Imnaha Subbasin Assessment

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1.1 Subbasin Overview

1.1.1 General Description

1.1.1.1 Location

The Imnaha subbasin is located in the farthest northeastern corner of Oregon (45˚ Latitude, 117˚ Longitude) near the center of the Columbia Basin. The Columbia Basin has been divided into 11 provinces by the Northwest Power and Conservation Council (NPCC, formerly the Northwest Power Planning Council or NPPC) to aid in the subbasin planning process. The grouping of subbasins into provinces was based on physical similarities among subbasins. The Imnaha subbasin is one of four subbasins in the Blue Mountain Province; it is bordered to the west by the Grande Ronde subbasin, to the east by the Snake Hells Canyon subbasin, and to the north by the Asotin subbasin (Figure 1).

Like the Grande Ronde, the Imnaha River flows in a northerly direction and is a direct tributary to the Snake River. The entire drainage is contained in U.S. Geological Survey (USGS) 4^{th} field hydrologic unit code (HUC) 17060102 and joins the Snake River at river mile (RM) 191.7, approximately 48 river miles upstream of Lewiston, Idaho, and 3.4 miles upstream of the Salmon River confluence. The headwaters of the Imnaha River drain the eastern escarpment of the Wallowa Mountains and originate within the Eagle Cap Wilderness. At lower elevations, the Imnaha obtains flow from streams draining an adjacent plateau, which is located between the Wallowa River drainage to the west and Hells Canyon of the Snake River to the east (Kucera 1989). Ninety-eight percent of the subbasin lies within Wallowa County, with the remaining 2% split between Baker and Union counties. The subbasin is sparsely populated and contains only the small town of Imnaha (population 25) within its boundaries (Figure 2).

1.1.1.2 Size

The Imnaha subbasin drains an area of 850 square miles (2,202 square kilometers or 549,600 acres). It is one of the smallest subbasins; of the 62 subbasins delineated by the NPCC for use in subbasin planning, 16 are smaller and 45 are larger. When compared with the other three subbasins within the Blue Mountain Province, the Imnaha subbasin ranks third in size since it is significantly smaller than the Grande Ronde subbasin (roughly 4,000 square miles), slightly smaller than the Snake Hells Canyon subbasin (924 square miles) and more than twice the size of the Asotin subbasin (325 square miles). The subbasin is commonly divided in half at the town of Imnaha, which marks the confluence of the mainstem Imnaha and its largest tributary, Big Sheep Creek. The total area of the mainstem Imnaha, including all tributaries but Big Sheep Creek, is 508 square miles, while the total area of the Big Sheep Creek watershed is approximately 350 square miles.

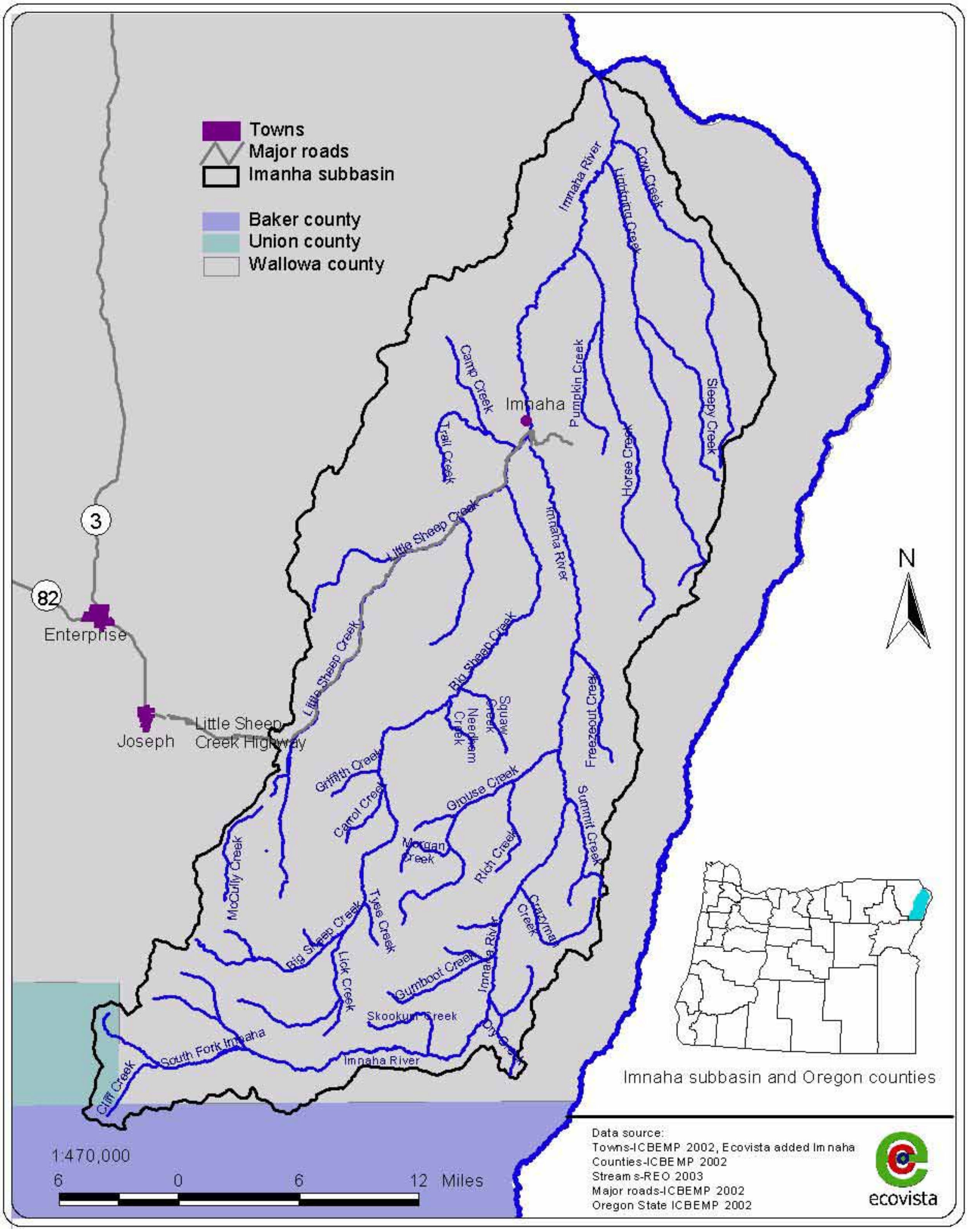

Figure 1. Location of the Imnaha subbasin in the Blue Mountain Province, Oregon, and the Columbia Basin.

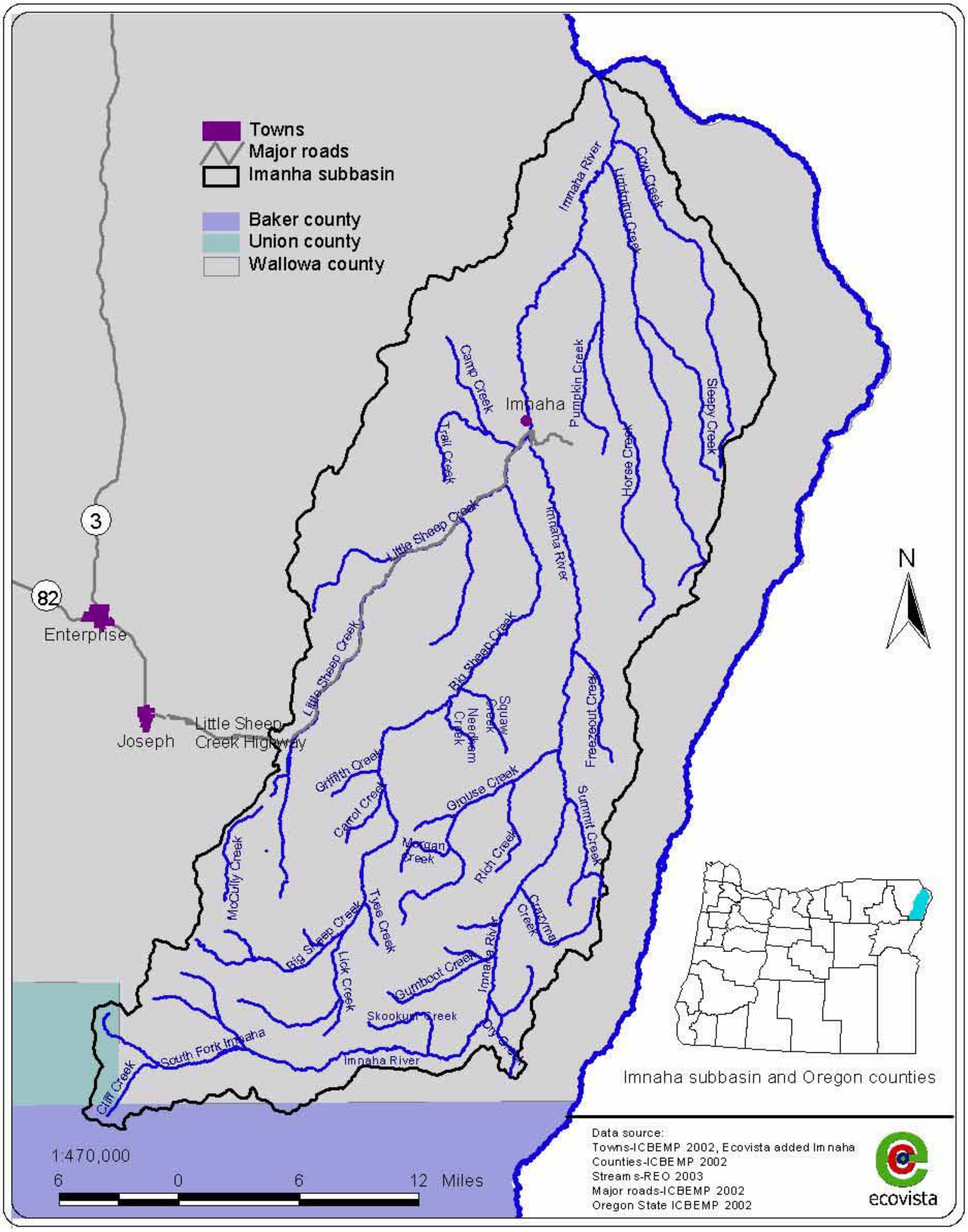

Figure 2. Counties and major features of the Imnaha subbasin.

1.1.1.3 Analysis Units

A combination of analysis units is used to characterize fish and wildlife resources throughout the assessment. In the overview section, the authors largely rely on U.S. Environmental Protection Agency (USEPA)-defined Level III ecoregions to stratify discussions pertinent to specific areas throughout the subbasin. In subsequent sections, analyses are based on 6th field HUCs. The two approaches were used since they provide varying levels of resolution. Assessment of broad-scale topics, such as climate, geology, and topography, were considered to be most suited toward the use of the ecoregion analysis unit, whereas assessment of finer-scale topics, such as fish habitat, required the resolution provided by the 6th field HUC. There are a total of 47 6th field HUCs (Figure 3) in the Imnaha subbasin, compared with only five subecoregions (discussed below; see also Table 1).

1.1.1.4 Ecoregions

The Blue Mountain Province, as defined by the NPCC, is contained within the Blue Mountain Level III Ecoregion defined by the USEPA. The larger Blue Mountain Ecoregion contains portions of the NPCC's Columbia Plateau and Middle Snake provinces, in addition to the Blue Mountain Province.

Ecoregions are defined as areas of general similarity in type, quality, and quantity of environmental resources (i.e., climate, geology, physiography, vegetation, soils, land use, wildlife, and hydrology) (Watershed Professionals Network 2001). Ecoregions also share a similar response pattern to physical activities (e.g., rainfall, fire, human land use activities, etc.), thereby providing a logical framework on which ecosystem research, assessment, management, and monitoring may be conducted (Watershed Professionals Network 1999).

Kagan (2001) and Pater et al. (1997) delineated a hierarchical set of ecoregions for Oregon, as have the USEPA and Oregon Natural Heritage Program (ONHP). The USEPA definitions, which are used in this document, have recently been summarized in Appendix A of the *Oregon Watershed Assessment Manual* (Watershed Professionals Network 1999). The USEPA delineations incorporate Level III and Level IV descriptions to characterize patterns within a watershed.

In the Imnaha subbasin, five subecoregions are nested within the Blue Mountain Ecoregion. The percentage of area by subecoregion type and location is shown in Table 1 and Figure 4. A textual characterization of the Blue Mountain Ecoregion and each subecoregion has been summarized in Bryce and Woods (2000) and is provided below.

Table 1. Subecoregion area and percentage of total area in the Imnaha subbasin.

