. Western juniper and mountain mahogany woodlands	41164.60	177853.70	332%	136689.10

Appendix table I. Changes in acreages of wildlife habitats thought to occur historically (1860) and currently (1999) in Deschutes Subbasin Assessment Units.

ASSESSMENT UNIT/HABITAT ID AND DESCRIPTION	HIST ACRES	CURR ACRES	% CHANGE	ACRES CHANGE
5. Eastside (interior) mixed conifer forest	1481.98	26941.40	1718%	25459.42
19. Agriculture, pasture and mixed environs	0.00	71369.50	#DIV/0!	71369.50
14. Eastside (interior) canyon shrublands	0.00	34382.22	#DIV/0!	34382.22
22. Herbaceous wetlands	0.00	1081.51	#DIV/0!	1081.51
20. Urban and mixed environs	0.00	2126.02	#DIV/0!	2126.02
TOTAL ACRES LOWER EASTSIDE DESCHUTES ASSESSMENT UNIT	791658.99	791659.23		
LOWER CROOKED				
9. Subalpine parkland	1663.25	0.00	-100%	-1663.25
8. Upland Aspen forest	740.99	0.00	-100%	-740.99
15. Eastside (interior) grasslands	34592.84	125.97	-100%	-34466.87
6. Lodgepole pine forest and woodlands	84160.50	9019.54	-89%	-75140.96
13. Western juniper and mountain mahogany woodlands	388845.39	346629.64	-11%	-42215.75
7. Ponderosa pine forest and woodlands	124663.95	113520.54	-9%	-11143.41
16. Shrub-steppe	464796.99	428886.05	-8%	-35910.94
21. Open water - lakes, rivers, streams	1706.46	2609.15	53%	902.69
5. Eastside (interior) mixed conifer forest	15140.22	29950.91	98%	14810.69
22. Herbaceous wetlands	0.02	2019.94	10099600%	2019.92
19. Agriculture, pasture and mixed environs	0.00	94469.38	#DIV/0!	94469.38
18. Desert playa and salt scrub shrublands	0.00	57.58	#DIV/0!	57.58
17. Dwarf Shrub-steppe	0.00	85752.72	#DIV/0!	85752.72
25. Eastside (interior) riparian wetlands	0.00	774.08	#DIV/0!	774.08
4. Montane mixed conifer forest	0.00	87.38	#DIV/0!	87.38
20. Urban and mixed environs	0.00	2480.93	#DIV/0!	2480.93
TOTAL ACRES LOWER CROOKED AU	1116310.61	1116383.81		
LOWER WESTSIDE DESCHUTES				
18. Desert playa and salt scrub shrublands	1001.60	0.00	-100%	-1001.60
15. Eastside (interior) grasslands	99279.39	0.00	-100%	-99279.39
22. Herbaceous wetlands	11808.24	237.18	-98%	-11571.06
25. Eastside (interior) riparian wetlands	9244.58	499.13	-95%	-8745.45
1. Mesic lowlands conifer-hardwood forest	4831.69	334.12	-93%	-4497.57
10. Alpine grassland and shrublands	402.15	62.66	-84%	-339.49
6. Lodgepole pine forest and woodlands	6360.54	1700.99	-73%	-4659.55
7. Ponderosa pine forest and woodlands	227418.98	142177.79	-37%	-85241.19
16. Shrub-steppe	344183.95	370939.00	8%	26755.05
13. Western juniper and mountain mahogany woodlands	42244.98	53109.19	26%	10864.21
5. Eastside (interior) mixed conifer forest	94472.99	141490.65	50%	47017.66

Appendix table I. Changes in acreages of wildlife habitats thought to occur historically (1860) and currently (1999) in Deschutes Subbasin Assessment Units.

ASSESSMENT UNIT/HABITAT ID AND DESCRIPTION	HIST ACRES	CURR ACRES	% CHANGE	ACRES CHANGE
9. Subalpine parkland	963.51	1478.58	53%	515.07
4. Montane mixed conifer forest	21202.70	44340.97	109%	23138.27
21. Open water - lakes, rivers, streams	1017.15	5845.91	475%	4828.76
19. Agriculture, pasture and mixed environs	0.00	52138.81	#DIV/0!	52138.81
14. Eastside (interior) canyon shrublands	0.00	47616.57	#DIV/0!	47616.57
24. Montane coniferous wetlands	0.00	1776.91	#DIV/0!	1776.91
3. Southwest Oregon mixed conifer-hardwood forest	0.00	40.45	#DIV/0!	40.45
20. Urban and mixed environs	0.00	730.23	#DIV/0!	730.23
TOTAL ACRES LOWER WESTSIDE DESCHUTES AU	864432	864519.14		
MIDDLE DESCHUTES				
15. Eastside (interior) grasslands	15686.87	0.00	-100%	-15686.87
25. Eastside (interior) riparian wetlands	1222.44	3.51	-100%	-1218.93
1. Mesic lowlands conifer-hardwood forest	16391.91	819.58	-95%	-15572.33
21. Open water - lakes, rivers, streams	11840.95	4922.30	-58%	-6918.65
10. Alpine grassland and shrublands	5525.30	2578.28	-53%	-2947.02
6. Lodgepole pine forest and woodlands	22910.88	11836.64	-48%	-11074.24
7. Ponderosa pine forest and woodlands	307650.56	162117.70	-47%	-145532.86
22. Herbaceous wetlands	1481.97	1575.58	6%	93.61
16. Shrub-steppe	30569.86	36036.10	18%	5466.24
9. Subalpine parkland	14129.77	19684.16	39%	5554.39
13. Western juniper and mountain mahogany woodlands	37417.47	67250.01	80%	29832.54
5. Eastside (interior) mixed conifer forest	53226.54	106881.34	101%	53654.80
4. Montane mixed conifer forest	18235.08	112138.08	515%	93903.00
19. Agriculture, pasture and mixed environs	0.00	9066.93	#DIV/0!	9066.93
12. Ceanothus-manzanita shrublands	0.00	74.41	#DIV/0!	74.41
24. Montane coniferous wetlands	0.00	717.69	#DIV/0!	717.69
20. Urban and mixed environs	0.00	587.53	#DIV/0!	587.53
TOTAL ACRES MIDDLE DESCHUTES AU	536289.60	536289.84		
UPPER CROOKED				
6. Lodgepole pine forest and woodlands	17304.74	0.00	-100%	-17304.74
15. Eastside (interior) grasslands	60817.21	4287.48	-93%	-56529.73
16. Shrub-steppe	1017733.63	635409.07	-38%	-382324.56
7. Ponderosa pine forest and woodlands	453939.94	295382.72	-35%	-158557.22
25. Eastside (interior) riparian wetlands	8150.78	5591.18	-31%	-2559.60

Appendix table I. Changes in acreages of wildlife habitats thought to occur historically (1860) and currently (1999) in Deschutes Subbasin Assessment Units.

ASSESSMENT UNIT/HABITAT ID AND DESCRIPTION	HIST ACRES	CURR ACRES	% CHANGE	ACRES CHANGE
21. Open water - lakes, rivers, streams	5433.87	7343.16	35%	1909.29
13. Western juniper and mountain mahogany woodlands	179291.95	580551.59	224%	401259.64
5. Eastside (interior) mixed conifer forest	17388.46	128495.80	639%	111107.34
17. Dwarf Shrub-steppe	5681.08	42025.01	640%	36343.93
18. Desert playa and salt scrub shrublands	247.00	3166.75	1182%	2919.75
19. Agriculture, pasture and mixed environs	0.00	35773.18	#DIV/0!	35773.18
22. Herbaceous wetlands	0.00	25569.25	#DIV/0!	25569.25
4. Montane mixed conifer forest	0.00	2992.49	#DIV/0!	2992.49
TOTAL ACRES UPPER CROOKED AU	1765988.66	1766587.68		
UPPER DESCHUTES				
15.Eastside (interior) grasslands	36924.00	0.00	-100%	-36924.00
25. Eastside (interior) riparian wetlands	1976.33	309.39	-84%	-1666.94
21. Open water - lakes, rivers, streams	27205.35	8174.10	-70%	-19031.25
16. Shrub-steppe	51541.87	22183.95	-57%	-29357.92
6. Lodgepole pine forest and woodlands	359368.05	180282.48	-50%	-179085.57
7. Ponderosa pine forest and woodlands	479624.27	488853.53	2%	9229.26
9. Subalpine parkland	5531.42	6124.96	11%	593.54
13. Western juniper and mountain mahogany woodlands	100381.46	119662.78	19%	19281.32
5. Eastside (interior) mixed conifer forest	70568.06	124245.39	76%	53677.33
4. Montane mixed conifer forest	52867.35	144269.67	173%	91402.32
10. Alpine grassland and shrublands	1879.77	6022.71	220%	4142.94
19. Agriculture, pasture and mixed environs	0.00	39202.31	#DIV/0!	39202.31
12. Ceanothus-manzanita shrublands	0.00	2919.87	#DIV/0!	2919.87
22. Herbaceous wetlands	0.00	17601.51	#DIV/0!	17601.51
24. Montane coniferous wetlands	0.00	11936.06	#DIV/0!	11936.06
20. Urban and mixed environs	0.00	16079.66	#DIV/0!	16079.66
TOTAL ACRES UPPER DESCHUTES AU	1187868	1187868.37		
WHITE RIVER				
15. Eastside (interior) grasslands	3342.07	0.00	-100%	-3342.07
22. Herbaceous wetlands	6966.38	384.02	-94%	-6582.36
6. Lodgepole pine forest and woodlands	881.68	291.79	-67%	-589.89
7. Ponderosa pine forest and woodlands	98697.75	42277.17	-57%	-56420.58
16. Shrub-steppe	74043.03	47252.02	-36%	-26791.01
1. Mesic lowlands conifer-hardwood forest	1498.40	1080.71	-28%	-417.69
5. Eastside (interior) mixed conifer forest	67779.81	82914.74	22%	15134.93
10. Alpine grassland and shrublands	10.41	32.16	209%	21.75

Appendix table I. Changes in acreages of wildlife habitats thought to occur historically (1860) and currently (1999) in Deschutes Subbasin Assessment Units.

ASSESSMENT UNIT/HABITAT ID AND DESCRIPTION	HIST ACRES	CURR ACRES	% CHANGE	ACRES CHANGE
4. Montane mixed conifer forest	354.56	44148.78	12352%	43794.22
19. Agriculture, pasture and mixed environs	0.00	31538.27	#DIV/0!	31538.27
14. Eastside (interior) canyon shrublands	0.00	727.85	#DIV/0!	727.85
25. Eastside (interior) riparian wetlands	0.00	346.40	#DIV/0!	346.40
24. Montane coniferous wetlands	0.00	349.91	#DIV/0!	349.91
21. Open water - lakes, rivers, streams	0.00	1149.21	#DIV/0!	1149.21
3. Southwest Oregon mixed conifer-hardwood forest	0.00	107.13	#DIV/0!	107.13
9. Subalpine parkland	0.00	974.06	#DIV/0!	974.06
TOTAL ACRES WHITE RIVER ASSESSMENT UNIT	253574.22	253574.22		

Appendix Table J Acreages of focal habitats within winter ranges by assessment unit, from current habitats map.