Subecoregion Name	Code	Area (Square Miles)	% Total Area
Canyons and Dissected Highlands	11f	229.7	27
Canyons and Dissected Uplands	11g	450.5	52
Blue Mountain Basins	11k	44.0	5
Mesic Forest Zone	11l	67.9	8
Subalpine Zone	11m	66.5	8

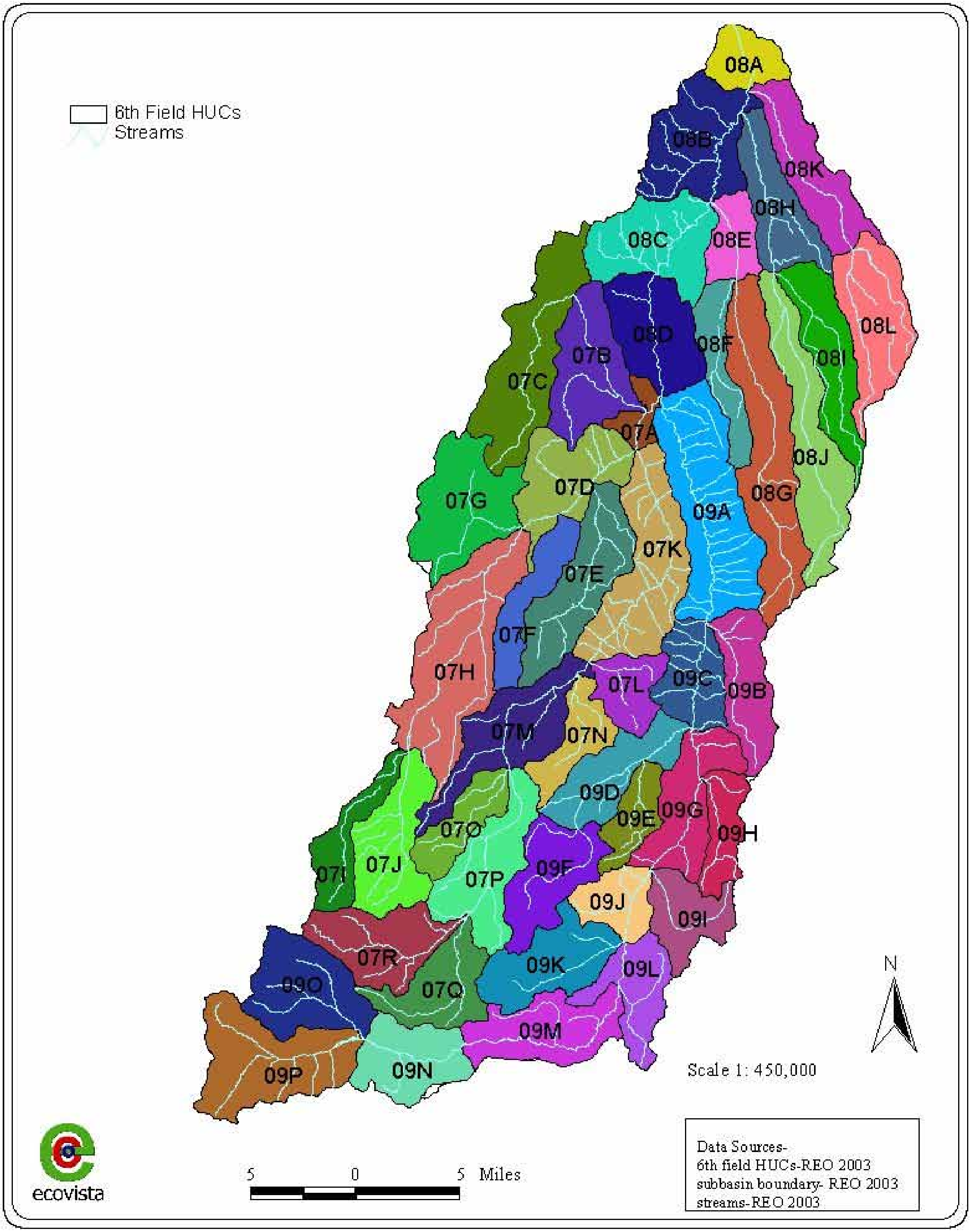

Figure 3. Sixth field HUC analysis units in the Imnaha subbasin.

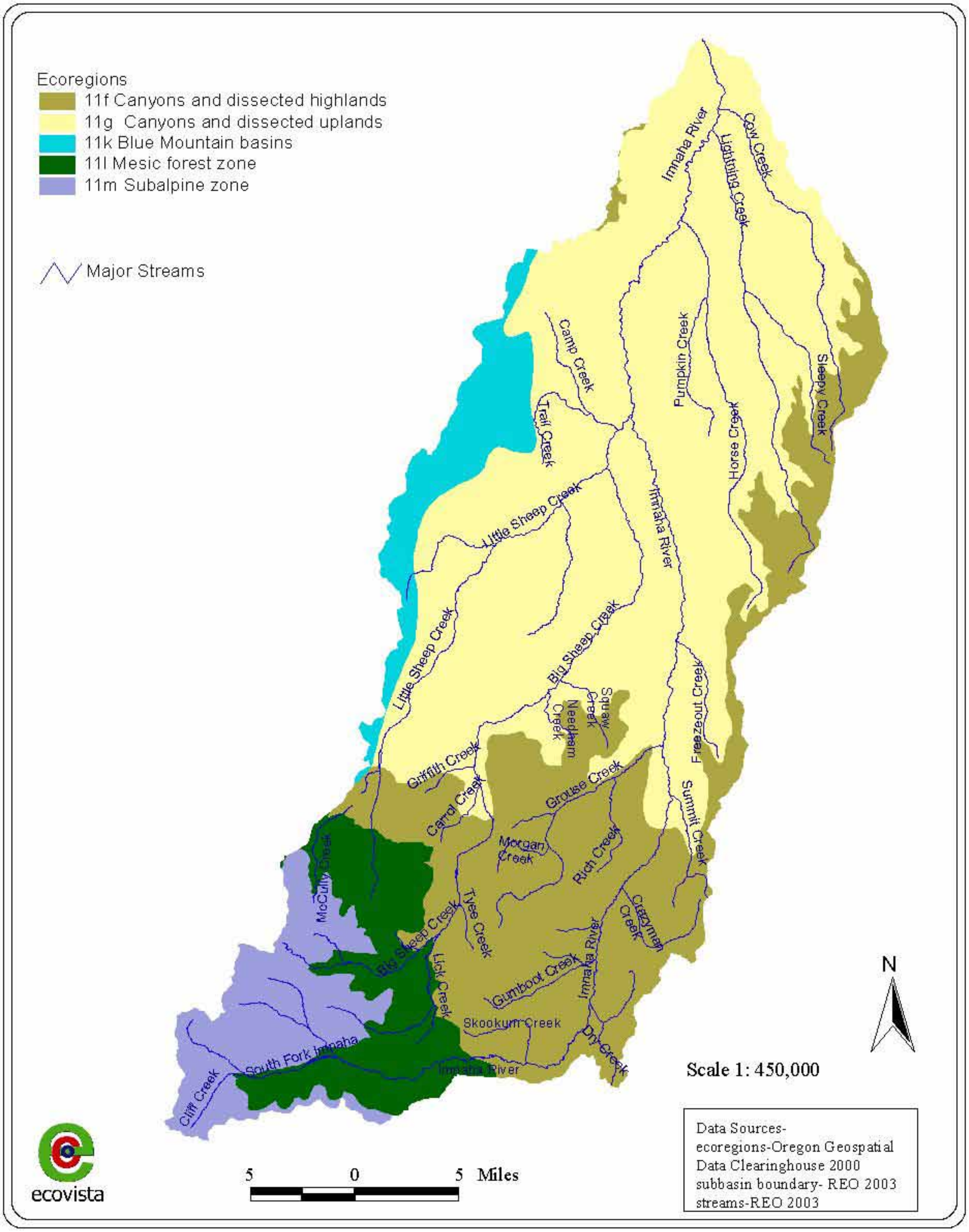

Figure 4. USEPA Level III and IV subecoregion classification in the Imnaha subbasin.

Blue Mountain Ecoregion (Ecoregion 11)

The Blue Mountain Ecoregion includes three mountain ranges: the Blue, Ochoco, and Wallowa mountain ranges. The Blue Mountains Ecoregion (11) is mostly volcanic in origin. Only its highest ranges, particularly the Wallowa and Elkhorn mountains, consist of intrusive rocks that rise above the dissected lava surface of the region. The area has deep canyons, high plateaus, broad river valleys, mountain lakes, forests, and meadows. Short, dry summers and long, cold winters characterize this region. Much of Ecoregion 11 is grazed by cattle.

Canyons and Dissected Highlands (Subecoregion 11f)

The Canyons and Dissected Highlands subecoregion includes the eastern Blue Mountains, the eastern Wallowa Mountains, and isolated islands of uplifted Columbia Plateau that have been cut by the Snake River in Hells Canyon. Subecoregion 11f is on the lee side of the mountains and is drier than the marine-influenced Mesic Forest Zone subecoregion (11l) found at similar elevations to the west. Vegetation is primarily coniferous, with subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), and Engelmann spruce (*Picea engelmannii*) occurring at the highest elevations. Grand fir (*Abies grandis*) and stringers of ponderosa pine (*Pinus ponderosa*) are the most abundant conifer species associated with the middle to lower elevations of subecoregion. Human activities are limited by the steep terrain of Subecoregion 11f.

Canyons and Dissected Uplands (Subecoregion 11g)

In the Canyons and Dissected Uplands subecoregion, deep river canyons divide the Blue Mountains from the Rocky Mountains. The Snake, Grande Ronde, Imnaha, and Salmon rivers and their tributaries have cut the Columbia Plateau to depths of 2,000 to 5,000 feet. These canyons are cut through the same metasedimentary and metavolcanic rock that forms the Wallowa and Seven Devil mountains; they differ from their lower stretches in Ecoregion 11, which are cut into basalt. The depth of the canyons and the exposed metamorphic rocks result in stony soils on canyon slopes that retain little moisture. Vegetative species of this subecoregion, which are primarily grasses, are adapted to grow in highly drained soil under hot, dry conditions. Land use includes grazing and recreation on National Forest land and in the Hells Canyon National Recreation Area (HCNRA).

Blue Mountain Basins (Subecoregion 11k)

The Blue Mountain Basins subecoregion includes the Wallowa, Grande Ronde, and Baker valleys. All three valleys are fault-bounded grabens or depressions; all are well-watered from surrounding mountains. Because the climate of the Wallowa and Grande Ronde valleys is moderated by a marine influence, these valleys receive an average annual precipitation of 13 to 24 inches. The fine-textured soils provide favorable agricultural conditions. Wetlands were once abundant in this subecoregion, but many have been drained for agricultural purposes, although remnants exist.

Mesic Forest Zone (Subecoregion 11l)

The Mesic Forest Zone subecoregion is found between 4,000 and 7,000 feet in the western Wallowa, the western Seven Devils, and the higher-elevation Blue Mountains. These areas are influenced by marine air coming through the Columbia River Gorge to the west. Much of the subecoregion's precipitation falls as snow that persists late into the spring. The soil has a significant ash layer, which is relatively rock free, that helps to retain moisture during the dry season. These soils make growing conditions favorable for a highly productive and diverse forest community that includes true firs, Engelmann spruce, Douglas-fir, larch (*Larix occidentalis*), and lodgepole pine (Bryce and Woods 2000).

Subalpine Zone (Subecoregion 11m)

The Subalpine Zone subecoregion includes the highest areas of the Elkhorn, Wallowa, Seven Devils, and Strawberry mountains, beginning near tree line at an elevation of 6,500 feet where the forest cover becomes broken by alpine meadows and continuing through alpine meadowland to include the exposed rock, snowfields, and glacial ice of the highest mountain peaks. These areas characteristically have cold soil, deep snowpack, and a very short growing season. Forest species adapted to these conditions include subalpine fir, Engelmann spruce, and whitebark pine (Bryce and Woods 2000).

1.1.1.5 Geology

The geology of the Imnaha subbasin is comparatively more diverse than other subbasins of similar size located throughout the Pacific Northwest. This diversity is due in large part to the combination of Paleozoic and Mesozoic rocks that occur in the area and the associated mountain building and canyon downcutting processes by which the rocks were formed.

The geologic foundation for the Blue Mountain Ecoregion consists of several unique oceanic terranes that were once part of the Blue Mountains volcanic island chain that occurred west of the North American landmass (Orr and Orr 1996). The terrane underlying the Imnaha subbasin is the Wallowa Terrane, the largest remnant of the ancestral Blue Mountains volcanic arc (Orr and Orr 1996). The Wallowa Terrane was formed from lava flows and ash deposition produced by offshore eruptions during two separate episodes in the Permian and Triassic periods and comprises the older basement rock found throughout the subbasin (Vallier 1973). The Clover Creek Greenstone, a massive, indurated strata of rocks, resulted from metamorphosed volcanic and sedimentary rock and is evident in the upper section of the subbasin (Vallier 1973).

A period of subsidence occurred during the late Triassic and early Jurassic periods (between 150 and 200 million years ago), during which oceans became shallower and ancient reefs of limestones and shales formed and accumulated atop the volcanic material. These fossiliferous and siltstone rocks belong to the Martin Bridge and Hurwal formations (respectively), which currently underlie headwater portions of the mainstem Imnaha River, Big Sheep Creek, and Little Sheep Creek (Figure 5). Cobbles of lime rock line the river and creek beds through this section of the subbasin (USFS 1998a).

The Wallowa batholith, Oregon's largest pluton, intruded the Wallowa Terrane during the Mesozoic era (Cretaceous/Jurassic period, 160–120 million years ago), forming the Wallowa granite and trapping many of the precious metals that would later be sought in the Imnaha subbasin by miners (Vallier and Brooks 1987). The weather-resistant granite forms the high peaks of the Wallowa Mountains with nine peaks over 9,000 feet in elevation (Weis et al. 1976).