Assessment Unit	Habitat	Acres
LOWER EASTSIDE DESCHUTES		16787.13
	Eastside (interior) grasslands	17.85
	Shrub-steppe	1166.37
	Ponderosa pine forest and woodlands	15602.91
LOWER CROOKED		133242.54
	Eastside (interior) grasslands	90.50
	Herbaceous wetlands	552.95
	Lodgepole pine forest and woodlands	1849.73
	Dwarf shrub-steppe	2998.25
	Ponderosa pine forest and woodlands	39761.49
	Shrub-steppe	87989.62
LOWER WESTSIDE DESCHUTES		2660.19
	Lodgepole pine forest and woodlands	163.71
	Ponderosa pine forest and woodlands	2496.48
MIDDLE DESCHUTES		86184.78
	Eastside (interior) riparian wetlands	0.21
	Herbaceous wetlands	262.77
	Lodgepole pine forest and woodlands	1340.06
	Shrub-steppe	17344.62
	Ponderosa pine forest and woodlands	67237.11
UPPER CROOKED		606500.76
	Eastside (interior) grasslands	2881.77
	Eastside (interior) riparian wetlands	3774.33
	Herbaceous wetlands	17128.71

Appendix Table J Acreages of focal habitats within winter ranges by assessment unit, from current habitats map.

Assessment Unit	Habitat	Acres
	Dwarf shrub-steppe	26005.35
	Ponderosa pine forest and woodlands	165167.09
	Shrub-steppe	391543.52
UPPER DESCHUTES		86050.20
	Eastside (interior) riparian wetlands	18.35
	Herbaceous wetlands	818.44
	Shrub-steppe	4005.91
	Lodgepole pine forest and woodlands	4858.71
	Ponderosa pine forest and woodlands	76348.79
WHITE RIVER		43994.73
	Herbaceous wetlands	274.54
	Lodgepole pine forest and woodlands	291.79
	Shrub-steppe	8389.87
	Ponderosa pine forest and woodlands	35038.53
Grand Total		975420.33

Appendix Table K. Acreages of Focal Habitats within ungulate winter ranges by Assessment Unit, from historic habitats map.

Assessment Unit	Habitat	Acres
LOWER EASTSIDE DESCHUTES		31701.25
	Eastside (interior) grasslands	343.98
	Lodgepole pine forest and woodlands	513.27
	Ponderosa pine forest and woodlands	28618.63
	Shrub-steppe	2225.37
LOWER CROOKED		158718.01
	Eastside (interior) grasslands	9024.25
	Lodgepole pine forest and woodlands	17818.55
	Ponderosa pine forest and woodlands	68082.58
	Shrub-steppe	63413.31
	Upland aspen forest	379.32
LOWER WESTSIDE DESCHUTES		6283.21
	Ponderosa pine forest and woodlands	6234.61
	Shrub-steppe	48.60
MIDDLE DESCHUTES		125161.20
	Eastside (interior) grasslands	10054.64
	Herbaceous wetlands	347.88
	Ponderosa pine forest and woodlands	97895.72

Appendix Table K. Acreages of Focal Habitats within ungulate winter ranges by Assessment Unit, from historic habitats map.		
Assessment Unit	Habitat	Acres
	Shrub-steppe	16862.97
UPPER CROOKED		1013300.64
	Dwarf shrub-steppe	4392.74
	Eastside (interior) grasslands	40038.43
	Eastside (interior) riparian wetlands	7703.15
	Lodgepole pine forest and woodlands	16795.76
	Ponderosa pine forest and woodlands	260570.43
	Shrub-steppe	683800.13
UPPER DESCHUTES		111957.99
	Eastside (interior) grasslands	10174.46
	Lodgepole pine forest and woodlands	19768.44
	Ponderosa pine forest and woodlands	74078.16
	Shrub-steppe	7936.93
WHITE RIVER		102894.29
	Eastside (interior) grasslands	594.66
	Herbaceous wetlands	299.15
	Lodgepole pine forest and woodlands	633.38
	Ponderosa pine forest and woodlands	91230.40
	Shrub-steppe	10136.70
Grand Total		1550016.59

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.		
Species/KEC Description	Optimal Conditions[1]	Environmental Potential
Columbia Spotted Frog		
exotic species	No exotic species should be present. Exotic bullfrog, bass, brown, brook trout may prey on frogs.	High
beaver/muskrat activity (dams, lodges, ponds) (Positive only)	Beaver ponds and channels are used as habitat.	High
water depth	Sufficient depth to be permanent optimal, but shallow ephemeral edges also used for reproduction.	High
Channel changes	Permanent unchanging channel	High

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.		
Species/KEC Description	Optimal Conditions[1]	Environmental Potential
	optimal.	
water velocity	Ponded, slow-moving, or slack water optimal.	High
rivers & streams	Oxbows, backwaters used.	High
banks	Vegetated, undercut banks used for winter hibernation.	High
emergent vegetation	Eggs deposited among emergent vegetation.	High
ephemeral pools	Used as refuge during movement from wintering to breeding sites.	Low
lakes/ponds/reservoirs	Reservoirs not used.	
sand/mud	Soft muck bottom used for hibernation	High
floating mats	Required.	High
riverine wetlands	Larger areas of pooled or slack water used.	High
seasonal flooding	Seasonally flooded edges of permanent water areas used for reproduction.	High
toxic chemical use (indicate only documented affects)	Unknown.	
pesticides	Unknown	
hatchery facilities and fish	Stocked exotic fish are thought to impact frog populations.	High
Golden Eagle		
Forest, Shrubland, & Grassland Habitat Elements		
forest/woodland vegetative elements or substrates	Cliff sites are used for nesting.	High
snag size (dbh)	Large trees or snags greater than 30 in dbh may be used for nesting.	Low
giant tree >= 30” dbh	Large trees or snags greater than 30 in dbh may be used for nesting.	Low
shrubland/grassland vegetative elements or substrates	Cliff sites are used for nesting.	High
trees (located in a shrubland/grassland context)	Large trees or snags may be used for nesting	Low
Ecological Habitat Elements		

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.