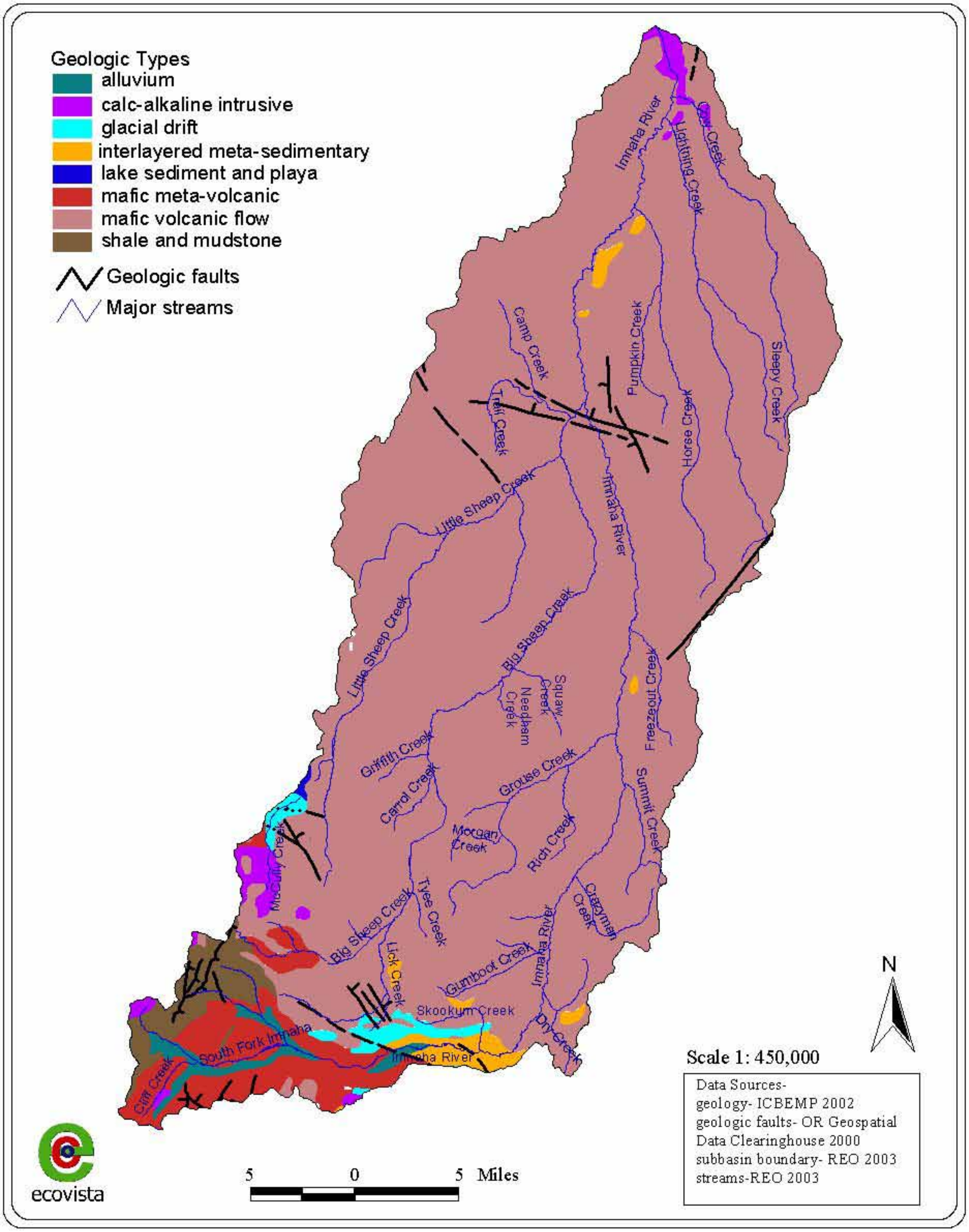

Figure 5. Geology of the Imnaha subbasin.

Layer upon layer of Columbia River basalts eventually covered the area during the Miocene epoch (17.5–15.6 million years ago), until only the tallest peaks projected above a seemingly level black landscape (Orr and Orr 1996). The Grande Ronde and Imnaha basalts, which represent two of six separate lava formations of the Columbia River basalts, brought about the most dramatic changes to the physiography of the province (Orr and Orr 1996). The Grande Ronde basalt, which is the most common of the Columbia River basalts, is more durable than the other Miocene flows (Orr and Orr 1996). The characteristic cliff-faced columnar exposures of the Grande Ronde basalt overlay previous flows and are common along the deep V-shaped valleys bordering tributaries such as Dry, Crazyman, Summit, and Freezeout creeks.

The underlying Imnaha basalt group is softer and more easily weathered than the Grande Ronde basalt. The Imnaha basalt is most evident in the lower canyon (below Summit Creek) and occur in areas of reduced relief that are mantled with deeper soils and fewer columnar basalt outcrops (Art Kreger, USFS soils scientist, personal communication, February 8, 2001). Big and Little Sheep creek valleys have a similar geology and morphology through the Columbia River basalt lava layers and join together in the Imnaha basalt in the central part of the subbasin. The successive basalt layers through which the rivers have cut can be seen from various vantage points, including the Hat Point overlook, an area bordering the Imnaha and Snake Hells Canyon subbasins.

Processes of glaciation dominated the Pleistocene era (≤ 2 million years ago) and sculpted the Wallowa Mountains, also known as “Oregon’s Alps” (Orr and Orr 1996). Long trough-like, U-shaped valleys; clear glacial lakes; and winding moraines of crushed rock, gravel, sand, and fine sediment characterize the area and serve as the headwaters for many of the streams and rivers in the subbasin (USFS 1998b). The points at which the myriad intermittent channels join often occur at terminal moraines. These junctions represent the uppermost reaches of perennial channels and may serve as source areas for the till that is common to Imnaha streams and rivers during runoff periods.

Quaternary alluvial deposits form narrow river terraces along the banks of the Imnaha River and its major tributaries. The alluvium contains river rock from upstream, colluvial basalt from the canyon side slopes, and Mazama ash and windblown silt mixed in with the soils that formed on the river terraces. These terraces are found in the central part of the Imnaha River and lower Big and Little Sheep creeks where the main channels have some ability to meander through the unconsolidated sediment. A study found that 84% of the riverbanks in the subbasin, including these terraces, are stable due mainly to vegetation and coarse sediment (USFS 1994a).

1.1.1.6 Climate and Weather

The climate in the Imnaha subbasin is temperate continental and dry. It is regionally influenced by the Cascade Mountains and locally influenced by the Wallowa Mountain Range. Variations in elevation, topography, and physiography contribute significantly to a number of unique microclimates found in the subbasin. For instance, north slopes tend to be wetter and cooler than south slopes; stream bottoms provide a cooler, damper climate than hillsides or ridge tops; and areas with good air drainage remain warmer in the winter than pockets with little or no air drainage. Long-term climate data specific to the Imnaha subbasin do not exist. Climate patterns in nearby drainages, reports, professional judgment, modeled data, and anecdotal accounts are the best available source of Imnaha-specific climate information.

Climate data from nearby drainages (Table 2) provide an indication of climatic conditions in the Imnaha and will be referenced in the following discussion. Because of topographic and elevational differences, the climate in the Imnaha subbasin is assessed using three general elevation zones (Figure 6). Data from the Riggins, Idaho station are used to characterize climate in the lower-elevation portions of the subbasin, while climate data from the Enterprise Ranger Station (RS in figures and tables) and Mt. Howard Snowpack Telemetry (SNOTEL) stations in Oregon are used to describe conditions in the middle and upper portions of the Imnaha, respectively.

Table 2. Climate station metadata. Stations shown do not occur in the Imnaha River drainage but are considered relevant for use due to their proximity and relative position and/or elevation.

Station Number	Station Name	Start Date	End Date	Latitude (ddmm)	Longitude (dddmm)	Elevation (feet)
107706	Riggins	01/01/1940	12/31/2000	4525	11619	1800
352672	Enterprise RS	12/01/1931	10/31/1981	4526	11716	3820
17D18S	Mt. Howard SNOTEL	10/01/1980	Present	4527	11717	7910

Lower-Elevation Climate (Based on Data from Riggins, Idaho)

In winter, average temperatures throughout the lower (≤1,800 feet) elevation portions of the subbasin fluctuate around 37 °F. The average daily minimum temperature in the winter is around 29 °F. Summer temperatures range from 52 to 92.3 °F (Table 3) and average 72.4 °F. The average daily maximum temperature during the summer is 88 °F.

Precipitation in the lower-elevation portions of the Imnaha subbasin occurs almost exclusively as rain and is most abundant during spring and early summer months. The lower and middle elevations in the Imnaha subbasin are most susceptible to rain-on-snow events (≤3,500 feet). On average, a total of 16.8 inches of precipitation accumulate each year in the lower Imnaha (Figure 7). An estimated 7.3 inches of total snowfall may be expected annually, although snow depth is considered negligible during all months except January (see Table 3). Thunderstorms occur on average about 15 to 20 days each year, primarily between May and August (based on data collected from First Order station, Lewiston, Idaho).

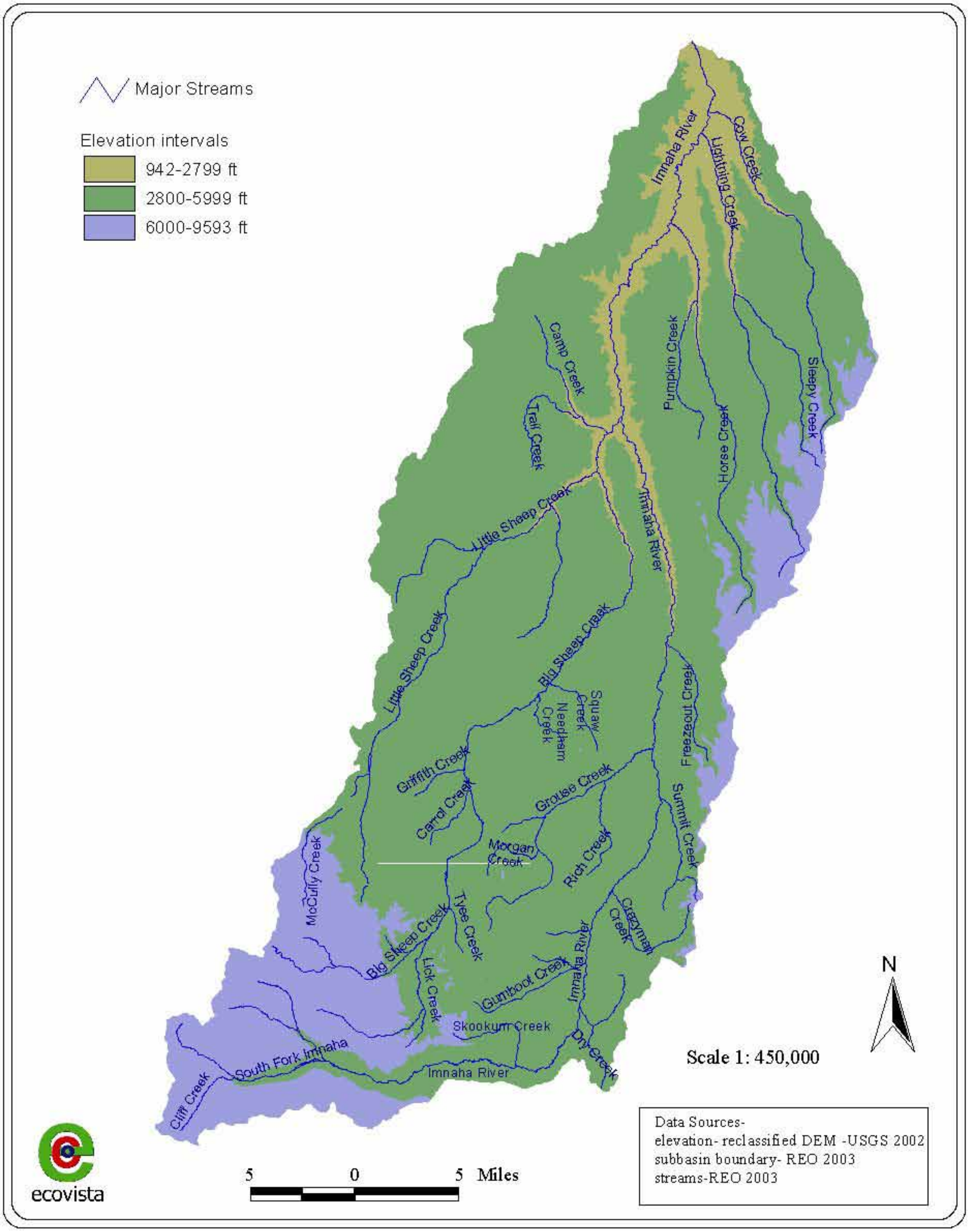

Figure 6. General elevation intervals in the Imnaha subbasin for climate.

Table 3. Monthly climate summary for stations representing conditions in the Imnaha subbasin during the period of record.

Station	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AnnualTotal
Riggins	Avg. maximum temp. (ºF)	41.5	49.4	57.1	65.9	74.0	81.4	92.2	92.3	81.4	67.4	50.8	42.4	66.3
	Avg. minimum temp. (ºF)	27.5	30.9	34.5	39.5	45.9	52.4	58.1	57.9	50.5	41.9	34.5	29.2	41.9
	Avg. total precip. (inches)	1.2	1.1	1.6	1.7	2.2	1.9	0.8	0.8	1.1	1.3	1.5	1.4	16.6
	Avg. total snowfall (inches)	3.0	1.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.1	7.4
	Avg. snow depth (inches)	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Enterprise Ranger Station	Avg. maximum temp. (ºF)	33.9	40.0	47.3	56.7	65.5	72.3	82.9	82.1	73.3	61.2	45.3	36.5	58.1
	Avg. minimum temp. (ºF)	13.9	18.6	23.0	28.9	34.7	39.9	42.8	40.4	35.1	29.1	22.3	17.5	28.9
	Avg. total precip. (inches)	0.9	0.7	1.0	1.2	1.7	2.1	0.7	0.8	1.0	1.1	1.0	1.0	13.2
	Avg. total snowfall (inches)	10.9	7.5	7.0	2.2	0.4	0.1	0.0	0.0	0.0	0.8	4.7	7.9	41.5
	Avg. snow depth (inches)	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Mt. Howard SNOTEL	Avg. maximum temp. (ºF)	31.1	33.7	38.0	42.1	49.4	53.4	63.8	66.5	59.3	44.6	33.5	30.8	45.5
	Avg. minimum temp. (ºF)	14.9	15.1	16.3	20.3	27.5	33.1	40.7	43.0	36.7	26.2	18.5	14.5	25.6
	Avg. total precip. (inches)	5.0	4.4	4.9	4.6	4.9	4.9	2.3	1.3	1.5	1.1	4.0	5.8	44.7
	Avg. snow water equiv. (inches) for 1st and 15th of each month	7.2	8.4	12.3	16.6	13.7	8.1	0.0	0.0	0.0	0.3	1.2	4.3	
		8.5	9.8	15.8	17.0	13.6	3.7	0.0	0.0	0.0	0.6	2.4	6.1	

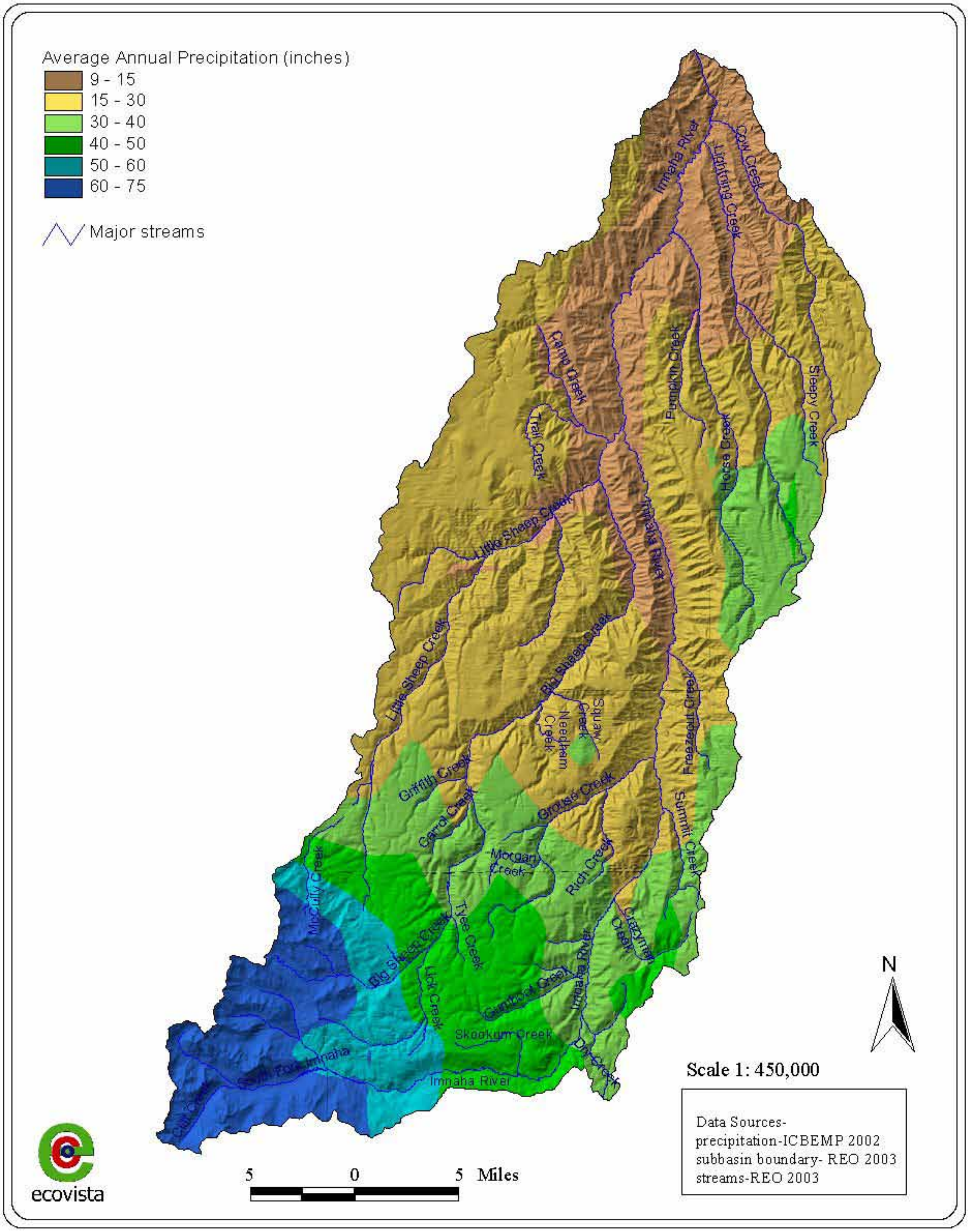

Figure 7. Precipitation patterns in the Imnaha subbasin.

Mid-Elevation Climate (Based on Data from Enterprise Ranger Station)

Based on climate data from the Enterprise Ranger Station, mid-elevation winter temperatures average around 27.3 °F. The average daily minimum temperature during winter months is 17.5 °F. During summer months, the average temperature is 60.5 °F. The average daily maximum temperature is 78.8 °F. Based on 30 years of data, two years in ten have an annual maximum temperature higher than 99 °F and an annual minimum temperature lower than –22 °F.

Average annual precipitation at the Enterprise Ranger Station is 12.8 inches. Precipitation generally increases monthly starting in February and peaking in June, during which an average 7 inches may accumulate (Figure 8). Average total annual precipitation measured at the Enterprise Ranger Station is less than that measured at the Riggins station (16.6 inches), a difference due in part to the rain shadow effect produced by the Wallowa Mountains. Average total snowfall is slightly less than 42 inches a year. On average, 31 days a year have at least 1 inch of snow on the ground.

The average relative humidity in midafternoon is about 70% in midwinter and about 25% in July and August. Humidity is higher at night, and the average at dawn is about 80% in midsummer. The sun shines 75 to 80% of the time in summer and about 40% in winter. Prevailing winds are very dependent on location due to the influence of the complex topography of the region, although they are generally from the southwest in winter and from the northwest in summer. Average wind speeds are highest in the spring, at around 10 miles an hour in open terrain in March and April.

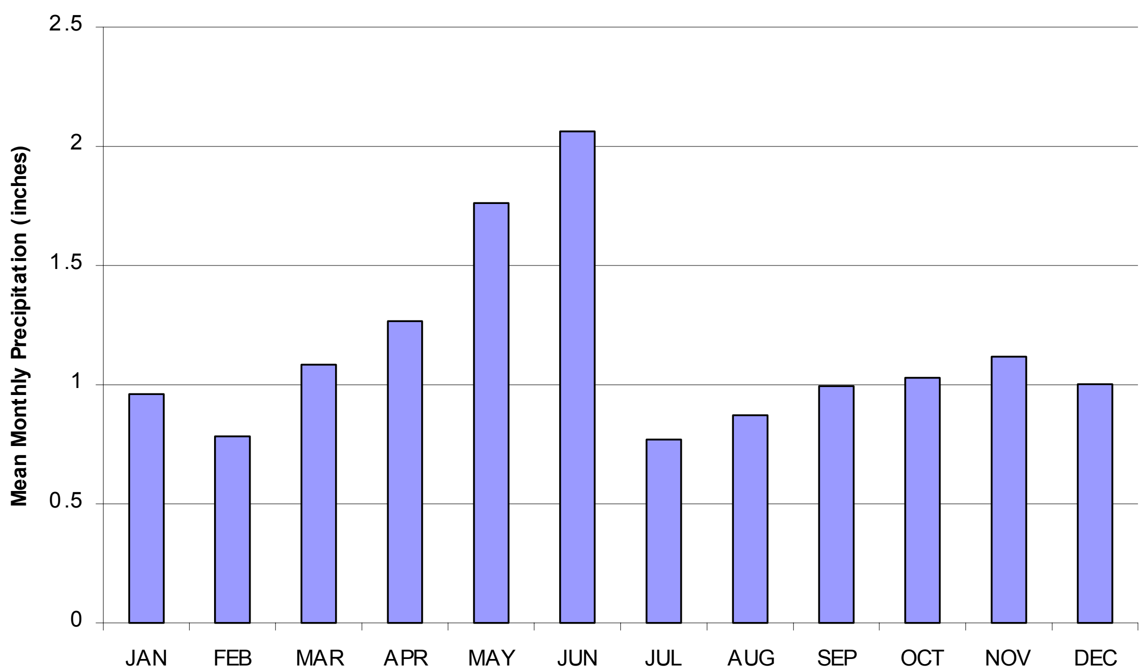

Figure 8. Mean monthly precipitation recorded at Enterprise Ranger Station (1932–1994).

Higher-Elevation Climate (Based on Data from Mt. Howard SNOTEL)

Not surprisingly the coolest climate occurs throughout the higher-elevation portions of the subbasin, where maximum temperatures recorded at the Mt. Howard SNOTEL climate station average only 46.5 °F over the course of the year, and minimum temperatures average less than 26 °F annually. The average maximum temperature during winter months at the SNOTEL site is just under 34 °F, although this statistic is based on only 10 years of data (1990–2000). In comparison, the average minimum temperature between December and March is 14.8 °F. Maximum temperatures during summer months range from 64.4 to 82.4 °F.

Average annual precipitation at Mt. Howard is 44.7 inches. Total precipitation over the period of record has varied considerably (Figure 9). Wet years recently occurred in 1982 and 1997; dry years, in 1987, 1992, 1994, and 2000. Precipitation at the Mt. Howard station is greatest during winter months and generally falls as snow (Figure 10). Although snowfall and snow depth data specific to the Mt. Howard station have not been collected, the higher-elevation areas of Wallowa County generally receives up to 80 inches or more each year (NRCS unpublished data). Based on snow water equivalent data and snow pillow data, the Mt. Howard station has at least one inch of snow on the ground over the course of four months. Snow water equivalent is highest between February and May and is negligible June through September. Snow water equivalent is variable and highly susceptible to moisture-laden warm fronts raising the freezing level in a short time period.

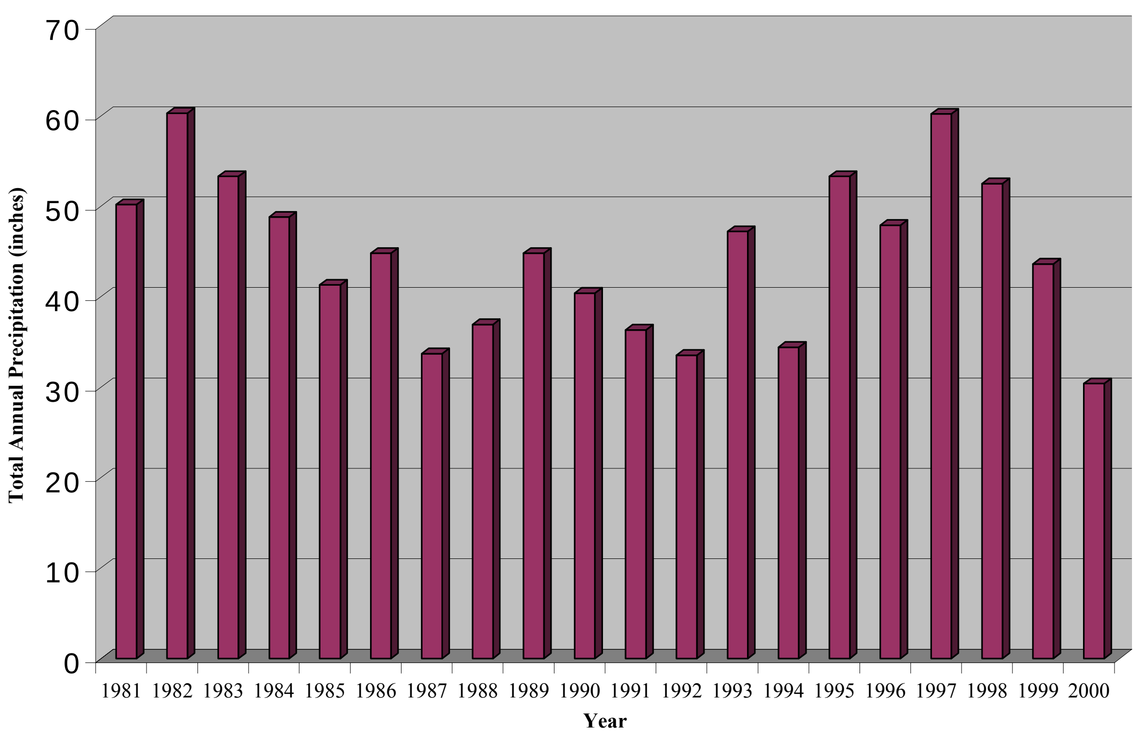

Figure 9. Annual precipitation recorded at Mt. Howard SNOTEL (1981–2000).