Species/KEC Description	Optimal Conditions[1]	Environmental Potential
exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)	No information.	Low
exotic plants	No information.	Low
Non-vegetative, Abiotic Habitat Elements	No information.	
cliffs	Used for nesting	High
rocky outcrops and ridges	Used for nesting	High
rock crevices	Used for nesting	High
Freshwater Riparian & Aquatic Bodies Habitat Elements		
seasonal flooding		
Anthropogenic-related Habitat Elements		
toxic chemical use (indicate only documented affects)	Birds are poisoned by chemicals used for other pests. No chemicals is optimal.	High
pesticides	Birds are poisoned by chemicals used for other pests. No chemicals is optimal.	High
powerlines/corridors	Will sometimes build nests on power poles, or perch on power poles. Electrocution of birds a source of mortality. No power lines is optimal.	High
harvest/persecution (of animals) (includes legal and illegal harvest, and incidental take)	Birds are sometimes killed. No illegal take is optimal.	High
Sage Grouse		
Forest, Shrubland, & Grassland Habitat Elements		
shrubland/grassland vegetative elements or substrates		
herbaceous layer	Full range of native herbaceous plants is optimal.	High
grasses	Full range of native grasses is optimal, nest areas were found to have a greater cover of grasses more than 7 in tall.	High

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.		
Species/KEC Description	Optimal Conditions[1]	Environmental Potential
flowers	Full range of native herbaceous plants is optimal.	High
shrub size (height)	Tall sagebrush stands are optimal.	High
percent shrub canopy cover	No information.	
forbs	Full range of native herbaceous plants is optimal.	High
Ecological Habitat Elements		
exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)	No exotic species present is optimal. Grazing removes needed grasses and other food and cover plants.	High
exotic plants	May displace native plants and affect fire periodocity; no exotic plants optimal.	High
habitat structure change	Tall sage and native grasses and forbs mix is optimal.	Jogj
Fire as a Habitat Element	Fire periodicity which maintains tall sage habitat with openings is optimal.	High
Anthropogenic-related Habitat Elements		
guzzlers and waterholes	No information.	
toxic chemical use (indicate only documented affects)	No information	
herbicides/fungicides	No herbicides is optimal; herbicides are used to eradicate big sage and other needed plants.	High
insecticides	No information	
powerlines/corridors	No information	
roads	No roads is optimal; roads fragment habitat areas.	High
Sharp-tailed Grouse		
shrub layer	Shrubs such as sage in mosaic pattern in grasslands optimal.	High
shrubland/grassland vegetative elements or substrates	Bunchgrasses minimum 20cm high optimal for nesting, brood rearing	High
herbaceous layer	Native herbaceous weeds optimal.	High
grasses	Bunchgrasses preferred over sod grasses	High

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.

Species/KEC Description	Optimal Conditions[1]	Environmental Potential
edges	Mosaic pattern of shrublands, grasslands, riparian brushy habitats, and woodland edges are optimal.	High
exotic plants	Cheatgrass, thistle, and other exotic weeds may displace native plants. No exotics is optimal.	Low
exotic animals	Grazing degrades habitat by removing tall grasses needed for nesting and refuge, and by removing riparian brush needed for feeding and resting cover. Other exotic animals such as foxes prey on eggs or adults. Introduced exotic birds such as pheasant may communicate diseases.	High
habitat structure change	Permanent grass structure for nesting is optimal.	High
Freshwater Riparian & Aquatic Bodies Habitat Elements	Streams with riparian vegetation such as hawthorn, aspen, willow, are optimal.	High
rivers & streams	Stream and river brushy riparian zones optimal	High
seeps or springs	Brushy riparian zones around springs are optimal	High
Fire as a Habitat Element	Periodic fire if maintains grassland and brush areas is optimal.	High
Anthropogenic-related Habitat Elements		
toxic chemical use (indicate only documented affects)	No information.	
hedgerows/windbreaks	If natural patches of shrubs or riparian brushy areas are not available, planted areas would be optimal.	Low
powerlines/corridors	No information.	
roads	Roads fragment habitat, so low number of roads is optimal.	Low
White-headed Woodpecker		
forest/woodland vegetative elements or substrates	Open pine forests of two species of pine mixed with large ponderosa pine is optimal.	High

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.		
Species/KEC Description	Optimal Conditions[1]	Environmental Potential
trees	Large diameter ponderosa pine in open woodland condition is optimal.	High
snags	Large diameter snags with hard outer wood and soft heartwood optimal for nesting.	High
snag size (dbh)	Large-diameter snags optimal.	High
tree size (dbh)	Nest trees in the Deschutes NF mean dbh 25.6 inches.	High
fruits/seeds/nuts	Ponderosa pine seeds needed for food.	High
insect population irruptions (specify whether negative or positive relationship in comments)	Insects are needed as food.	Low
Fire as a Habitat Element	Fire is needed to maintain open pine forests which are optimal for nesting.	High
American Beaver		
trees	Aspen, cottonwood, alder are preferred for food.	High
shrubland/grassland vegetative elements or substrates	Herbaceous plants used for food.	High
shrubs	Willow, alder are preferred food items.	High
water characteristics (specify whether negative or positive relationship in comments)	Permanent water of stable water level and sufficient depth and area for refuge. Reservoirs are not suitable.	High
water velocity	Fast-flowing upper tributaries of gradient more than 15 percent are not suitable.	High
rivers & streams	Gradient less than 6 percent, with wide banks optimal, with minimal water level fluctuation.	High
intermittent	Not suitable for habitat.	Low
upper perennial	Fast-flowing upper tribs in v-shaped canyons not suitable habitat, but necessary to provide lower-area perennial water habitat.	High
open water	Protected open water needed for refuge.	Low

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.