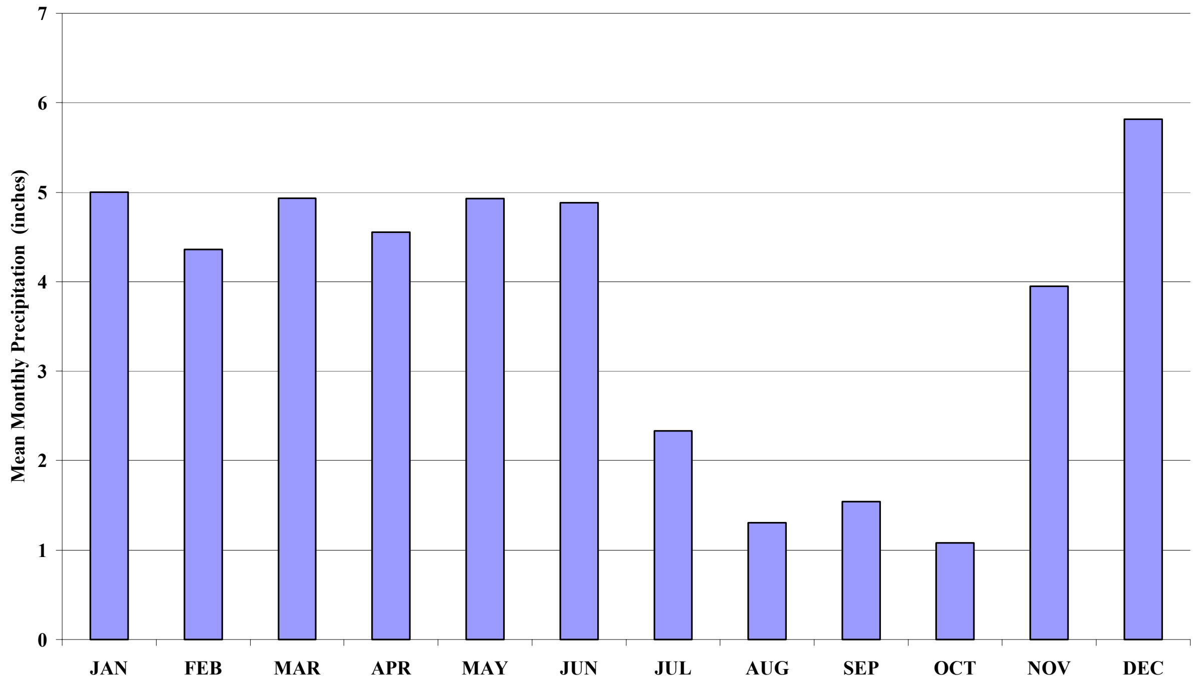

Figure 10. Mean monthly precipitation recorded at Mt. Howard SNOTEL (1980–2000).

1.1.1.7 Soils

The Imnaha River drainage provides a unique and diverse area for soil development due to its geologic setting. Varying rock type, topography, and climatic conditions have a large impact on soil-forming processes throughout the subbasin. General characteristics of soils in the Imnaha subbasin, as they relate to subecoregions, are presented in Table 4.

Table 4. General soil characteristics of subecoregions in the Imnaha subbasin (Watershed Professionals Network 1999).

Subecoregion	Soil Characteristics	Erosion Rate
Canyons and Dissected Highlands	Clay loam to gravelly loam derived from basalt with an ash and loess (western portion) mantle	Moderate due to moderate precipitation and stable geology
Canyons and Dissected Uplands	Clay loam to gravelly clay loam	Low due to low precipitation and gentle slopes
Blue Mountain Basins	Deep and fine-textured	Low due to gentle terrain
Mesic Forest Zone	Usually highly productive, with abundant soil moisture	Moderate; most erosion occurs during high-intensity runoff events during snow melt or during thunderstorms
Subalpine Zone	Fine-textured in meadows and rocky in canyon areas	Low; most erosion occurs during high-intensity runoff events during snow melt or during thunderstorms

Soils are generally derived from the weathering of local bedrock or colluvial rock materials (called residual soils). Thus, granitic soils predominate above Indian Crossing Campground (from weathering of the Wallowa batholith), while basaltic soils predominate below Indian Crossing. Residual soils tend to be deeper on north- and east-facing slopes (capable of supporting conifer stands) and shallower on south- and west-facing slopes (capable of supporting mainly grasslands). Forces other than weathering of bedrock, however, have also been active in the subbasin.

Wind-derived soils (loess) and ash deposits from the eruptions of Glacier Peak (12,000 years ago) and Mount Mazama (6,600 years ago) have added greatly to the productivity of the local soils. Ash deposits are very productive, with low compactibility and high permeability and water holding capacity, but because of their low density, they are easily erodible. They are generally found on the plateaus where the densest conifer stands are located.

Sedimentation rates are accelerated in the upper portion of the subbasin due to the instability of the barren granite mountain peaks. Primary mechanisms of sediment delivery to aquatic habitats in these areas include debris flows and other processes of mass wasting, which are commonly triggered by thunderstorms or rain-on-snow events (BLM 1993). Low-gradient areas and deep pools in the upper and middle portions of the subbasin act to filter out much of the suspended sediment load delivered to headwater tributaries and mainstem reaches (Art Kreger, USFS soils scientist, personal communication, February 8, 2001).

The soils that formed from Imnaha basalt along the central part of the valley have much higher clay and coarse sand content than typically found in similar soils in the region (Art Kreger, USFS soils scientist, personal communication, February 8, 2001). The well-drained and fertile soils of this area are suited to agriculture, but are also a potential source of sedimentation into the river during flood stages or following storm events (Tom Smith, NRCS soils scientist, personal communication, February 8, 2001).

Soil surveys at varying resolutions have been conducted or are in development in the Imnaha subbasin. State Soil Geographic (STATSGO) data at 1:250,000-scale are available across the entire subbasin. The finer-scale Soil Survey Geographic (SSURGO) data have recently been completed for the privately owned lands in the subbasin but does not include public land ownerships (NRCS 2002). The Wallowa-Whitman National Forest is currently developing a detailed soil survey for the lands they manage, but such a survey has not yet been developed for the Imnaha subbasin (USFS 2002).

The Imnaha subbasin contains seven STATSGO Map Units (MUIDs) (Figure 11). Each MUID may contain multiple soil components and layers. To determine the average soil properties across the MUID, weighted averages were calculated based on the thickness of soil layers and the percent contributed by each soil component (Table 5).

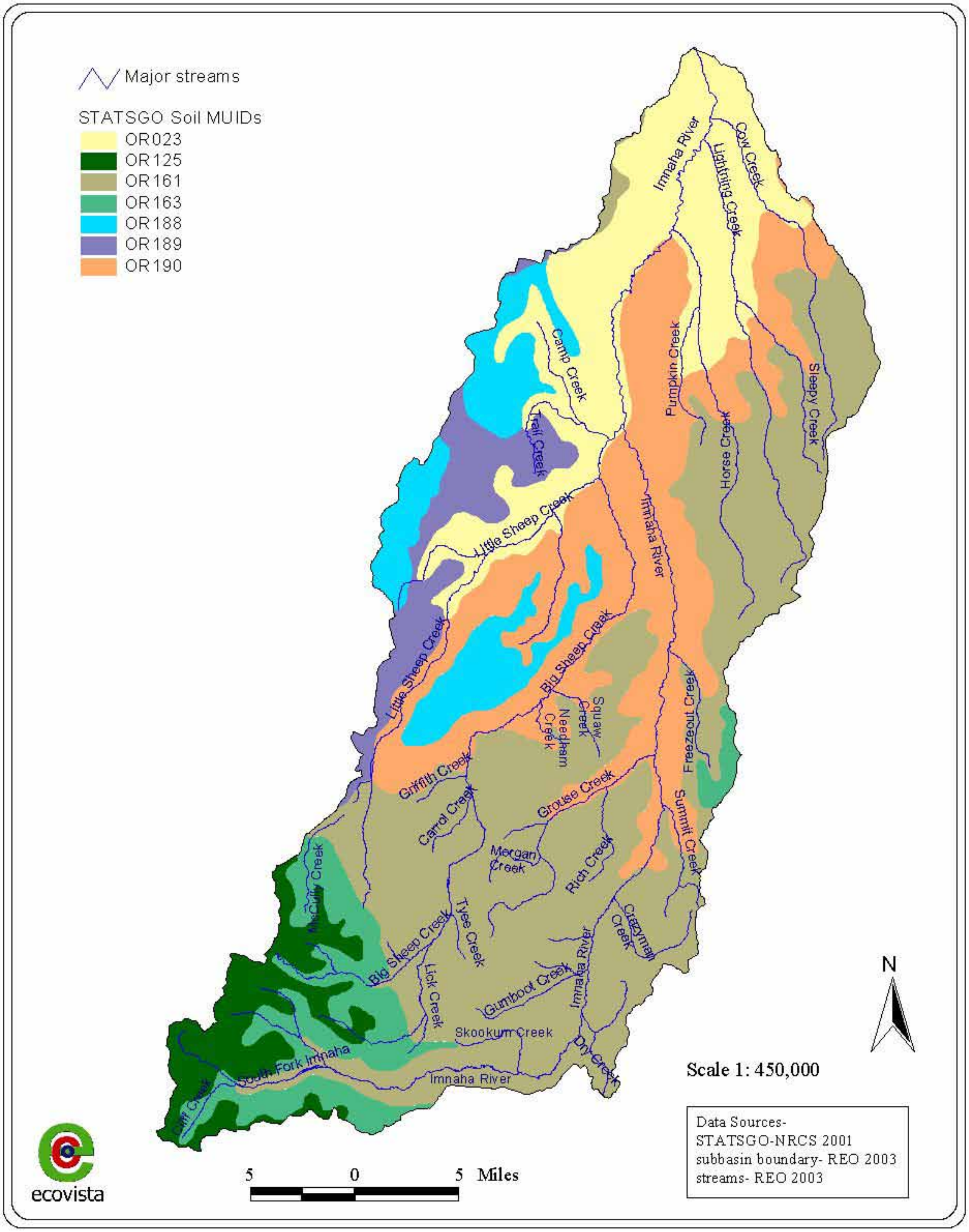

Figure 11. Soil mapping units of the Imnaha subbasin.

Table 5. Soil properties of the STATSGO Map Units (MUIDs) in the Imnaha subbasin.

MUID	Map Unit Name	Depth to Seasonally High Water Table (Inches)	Depth to Bedrock (inches)	Permeability (inches/hour)	Available Water Capacity (inches/inch)	Bulk Density (grams/cubic centimeter)	Organic Matter Content (percent by weight)	Soil Loss Tolerance Factor	Wind Erosion Factor	Soil Erodibility Factor
OR23	Lickskillet-Schuelke-Bolicker	6.000	26–37	0.75–2.43	0.089–0.140	1.261–1.402	0.794–1.583	1.968	6.779	0.225
OR125	Rock Outcrop									
OR161	Tolo-Klicker-Anatone	6.000	37–48	0.32–1.96	0.151–0.215	1.095–1.276	0.777–0.202	3.220	5.900	0.281
OR163	Helter-Brickel-Ateron	6.000	34–49	0.73–2.60	0.119–0.184	1.087–1.279	0.724–1.805	2.814	6.093	0.274
OR180	Lostine-Ladd-Langrell	5.140–5.435	60	3.16–4.75	0.113–0.154	1.257–1.427	0.810–1.811	4.170	5.450	0.251
OR188	Powwatka-Zumwalt-Wallowa	6.000	19–38	0.49–1.61	0.181–0.202	1.122–1.258	1.898–4.566	1.900	5.950	0.275
OR189	Hurwal-Snell-Ateron	6.000	24–41	0.32–1.02	0.101–0.148	1.228–1.374	1.050–2.175	2.050	7.300	0.224
OR190	Snell-Harlow-Getaway	6.000	22–39	0.32–1.04	0.086–0.125	1.238–1.410	1.174–2.444	1.950	7.450	0.124

1.1.1.8 Topography

The Imnaha subbasin is made up of a broad range of elevation and topographic relief (975–10,000 feet and 0 to > 90% slopes) (Figure 12). The granite peaks of the Wallowa Mountains are barren rock slopes and cliffs ranging from 90% to vertical slopes. The Martin Bridge and Hurwal formations have soils forming on 30 to 90% slopes in the higher elevations in the Imnaha drainage where the South, Middle, and North forks converge in U-shaped valleys on the eastern side of the Wallowa Mountains (Weis et al. 1976).

As the river turns north near Coverdale Campground, it begins cutting through the Grande Ronde basalt, forming a deep V-shaped valley with the typical columnar basalt cliff faces on the steeper slopes (30 to 90%). This is often referred to as "bench type" topography (Tom Smith, NRCS soils scientist, personal communication February 8, 2001). The Imnaha river channel erodes through the Grande Ronde basalt and into the more erodible Imnaha basalt near the intersection of North Pine Road and the Imnaha River Road. The river valley begins to widen, forming the shallow valley slopes that typify the central part of the Imnaha River valley corridor. The shallow slopes range from 5 to 15% near the river and 15 to 30% near the canyon walls (Art Kreger, USFS soils scientist, personal communication, February 8, 2001).

Near-vertical canyon walls contain the Imnaha River as it courses its way through the more durable metamorphic rocks of the Wallowa Terrane (USFS 1998b). The canyon bottoms in these areas provide only enough room for the riverbed itself and the well known Ni-Mi-Puu foot trail.

1.1.1.9 Land Cover

Cover Types

As explained in section 1.1.1.4 the distribution of vegetative communities in the subbasin is a reflection of its climate, soils, elevation and topography. The uppermost part of the subbasin occurs above tree line and contains alpine communities (Rose et al. 1992). Below the tree line, the watershed contains subalpine communities that grade into mixed conifer forests and eventually grassland as elevations decrease (USFS 1995).