Species/KEC Description	Optimal Conditions[1]	Environmental Potential
shoreline	Large lakes must have irregular shoreline with bays and coves.	Low
lakes/ponds/reservoirs	Reservoirs usually not suitable due to water level fluctuation.	Low
ponds (<2ha)	Suitable if forage available.	Low
wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)	Permanent open water with forage available optimal.	High
Anthropogenic-related Habitat Elements	Agricultural areas not suitable habitat: clearing of riparian vegetation and conflicts with damming and cutting trees.	High
repellents	Used to prevent beaver damage.	Low
chemical (taste or smell)	No information.	
irrigation ditches/canals	Conflicts with beaver habitat.	Low
pollution	No information.	
chemical	No information.	
sewage	No information.	
Mule Deer		
Forest, Shrubland, & Grassland Habitat Elements	All habitats used.	
forest/woodland vegetative elements or substrates	Wide variety and high quality browse optimal.	Low
herbaceous layer	Vigorous, healthy plants optimal	Low
edges	Mosaic of vegetation and habitats optimal	Low
shrub layer	Vigorous, healthy plants optimal	Low
forbs	Vigorous, healthy plants optimal	Low
shrubland/grassland vegetative elements or substrates	Wide vegetative variety and high quality browse optimal.	Low
Ecological Habitat Elements		
exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)	No competition from other ungulates is optimal.	Low
exotic animals		
predation	Low or no numbers of predators such as coyote and cougar is optimal.	Low
direct displacement	No displacement by cattle, elk, or	Low

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.

Species/KEC Description	Optimal Conditions[1]	Environmental Potential
	other grazing animals is optimal	
habitat structure change		
insect population irruptions (specify whether negative or positive relationship in comments)	May be beneficial if growth of shrubs, forbs, and grasses on the exposed forest floor is initiated.	High
mountain pine beetle	May be beneficial if growth of shrubs, forbs, and grasses on the exposed forest floor is initiated.	High
Non-vegetative, Abiotic Habitat Elements		
snow	Short time of snow and frequent snow cover is optimal, since plants will be adequately watered for greenup but not covered so they are not available to deer.	Low
snow depth (specify whether negative or positive relationship in comments)	Shallow depth and frequent snow during the precipitation season is optimal.	Low
Freshwater Riparian & Aquatic Bodies Habitat Elements		
water characteristics (specify whether negative or positive relationship in comments)	Free water throughout the habitat is optimal.	High
free water (derived from any source)	Free water availability is optimal.	High
wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)	No information.	
context		
forest		
non-forest		
Fire as a Habitat Element	Periodic fires in a mosaic pattern is optimal to rejuvenate brush and other vegetation for high quality forage.	High
Anthropogenic-related Habitat Elements		
guzzlers and waterholes	May improve habitat where natural free water is not available.	High
repellents	If repellent is effective in solving deer damage complaints, it would be considered optimal since deer would not have to be removed from the	Low

Appendix Table L. Optimal conditions and environmental potential for Key Environmental Correlates (KECs) for focal species.

Species/KEC Description	Optimal Conditions[1]	Environmental Potential
	damaged area	
chemical (taste or smell)	No unnatural taste or smell is optimal, since food items are chosen by deer partly on the basis of taste and smell.	Low
irrigation ditches/canals	No barriers in habitat is optimal. If t fencing presen to prevent drowning of deer, with overpass bridges is optimal. Water presence is beneficial.	Low
roads	No barriers in habitat is optimal. If present, underpasses or overpasses with fences to prevent deer-vehicle collisions is optimal. Access roads on winter ranges closed in winter optimal.	High
harvest/persecution (of animals) (includes legal and illegal harvest, and incidental take)	Well-regulated hunting seasons with no illegal harvest is optimal. If illegal harvest occurs, consideration along with legal harvest when setting harvest levels is optimal.	High
fences/corrals	No barriers in habitat is optimal.	High
supplemental food	No supplemental food is optimal.	Low

Table supplied by NHI, 2004.

[1] optimal conditions are taken from species accounts.

Appendix Table M. Key ecological functions (KEFs) for focal species, sorted to show redundancy.

Common Name	SHP-KEF*	KEF Description
Columbia Spotted Frog	1	Trophic relationships
American Beaver	1	Trophic relationships
Columbia Spotted Frog	1.1	heterotrophic consumer
American Beaver	1.1	heterotrophic consumer
Columbia Spotted Frog	1.1.1	primary consumer (herbivore) (also see below under Herbivory)
American Beaver	1.1.1	primary consumer (herbivore) (also see below under Herbivory)

Appendix Table M. Key ecological functions (KEFs) for focal species, sorted to show redundancy.

Common Name	SHP-KEF*	KEF Description
Sage Grouse	1.1.1.1	foliovore (leaf-eater)
Sharp-tailed Grouse	1.1.1.1	foliovore (leaf-eater)
American Beaver	1.1.1.1	foliovore (leaf-eater)
Mule Deer	1.1.1.1	foliovore (leaf-eater)
Sage Grouse	1.1.1.10	flower/bud/catkin feeder
Sharp-tailed Grouse	1.1.1.10	flower/bud/catkin feeder
Columbia Spotted Frog	1.1.1.11	aquatic herbivore
American Beaver	1.1.1.11	aquatic herbivore
Columbia Spotted Frog	1.1.1.12	feeds in water on decomposing benthic substrate
American Beaver	1.1.1.13	bark/cambium/bole feeder
Sharp-tailed Grouse	1.1.1.2	spermivore (seed-eater)
White-headed Woodpecker	1.1.1.2	spermivore (seed-eater)
American Beaver	1.1.1.3	browser (leaf, stem eater)
Mule Deer	1.1.1.3	browser (leaf, stem eater)
Mule Deer	1.1.1.4	grazer (grass, forb eater)
Sage Grouse	1.1.1.5	frugivore (fruit-eater)
Sharp-tailed Grouse	1.1.1.5	frugivore (fruit-eater)
Mule Deer	1.1.1.9	fungivore (fungus feeder)
Columbia Spotted Frog	1.1.2	secondary consumer (primary predator or primary carnivore)
Columbia Spotted Frog	1.1.2.1	invertebrate eater
Columbia Spotted Frog	1.1.2.1.1	terrestrial invertebrates
Golden Eagle	1.1.2.1.1	terrestrial invertebrates
Sage Grouse	1.1.2.1.1	terrestrial invertebrates
Sharp-tailed Grouse	1.1.2.1.1	terrestrial invertebrates
White-headed Woodpecker	1.1.2.1.1	terrestrial invertebrates
Columbia Spotted Frog	1.1.2.1.2	aquatic macroinvertebrates
Golden Eagle	1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
Golden Eagle	1.1.4	carrion feeder
Columbia Spotted Frog	1.2	prey relationships
American Beaver	1.2	prey relationships
Columbia Spotted Frog	1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)
Sage Grouse	1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)

Appendix Table M. Key ecological functions (KEFs) for focal species, sorted to show redundancy.

Common Name	SHP-KEF*	KEF Description
Sharp-tailed Grouse	1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)
American Beaver	1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)
Mule Deer	1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)
Columbia Spotted Frog	2	aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
American Beaver	2	aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
Golden Eagle	3	organismal relationships
Sharp-tailed Grouse	3	organismal relationships
White-headed Woodpecker	3	organismal relationships
American Beaver	3	organismal relationships
Mule Deer	3	organismal relationships
American Beaver	3.11	primary burrow excavator (fossorial or underground burrows)
American Beaver	3.11.1	creates large burrows (rabbit-sized or larger)
American Beaver	3.13	creates runways (possibly used by other species)
Mule Deer	3.13	creates runways (possibly used by other species)
Mule Deer	3.14	uses runways created by other species)
Mule Deer	3.16	interspecific hybridization
Golden Eagle	3.2	controls terrestrial vertebrate populations (through predation or displacement)
American Beaver	3.4	transportation ofviable seeds, spores, plants or animals
Sharp-tailed Grouse	3.4.5	disperses seeds/fruits (through ingestion or caching)
White-headed Woodpecker	3.4.5	disperses seeds/fruits (through ingestion or caching)
American Beaver	3.6	primary creation of structures (possibly used by other organisms)
Golden Eagle	3.6.1	aerial structures
American Beaver	3.6.3	aquatic structures

Appendix Table M. Key ecological functions (KEFs) for focal species, sorted to show redundancy.

Common Name	SHP-KEF*	KEF Description
White-headed Woodpecker	3.9	primary cavity excavator in snags or live trees
Sage Grouse	4	carrier, transmitter, or reservoir of vertebrate diseases
Sharp-tailed Grouse	4	carrier, transmitter, or reservoir of vertebrate diseases
Sage Grouse	4.3	diseases that affect other wildlife species
Sharp-tailed Grouse	4.3	diseases that affect other wildlife species
American Beaver	5	soil relationships
American Beaver	5.1	physically affects (improves) soil structure, aeration (typically by digging)
White-headed Woodpecker	6	wood structure relationships (either living or dead wood)
Mule Deer	6	wood structure relationships (either living or dead wood)
White-headed Woodpecker	6.1	physically fragments down wood
Mule Deer	6.1	physically fragments down wood
White-headed Woodpecker	6.2	physically fragments standing wood
American Beaver	7	water relationships
American Beaver	7.1	impounds water by creating diversions or dams
American Beaver	7.2	creates ponds or wetlands through wallowing
American Beaver	8	vegetation structure and composition relationships
American Beaver	8.1	creates standing dead trees (snags)
Mule Deer	8.2	herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
Mule Deer	8.3	herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)

Table supplied by NHI, 2004.
*hierarchical number assigned from the table of KEF definitions.

Appendix Table N. KECs sorted to show interspecific relationships.	
Common Name	KEC_Description
Columbia Spotted Frog	Anthropogenic-related Habitat Elements
Golden Eagle	Anthropogenic-related Habitat Elements
Sage Grouse	Anthropogenic-related Habitat Elements
Sharp-tailed Grouse	Anthropogenic-related Habitat Elements
American Beaver	Anthropogenic-related Habitat Elements
Mule Deer	Anthropogenic-related Habitat Elements
Columbia Spotted Frog	banks
American Beaver	banks
Columbia Spotted Frog	beaver/muskrat activity (dams, lodges, ponds) (Positive only)
American Beaver	beaver/muskrat activity (dams, lodges, ponds) (Positive only)
American Beaver	chemical
American Beaver	chemical (taste or smell)
Mule Deer	chemical (taste or smell)
Golden Eagle	cliffs
American Beaver	coarse woody debris in streams and rivers
American Beaver	context
Mule Deer	context
White-headed Woodpecker	decay class
Columbia Spotted Frog	direct displacement
Mule Deer	direct displacement
Mule Deer	down wood (includes downed logs, branches, and rootwads, in any context)
Columbia Spotted Frog	Ecological Habitat Elements
Golden Eagle	Ecological Habitat Elements
Sage Grouse	Ecological Habitat Elements
Sharp-tailed Grouse	Ecological Habitat Elements
White-headed Woodpecker	Ecological Habitat Elements
American Beaver	Ecological Habitat Elements
Mule Deer	Ecological Habitat Elements