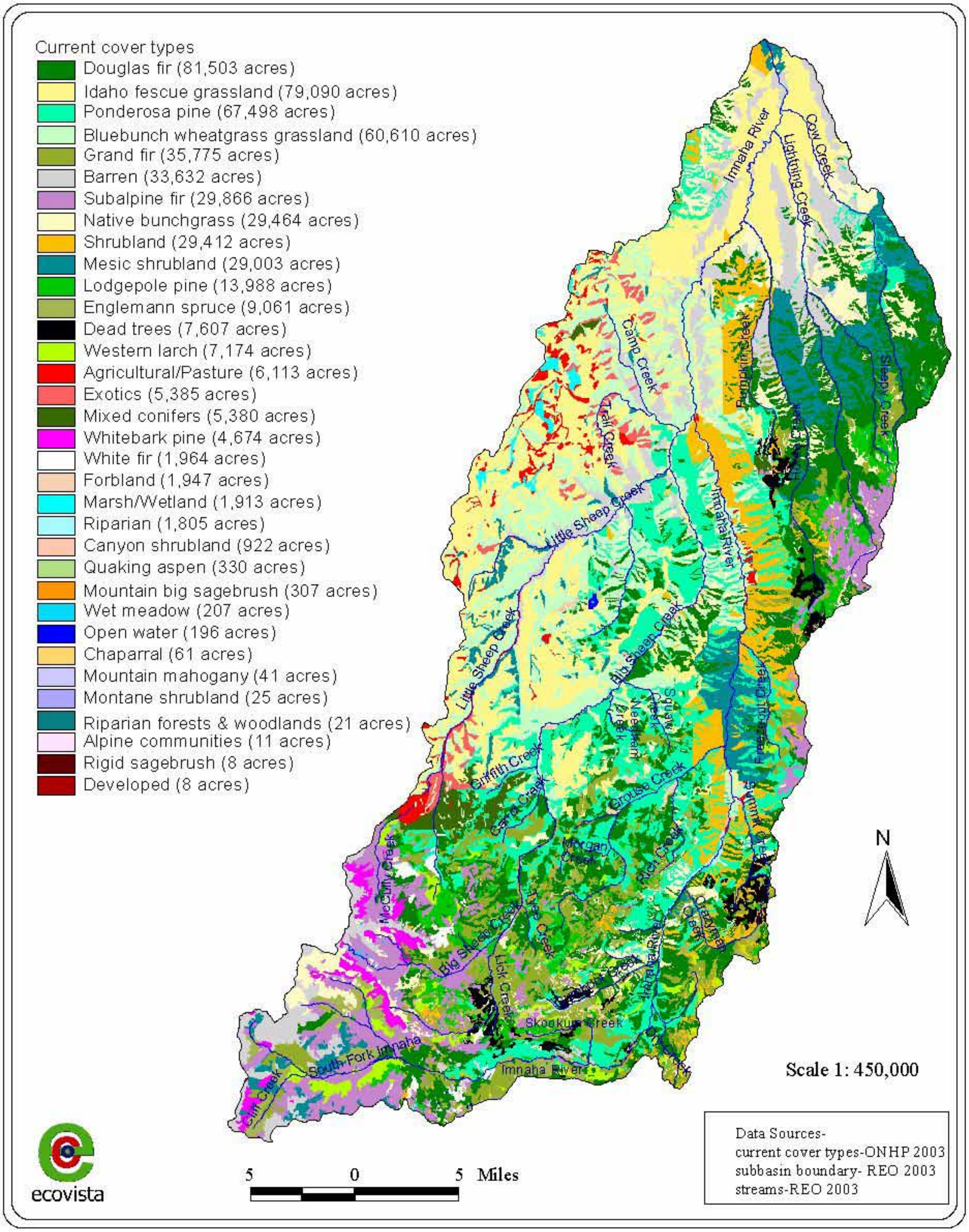

Figure 13 shows the locations and relative abundance of cover types in the subbasin. These data were compiled by the Oregon Natural Heritage Program (ONHP) using Wallowa-Whitman

National Forest data on the USFS lands and SSURGO and Gap Analysis Program (GAP) data on the non-USFS lands.

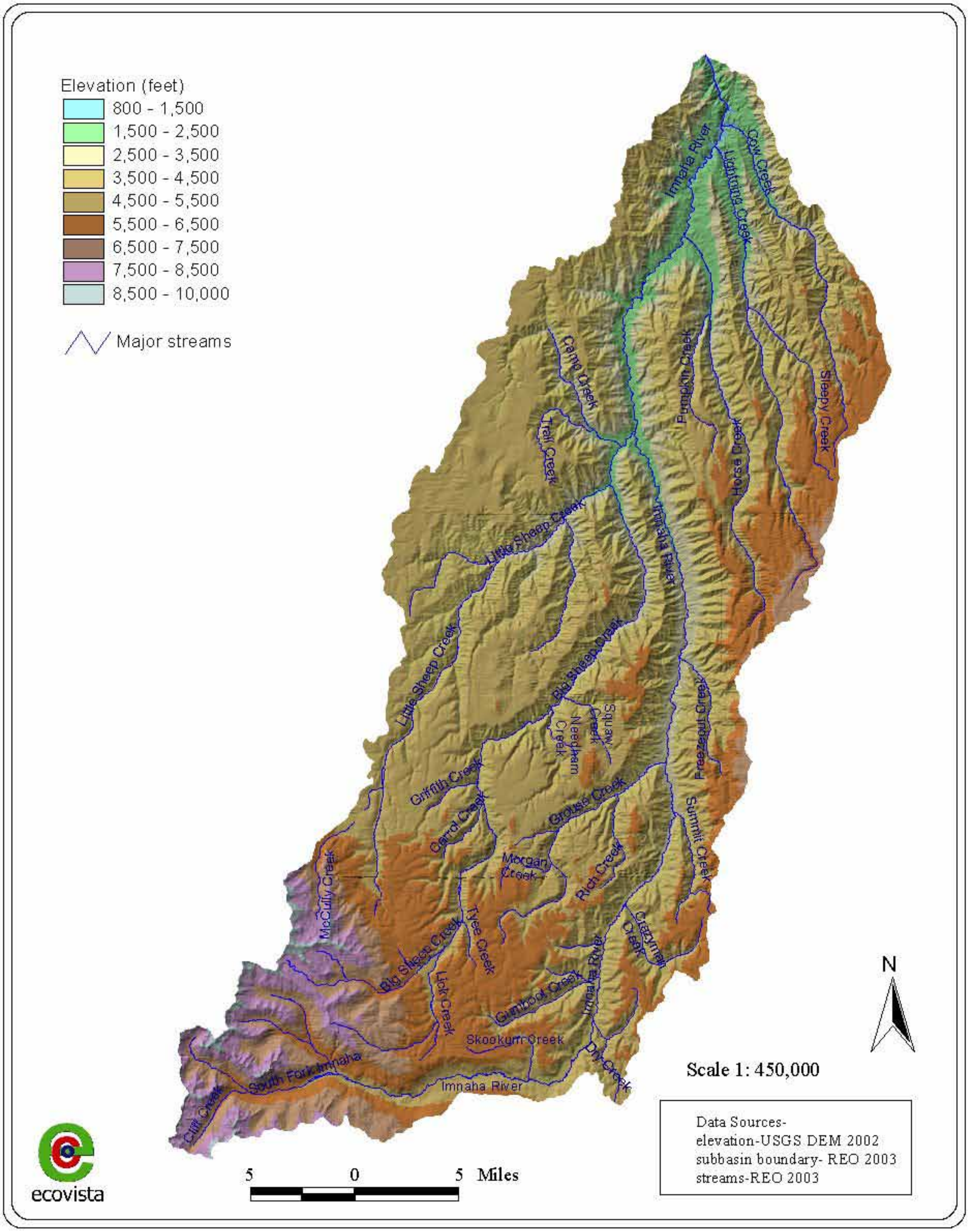

Figure 12. Topography and elevation in the Imnaha subbasin.

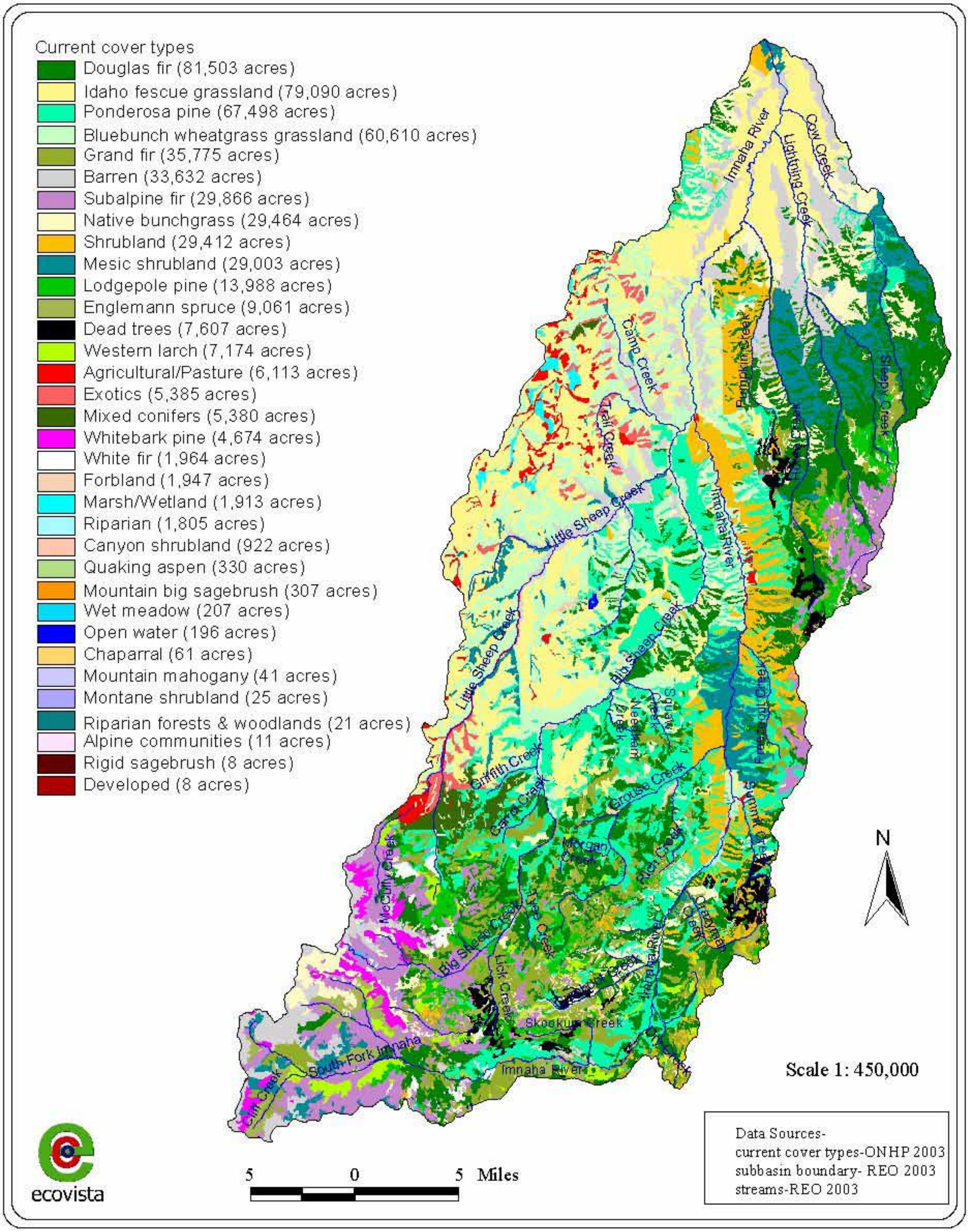

Figure 13. Current land cover types of the Imnaha subbasin.

Based on the ONHP data, Douglas-fir is currently the most abundant cover type in the subbasin covering 81,500 acres. Grassland areas dominated by Idaho fescue are a close second covering slightly more than 79,000 acres. Idaho fescue and bluebunch wheatgrass vegetation types cover most of the lower-elevation areas of the subbasin. Cover types reflecting the highest degree of human influence occur primarily on the lower western side of the subbasin, the agricultural and pasture areas are here as well as many of the areas dominated by undesirable exotic species. Ponderosa pine occurs intermixed with shrub communities, as stringers along draws in the grassland dominated areas. The mid-elevation areas are dominated by a mix of conifer species, particularly Douglas-fir but also grand fir, western larch, lodgepole pine, and ponderosa pine. At higher elevations, white-fir, Engelmann spruce, subalpine fir and whitebark pine are also important forest components (Figure 12 and

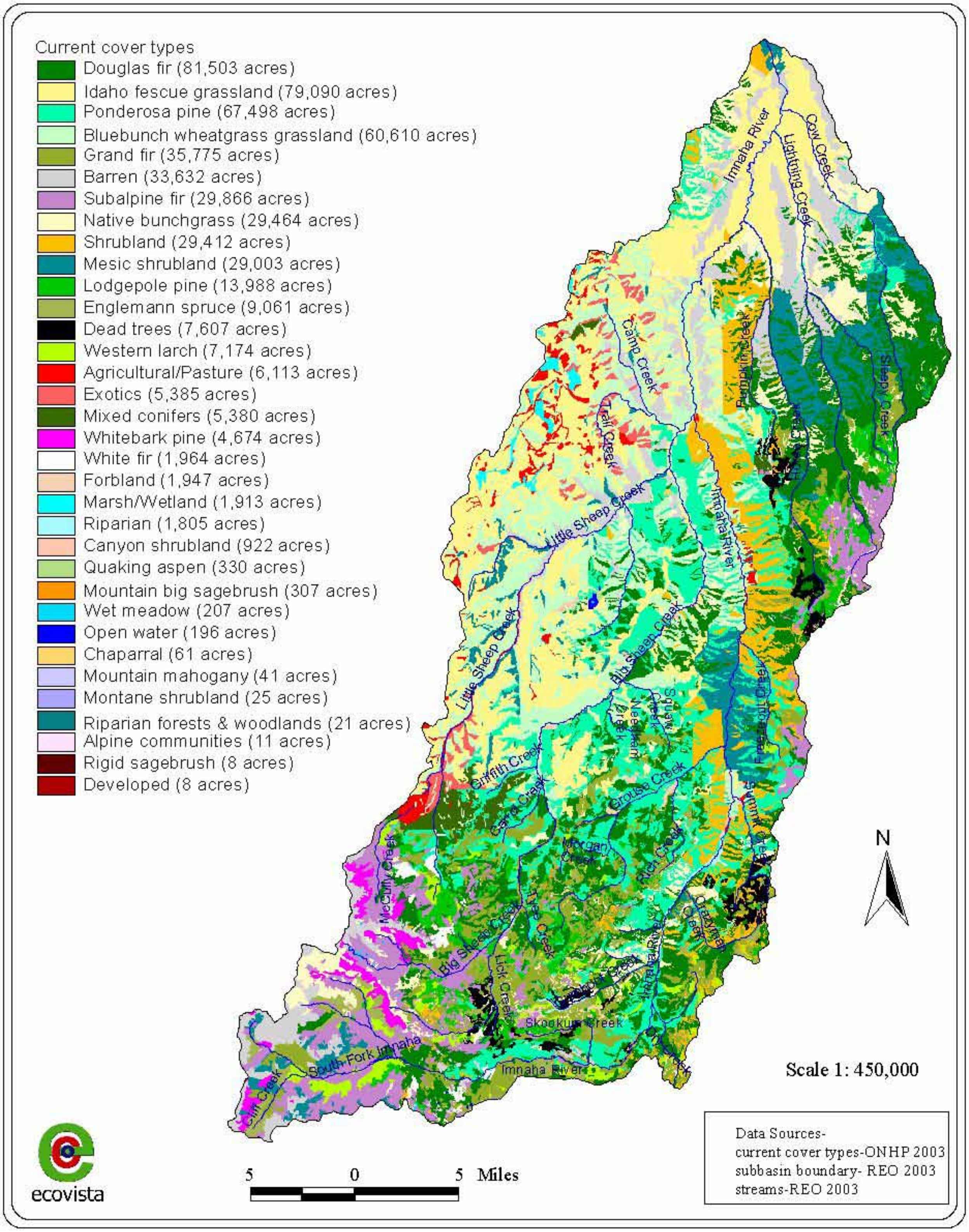

Figure 13). Characteristics of these vegetative communities and their understory components are discussed in greater depth in the following section.