Appendix Table N. KECs sorted to show interspecific relationships.	
Common Name	KEC_Description
Golden Eagle	edges
Sharp-tailed Grouse	edges
Sharp-tailed Grouse	edges
American Beaver	edges
Mule Deer	edges
Mule Deer	edges
Columbia Spotted Frog	emergent vegetation
Columbia Spotted Frog	emergent vegetation
Columbia Spotted Frog	ephemeral pools
American Beaver	ephemeral pools
Columbia Spotted Frog	exotic animals
Sage Grouse	exotic animals
Sharp-tailed Grouse	exotic animals
Mule Deer	exotic animals
Golden Eagle	exotic plants
Sage Grouse	exotic plants
Sharp-tailed Grouse	exotic plants
Columbia Spotted Frog	exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)
Golden Eagle	exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)
Sage Grouse	exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)
Sharp-tailed Grouse	exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)
Mule Deer	exotic species (specify whether the species is negatively or positively influenced by the presence of introduced plants or animals)
Mule Deer	fences/corrals
Sage Grouse	Fire as a Habitat Element
Sharp-tailed Grouse	Fire as a Habitat Element
White-headed Woodpecker	Fire as a Habitat Element
Mule Deer	Fire as a Habitat Element
Columbia Spotted Frog	floating mats

Appendix Table N. KECs sorted to show interspecific relationships.

Common Name	KEC_Description
Sage Grouse	flowers
Sharp-tailed Grouse	flowers
Sage Grouse	forbs
Sharp-tailed Grouse	forbs
Mule Deer	forbs
Mule Deer	forbs
American Beaver	forest
Mule Deer	forest
Golden Eagle	Forest, Shrubland, & Grassland Habitat Elements
Sage Grouse	Forest, Shrubland, & Grassland Habitat Elements
Sharp-tailed Grouse	Forest, Shrubland, & Grassland Habitat Elements
White-headed Woodpecker	Forest, Shrubland, & Grassland Habitat Elements
American Beaver	Forest, Shrubland, & Grassland Habitat Elements
Mule Deer	Forest, Shrubland, & Grassland Habitat Elements
Golden Eagle	forest/woodland vegetative elements or substrates
Sharp-tailed Grouse	forest/woodland vegetative elements or substrates
White-headed Woodpecker	forest/woodland vegetative elements or substrates
American Beaver	forest/woodland vegetative elements or substrates
Mule Deer	forest/woodland vegetative elements or substrates
American Beaver	free water (derived from any source)
Mule Deer	free water (derived from any source)
Columbia Spotted Frog	Freshwater Riparian & Aquatic Bodies Habitat Elements
Golden Eagle	Freshwater Riparian & Aquatic Bodies Habitat Elements
Sharp-tailed Grouse	Freshwater Riparian & Aquatic Bodies Habitat Elements
American Beaver	Freshwater Riparian & Aquatic Bodies Habitat Elements
Mule Deer	Freshwater Riparian & Aquatic Bodies Habitat Elements
White-headed Woodpecker	fruits/seeds/nuts

Appendix Table N. KECs sorted to show interspecific relationships.	
Common Name	KEC_Description
Golden Eagle	giant tree >= 30” dbh
Golden Eagle	giant tree >= 30” dbh
Golden Eagle	giant tree >= 30” dbh
Golden Eagle	giant tree >= 30” dbh
White-headed Woodpecker	giant tree >= 30” dbh
White-headed Woodpecker	giant tree >= 30” dbh
American Beaver	giant tree >= 30” dbh
American Beaver	giant tree >= 30” dbh
Sage Grouse	grasses
Sharp-tailed Grouse	grasses
Sage Grouse	guzzlers and waterholes
Mule Deer	guzzlers and waterholes
Columbia Spotted Frog	habitat structure change
Sage Grouse	habitat structure change
Sharp-tailed Grouse	habitat structure change
Mule Deer	habitat structure change
Golden Eagle	harvest/persecution (of animals) (includes legal and illegal harvest, and incidental take)
Mule Deer	harvest/persecution (of animals) (includes legal and illegal harvest, and incidental take)
Columbia Spotted Frog	hatchery facilities and fish
Sharp-tailed Grouse	hedgerows/windbreaks
Sage Grouse	herbaceous layer
Sharp-tailed Grouse	herbaceous layer
Mule Deer	herbaceous layer
Mule Deer	herbaceous layer
Sage Grouse	herbicides/fungicides
White-headed Woodpecker	insect population irruptions (specify whether negative or positive relationship in comments)
Mule Deer	insect population irruptions (specify whether negative or positive relationship in comments)
Sage Grouse	insecticides
Sharp-tailed Grouse	insecticides
American Beaver	intermittent
Columbia Spotted Frog	in-water substrate
American Beaver	irrigation ditches/canals
Mule Deer	irrigation ditches/canals
Columbia Spotted Frog	lakes/ponds/reservoirs

Appendix Table N. KECs sorted to show interspecific relationships.