Wildlife Habitat Types

Johnson and O'Neil define a wildlife habitat as "an area with the combination of the necessary resources (e.g., food, cover, water) and environmental conditions (temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species (or population) and allows those individuals to survive and reproduce" (2001). Wildlife habitats are viewed as hierarchical in nature with vegetative type being the coarsest element selected for by a species, vegetative structure the next, and unique habitat elements (e.g., snags) the finest (Johnson and O'Neil 2001).

Wildlife habitat types (WHTs) represent the first level in this hierarchy. They are groupings of vegetative cover types based on similarity of wildlife use that have been delineated across the Columbia Basin by the Northwest Habitat Institute. The use of WHTs in this assessment facilitates the assessment of wildlife conditions at the scale of the subbasin and allows for interpretation of this subbasin scale assessment in the context of the Blue Mountain Province and the Columbia Basin as a whole. The 395 species of wildlife with potential habitat in the Imnaha subbasin and the WHTs with which they are closely associated are displayed in Appendix A. The current distributions and abundance of WHTs in the subbasin are shown in Figure 14. When compared with the current cover type distributions

(

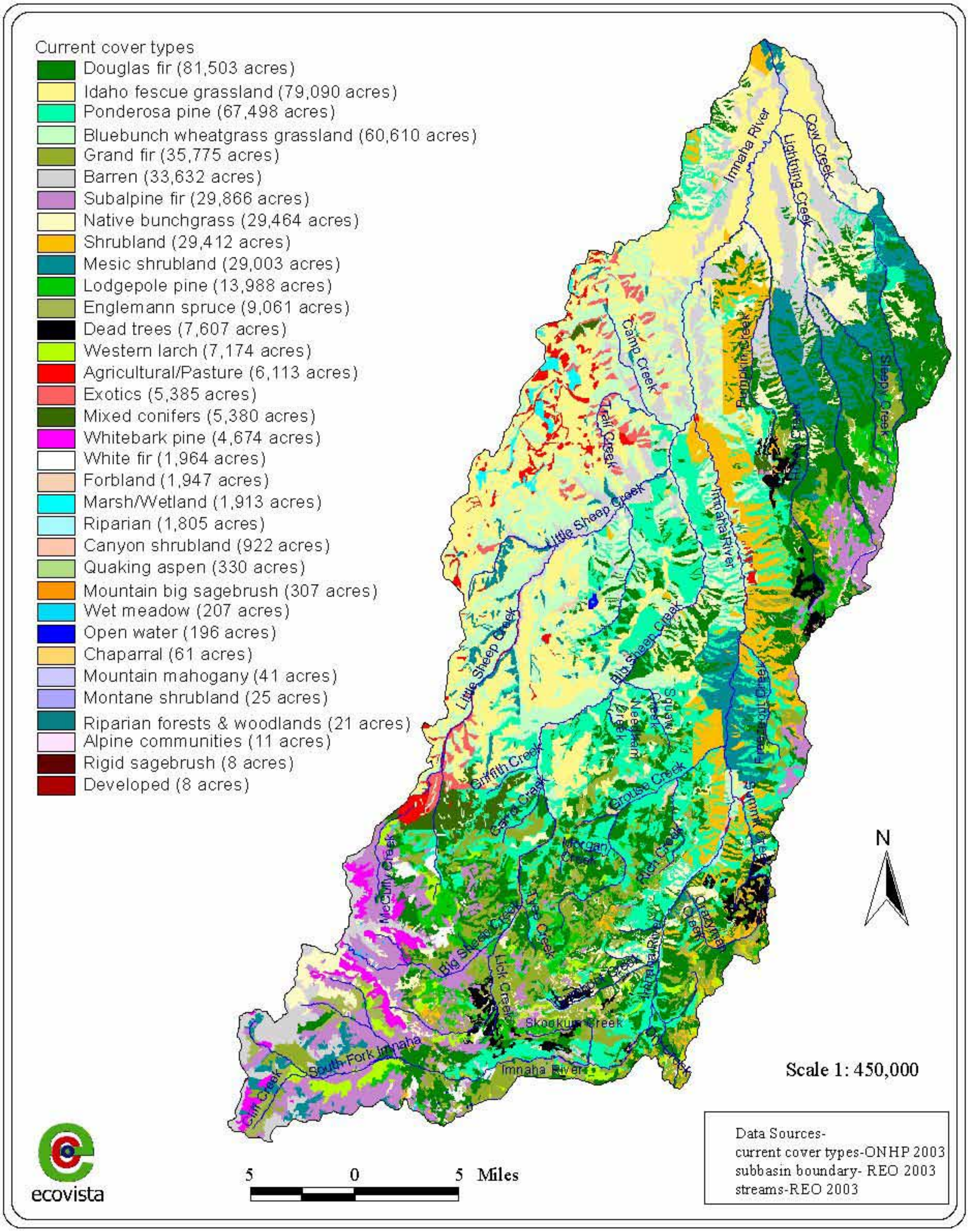

Figure 13) some apparent discrepancies emerge. This is partially due to differences in the sources and resolution of the base data but also to differences in the definitions of a cover type

and a WHT. For example an area of the subbasin currently covered by ponderosa pine trees would be classified as ponderosa pine cover type but could be classified as eastside mixed conifer forest WHT if ponderosa pine is seral to grand fir on that site.

Columbia Basin scale descriptions of the vegetation and climatic conditions characteristic of each WHT have been developed by the Northwest Habitat Institute. Imnaha subbasin specific descriptions of vegetative characteristics, organized by vegetative series, were written by the Wallowa-Whitman National Forest for inclusion in the *Big Sheep Creek Watershed Analysis Report* released in August 1995. The vegetative series align closely with the WHTs, and so their descriptions were used to interpret the coarse-scale WHT descriptions and make them more specific to the Imnaha subbasin. Table 6 documents the assumptions made when “crosswalking” between vegetative series and WHT.

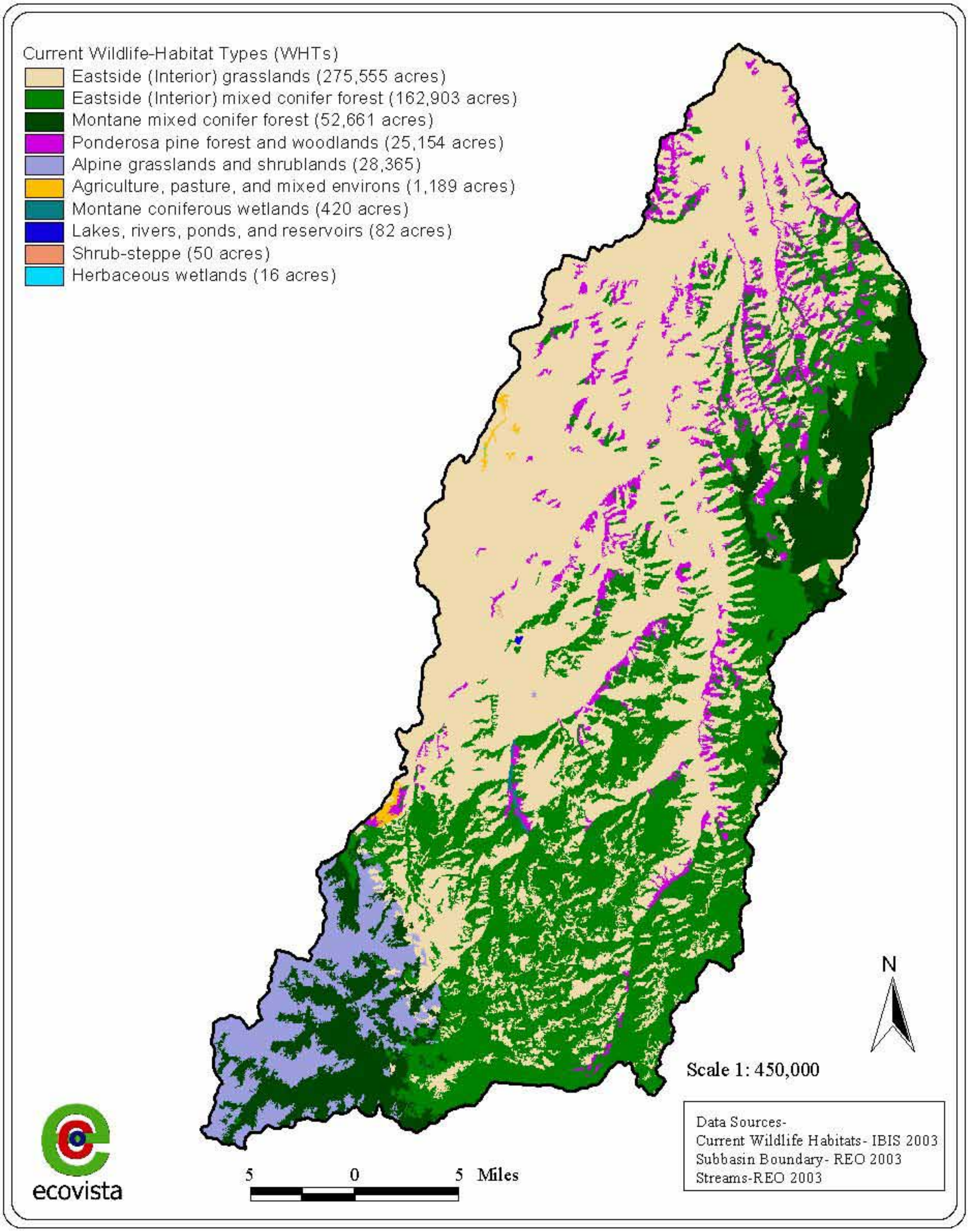

Figure 14. Current wildlife habitat types (WHTs) of the Imnaha subbasin.

Table 6. Assumptions made about relationship between vegetative series and wildlife habitat types (WHTs).

Vegetative Series or Type (USFS 1995)	WHT (IBIS 2003)
Alpine Green fescue	Subalpine parkland Alpine grasslands and shrublands
Subalpine fir	Montane mixed conifer forest
Mixed conifer	Eastside mixed conifer forest Lodgepole pine forest and woodlands
Douglas-fir Ponderosa pine	Ponderosa pine forests and woodlands
Idaho fescue Shrublands	Eastside grasslands
Moist and wet meadows	Herbaceous wetlands Montane coniferous wetlands
Quaking aspen	Upland aspen forest
Riparian vegetation	Eastside riparian-wetlands

Descriptions of the current WHTs in the Imnaha subbasin follow. Lodgepole pine forest and woodlands, subalpine parklands, wetlands and upland aspen habitat are important components of the historical WHT map but are absent from the current WHT map. Most local literature indicates that, although these WHTs may have declined in the Imnaha subbasin, they are not absent. Therefore, these WHTs are also described below to aid the reader in understanding the factors that may have led to their decline, which will be discussed later in this document. A very small amount of the shrub-steppe WHT occurs in the subbasin; this habitat is viewed by the terrestrial subcommittee to be almost nonexistent in the subbasin and will not be discussed in this document. Conversely, the eastside riparian and wetland habitat is absent for the current WHTs, this is likely due to the difficulties associated with mapping riparian habitats at all but the finest of data resolutions; this habitat type is considered a priority habitat by the terrestrial subcommittee and is discussed in detail in section 1.1.2.4. The Open Water (lakes, streams and rivers) and wetlands habitats are also described in sections 1.1.2.1, and 1.1.2.5, respectively. See section 1.1.1.10 for a description of agricultural areas in the subbasin.

Montane Mixed Conifer

This WHT occurs in the upper elevation forests (4,800–9,100 feet) of the Imnaha subbasin and is usually dominated by subalpine fir or Engelmann spruce. Other tree species that occur within this WHT include Douglas-fir, lodgepole pine, western larch, grand fir, white bark pine, or white fir. Understory species include grouse huckleberry, big huckleberry, Utah honey suckle, prince's pine, round-leafed violet, and skunk leave polemonium. Succession lodgepole pine and western larch are early seral pioneers of this WHT following disturbance (USFS 1995). This WHT receives an average of 48.0 inches of precipitation a year (Figure 7 and Figure 12).