Common Name	KEC_Description
American Beaver	lakes/ponds/reservoirs
American Beaver	large – 6.6’ – 16.5’
Golden Eagle	large tree 20-29” dbh
Golden Eagle	large tree 20-29” dbh
Golden Eagle	large tree 20-29” dbh
Golden Eagle	large tree 20-29” dbh
White-headed Woodpecker	large tree 20-29” dbh
White-headed Woodpecker	large tree 20-29” dbh
American Beaver	large tree 20-29” dbh
Golden Eagle	live remnant/legacy trees
White-headed Woodpecker	live remnant/legacy trees
American Beaver	lower perennial
Sage Grouse	medium – 20”- 6.5’
American Beaver	medium – 20”- 6.5’
Golden Eagle	medium tree 15-19” dbh
Golden Eagle	medium tree 15-19” dbh
Golden Eagle	medium tree 15-19” dbh
Golden Eagle	medium tree 15-19” dbh
White-headed Woodpecker	medium tree 15-19” dbh
White-headed Woodpecker	medium tree 15-19” dbh
American Beaver	medium tree 15-19” dbh
American Beaver	medium tree 15-19” dbh
White-headed Woodpecker	moderate [class 3]
Mule Deer	mountain pine beetle
American Beaver	non-forest
Mule Deer	non-forest
Golden Eagle	Non-vegetative, Abiotic Habitat Elements
Mule Deer	Non-vegetative, Abiotic Habitat Elements
American Beaver	open water
American Beaver	open water
American Beaver	order and class
Columbia Spotted Frog	oxbows
American Beaver	oxbows
Sage Grouse	percent shrub canopy cover
Columbia Spotted Frog	pesticides
Golden Eagle	pesticides

Appendix Table N. KECs sorted to show interspecific relationships.

Common Name	KEC_Description
Sharp-tailed Grouse	pesticides
American Beaver	pollution
American Beaver	ponds (<2ha)
American Beaver	pools
Golden Eagle	powerlines/corridors
Sage Grouse	powerlines/corridors
Sharp-tailed Grouse	powerlines/corridors
Columbia Spotted Frog	predation
Mule Deer	predation
American Beaver	repellents
Mule Deer	repellents
Columbia Spotted Frog	riverine wetlands
American Beaver	riverine wetlands
Columbia Spotted Frog	rivers & streams
Sharp-tailed Grouse	rivers & streams
American Beaver	rivers & streams
Sage Grouse	roads
Sharp-tailed Grouse	roads
Mule Deer	roads
Golden Eagle	rock crevices
Golden Eagle	rock substrates
Golden Eagle	rocky outcrops and ridges
Columbia Spotted Frog	sand/mud
American Beaver	sapling/pole 1-9” dbh
American Beaver	sapling/pole 1-9” dbh
Columbia Spotted Frog	seasonal flooding
Golden Eagle	seasonal flooding
American Beaver	seedling <1” dbh
American Beaver	seedling <1” dbh
Sharp-tailed Grouse	seeps or springs
American Beaver	sewage
American Beaver	shoreline
American Beaver	shoreline
Sharp-tailed Grouse	shrub layer
Mule Deer	shrub layer
Sage Grouse	shrub size (height)
American Beaver	shrub size (height)
Golden Eagle	shrubland/grassland vegetative elements or substrates
Sage Grouse	shrubland/grassland vegetative elements or substrates
Sharp-tailed Grouse	shrubland/grassland vegetative elements or substrates

Appendix Table N. KECs sorted to show interspecific relationships.

Common Name	KEC_Description
American Beaver	shrubland/grassland vegetative elements or substrates
Mule Deer	shrubland/grassland vegetative elements or substrates
Golden Eagle	shrubs
Sage Grouse	shrubs
American Beaver	shrubs
Mule Deer	shrubs
American Beaver	size
Sage Grouse	small - <20”
American Beaver	small - <20”
American Beaver	small tree 10-14” dbh
American Beaver	small tree 10-14” dbh
Golden Eagle	snag size (dbh)
Golden Eagle	snag size (dbh)
White-headed Woodpecker	snag size (dbh)
American Beaver	snag size (dbh)
Golden Eagle	snags
White-headed Woodpecker	snags
Mule Deer	snow
Mule Deer	snow depth (specify whether negative or positive relationship in comments)
White-headed Woodpecker	spruce budworm
Columbia Spotted Frog	submergent vegetation
Columbia Spotted Frog	submergent vegetation
Mule Deer	supplemental food
Columbia Spotted Frog	toxic chemical use (indicate only documented affects)
Golden Eagle	toxic chemical use (indicate only documented affects)
Sage Grouse	toxic chemical use (indicate only documented affects)
Sharp-tailed Grouse	toxic chemical use (indicate only documented affects)
Golden Eagle	tree size (dbh)
Golden Eagle	tree size (dbh)
White-headed Woodpecker	tree size (dbh)
American Beaver	tree size (dbh)
Golden Eagle	trees

Appendix Table N. KECs sorted to show interspecific relationships.	
Common Name	KEC_Description
White-headed Woodpecker	trees
American Beaver	trees
Golden Eagle	trees (located in a shrubland/grassland context)
American Beaver	upper perennial
Columbia Spotted Frog	vegetation
Columbia Spotted Frog	vegetation
Columbia Spotted Frog	water characteristics (specify whether negative or positive relationship in comments)
American Beaver	water characteristics (specify whether negative or positive relationship in comments)
Mule Deer	water characteristics (specify whether negative or positive relationship in comments)
Columbia Spotted Frog	water depth
American Beaver	water depth
Columbia Spotted Frog	water velocity
American Beaver	water velocity
Columbia Spotted Frog	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
American Beaver	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
Mule Deer	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
American Beaver	zone
American Beaver	zone

Table supplied by NHI, 2004.

Appendix

Maps