Eastside Mixed Conifer

This WHT makes up most of the continuous montane forests of the inland Pacific Northwest. It is located between the subalpine portions of the montane mixed conifer forest and the lower tree line ponderosa pine and Forest (IBIS 2003). In the Imnaha subbasin, this WHT is found between approximately 1,000 and 7,200 feet in elevation. These areas receive an average of 33.6 inches a year (Figure 7 and Figure 12).

The Eastside Mixed Conifer WHT of the subbasin is characterized by a wide variety of tree species, which includes seral ponderosa pine, lodgepole pine, western larch, Douglas-fir, and during middle to late seral stages, grand fir and Engelmann spruce. Understory species include big huckleberry, Utah honeysuckle, prince's pine, ninebark, round leaved pyrola, heartleaf arnica, and rattlesnake plantain. Due to past activities, introduced grasses such as timothy orchard grass and mountain brome are also a component of the understory (USFS 1995). Stand structure is diverse, including both single-layered forest canopies and multilayered forests. Stands can be open or closed (IBIS 2003).

Generally, on this WHT early seral forests develop on previously forb and/or shrub dominated communities around 50 years after disturbance. Early seral forest develops into mid-seral habitat of large trees during the next 50 to 100 years. Under natural conditions stand replacing fires would recycle most of the landscape back to an early seral condition but areas that escaped these fires typically, cooler wetter areas would develop into large diameter mature forests (IBIS 2003).

Lodgepole Pine Forests and Woodlands

In most parts of the Columbia Basin, this WHT is located mostly at middle to higher elevations (3,000–9,000 feet). These environments are usually cold and relatively dry, with persistent winter snowpack. Historically, this WHT was a relatively minor component (1%) of the subbasins forests, and it does not exist on the current WHT map (Figure 14). The loss may be in part due to differences in mapping techniques between the historical and current data, but is probably also attributable to the affects of fire suppression (IBIS 2003).

Lodgepole pine WHTs originated with fires. Typically, lodgepole pine establishes within 10 to 20 years after fire. With time, lodgepole pine stands increase in fuel loads. Woody fuels accumulate on the forest floor from insect (typically mountain pine beetle) and disease outbreaks and residual wood from past fires. Under natural conditions a fire eventually, burns the stand and succession is reinitiated. Inland Pacific Northwest lodgepole pine has a mean fire interval of 112 years (IBIS 2003).

Lodgepole pine is dependent on fire to reinitiate growth, since it cannot reproduce under its own canopy. In the absence of fire, lodgepole pine stands are eventually replaced by shade-tolerant conifers. These species, which are common in the undergrowth of most stands, grow up through the understory and eventually shade out the lodgepole pine. This would result in the conversion of the lodgepole pine WHT to Eastside Mixed Conifer Forest. On well-drained, deep Mazama pumice soils in this WHT lodgepole pine is the climax tree species. Lack of natural regeneration on these sites can lead to the creation of "pumice deserts" within otherwise forested habitats (IBIS 2003).

Ponderosa Pine Forests and Woodlands

This woodland habitat typifies the lower treeline zone forming transitions with Eastside Mixed Conifer Forest and Eastside Grassland WHTs. In the Imnaha subbasin, it occurs between approximately 1,000 and 5,900 feet in elevation. These areas receive an average of 19 inches of precipitation a year (Figure 7 and Figure 12).

The Ponderosa pine WHT contains areas where Ponderosa pine is the mature community dominant as well as areas where Ponderosa pine is seral and replaced by Douglas-fir at climax (IBIS 2003). In the hottest driest forested sites of the subbasin, ponderosa pine is the only tree species that can exist. These sites occur on southern aspects at middle elevations or on northern aspects in lower elevations. On low-elevation sites ponderosa pine occurs in narrow stringers along draws. Common understory species include common snowberry, Idaho fescue, bluebunch wheatgrass, pinegrass, and introduced cheatgrass (USFS 1995).

On cooler sites with more precipitation within this WHT ponderosa pine is seral to Douglas-fir. These areas sometimes also support a western larch or grand fir contingent (IBIS). Here common understory species include common snowberry, spirea, ninebark, Oregon-grape, pinegrass, elk sedge and western fescue (USFS 1995).

Natural fire regimes maintained open park-like stands of mature ponderosa pine on this WHT. Fire suppression has resulted in an increase in the prominence of Douglas-fir and higher stand densities (USFS 1995).

Upland Aspen Forest

This WHT type was mapped as occurring historically in the subbasin but is absent from the current WHT maps. Local knowledge indicates that while rare and typically small, quaking aspen stands continue to be an important component of the subbasin's forests. Aspen clones are generally limited to fringes around meadows or as islands in a ridgetop grassland where subsurface moisture is available throughout most of the growing season. Because most aspen stands have been highly modified by cattle and big game use, describing the native community is difficult. Grasses and sedges occurring in better condition stands include pinegrass, elk sedge, Hood's sedge, Kentucky bluegrass, and mountain brome. Major associated species include leafy aster, showy fleabane, sticky cinquefoil, paintbrush, lupines, penstemons, blue stickseed, and meadowrue (USFS 1995).

Subalpine Parkland

The Subalpine Parkland habitat represents the highest elevation habitat in the subbasin able to support trees. It is very cold, with a very short growing season and high snow levels. Tree species found on these sites are whitebark pine and subalpine fir. Tree canopy cover on these sites is sparse, usually between 10 and 30%. Trees are distributed either as isolated trees or in small groups. Understory species can include grouse huckleberry, Parry's rush, and green fescue. Large rock and talus slopes can be prominent landscape components (USFS 1995).

Alpine Grasslands and Shrublands

The climate of this WHT is the coldest of any in the subbasin. Conditions are extreme with a short growing seasons, high snow levels and intense winds (USFS 1995). Blowing snow and ice crystals on top of the snow pack at and above treeline prevent vegetation such as trees from growing above the depth of the snow pack (IBIS 2003). In the Imnaha, this WHT is found between 5,100 and 9,600 feet in elevation. It receives an average of 64 inches of precipitation per year (Figure 7 and Figure 12). Historically, it occurred adjacent to, or in a mosaic with, Subalpine Parkland but now abuts Montane Mixed Conifer Forest (IBIS 2003).

Green fescue plant communities dominate much of the Alpine Grassland and Shrubland WHT in the subbasin. Under natural conditions, late seral stands of green fescue will form dense mats of almost continuous sod virtually free of forbs (USFS 1995). The green fescue communities of the Imnaha subbasin were severely overgrazed by sheep in the late 1800s and early 1900s (Reid, Johnson and Hall 1991). This resulted in severe erosion of topsoil and the replacement of much of the green fescue by Letterman's needlegrass (*Stipa lettermanii*) and Western needle grass (*Stipa occidentalis*). Dramatic reductions in sheep grazing in the subbasin between 1900 and 1960 resulted in improved conditions. By 1988, concentrations of needlegrass and forbs had decreased and green fescue had increased. Slender wheatgrass, prairie junegrass (*Koeleria cristata*), and timber oatgrass (*Danthonia intermedia*) began to occupy what had been bare patches between the Idaho fescue clumps. Forbs that continue to be associated with these sites include Wyeth's buckwheat (*Eriogonum heracleoides*), fleeceflower (*Polygonum phytolaccaefolium*), Nuttall's lianthastrum (*Linanthastrum nuttalli*) (Reid, Johnson, and Hall 1991), and spurred lupine (*Lupinus laxiflorus*) (USFS 1995). Conditions continue to improve on the green fescue grasslands of the subbasin, although evidence still remains of past overuse with areas of erosion persisting (USFS 1995).

Eastside Grasslands

Eastside Grassland WHT occurs in the lowest elevations of the subbasin. These sites receive an average of 20 inches of precipitation a year (Figure 7 and Figure 12). The majority of grasslands in the subbasin are dominated by Idaho fescue or bluebunch wheatgrass association (USFS 1995). Characteristics of the major grassland associations found in this watershed follow.

Idaho Fescue–Prairie Junegrass (*Festuca idahoensis–Koeleria cristata*)

Idaho fescue–prairie junegrass associations are among the most productive in the watershed producing between 990 and 1,200 pounds per acre. They occur at a wide range of elevations and on all aspects. Associated plant species include bluebunch wheatgrass, Sandberg bluegrass, and rattlesnake brome, as well as forbs such as arnica, geum, red besseya, wild hyacinth, frasera, hawkweed, lupine, Wyeth's buckwheat, gumweed, yarrow, and paintbrush. Degraded areas can be invaded by annuals such as bromes, red threeawn, chickweed, arnica, annual fescues, and goat weed. Disturbance may also result in replacement of Idaho fescue by Kentucky bluegrass on deeper soils (USFS 1995).

Idaho Fescue–Bluebunch Wheatgrass (*Festuca idahoensis–Agropyron spicatum*)

These plant associations occur up to 6,000 feet in elevation on all aspects depending on the particular association. Associated plant species included prairie junegrass, Sandberg bluegrass, rattlesnake brome, one spike oat grass and forbs such as silky lupine, deerhorn, willowweed, balsamroot, hawksbeard, fleabane, and phlox. Production in the deeper soil types averages between 600 and 805 pounds per acre; on ridgetops, production is lower, at 360 pounds per acre (USFS 1995).

Bluebunch Wheatgrass–Sandberg Bluegrass (*Agropyron spicatum–Poa sandbergii*)

The bluebunch wheatgrass–Sandberg bluegrass association produces an average of 685 pounds per acre. Associated species include lupine, yarrow, balsam root, and annual bromes. On highly disturbed sites cheatgrass will invade aggressively and may form continuous pure stands.

Bluebunch Wheatgrass–Wyeth's Buckwheat

Bluebunch wheat grass–Wyeth's buckwheat plant associations are found at moderate elevations in the watershed and produces an average of 420 pounds of forage per acre. Associated plant species include sulfur buckwheat, pine bluegrass, oniongrass, and forbs such as yarrow, penstemon, lupine, lomatium, balsamroot, frasera, and paintbrush (USFS 1995).

1.1.1.10 Human Influences on Natural Resources

The use of natural resources and associated population of lands within the Imnaha subbasin has been relatively minimal, when compared with that which has taken place in similar sized subbasins throughout the Columbia Basin. Peak periods of land use in the Imnaha coincide with the introduction of domestic livestock, establishment of a transportation infrastructure, and advancements in industrial technology. The relative remoteness and ruggedness of the subbasin has precluded it from much of the development and/or population common to similar subbasins. Land use activities most commonly cited as producing a measurable impact on fish and wildlife communities in the Imnaha subbasin include grazing, roads and road building, timber harvest, agriculture, and to a lesser extent, water development and mining.

Population of the Subbasin—Historical and Current

In the late 1700s, events in eastern North America set the stage for the changes about to commence in the Imnaha subbasin, and in the Pacific Northwest. After signing the Declaration of Independence in 1776, a newly formed nation of states along the eastern seaboard looked westward for expansion possibilities. Exploration of the recently acquired Louisiana Purchase in the early 1800s led Meriwether Lewis and William Clark into the largely unknown Oregon Country and ultimately to the mouth of the Columbia River. Early reports of vast and valuable natural resources prompted a westward migration of immigrants, some who eventually settled in the Imnaha subbasin.

In 1878 the first permanent white settlers in the Imnaha established residence just south of the present town of Imnaha (Mays 1992). Homesteaders and associated livestock production were soon to follow, especially along the gentler slopes and benchland areas. These regions, which coincided with many of the areas previously occupied by the Nez Perce, were primarily public domain lands (USFS 1998d). Passage of the Timber and Stone Act, coupled with railroad construction in the late 1880s, initiated the first nonagricultural resource use in the Imnaha subbasin and stimulated further development of ranches and farms in the valleys (Duncan and Cawthorn 1994).

As more settlers entered the Wallowa Valley, their grazing operations were expanded throughout the region. This expansion included some of the more remote areas along the Imnaha and Big and Little Sheep creeks (USFS 1995). By 1881, the Pallette Ranch area (formerly Fruita, OR), represented one of the more upstream regions of the mainstem Imnaha where settlers established residency and livestock operations.

Early accounts of locations of schools and/or school districts provide insight into settlement patterns and population densities in the Imnaha. Government Land Office records describe the establishment of the Bridge School District No. 11 at the present site of the town of Imnaha in 1884 (USFS 1998d). The Bridge is the only remaining school district presently in operation in the subbasin. Other districts historically in the subbasin included District No. 9, located on the divide between Twobuck and Coyote creeks (out of the subbasin), District No. 15, located near the present site of the old Midway stage stop on the Zumwalt Road, District No. 53, located in the head of Camp Creek between Harsin and Findley Buttes, District No. 73, located on Clear Lake Ridge, and District No. 89, located on Marr Flat (Government Land Office records presented in USFS 1995). Government Land Office data indicate a period of rapid population growth in the subbasin between 1881 and 1889. However, by 1949, the only remaining school district in the subbasin was the Bridge School District. This was due to several factors including improved transportation networks, changes in population distribution, and shifts in agricultural production.

Based on Government Land Office data analysis, early homesteaders preferred lands in or near stream valleys to uplands or ridge tops (USFS 1995). This preference was also shared by the Nez Perce and is evident today. The selection of lands is clearly based on resource abundance and quality, as the upland areas tend to have less water and thinner soils than in the valleys. The early settlers rapidly exploited riparian areas, meadows, and any other lands near the homestead that could potentially be used in the production of livestock or agricultural commodities (Wallowa County and NPT 1993). The Wallowa National Forest Atlas reveals that, by 1917, the bottoms of Big and Little Sheep creeks had all been claimed (USFS 1995).

Regardless of location, the early settlers in the Imnaha were mainly subsistence oriented (USFS 1995). They generally maintained a few head of livestock, farmed tillable lands within the boundaries of their homestead, and built cabins from locally available materials, which were often large diameter logs from adjacent timber stands. Crops of hay or grain were raised for livestock feed, and were often grown on the bars adjacent to the stream channel (USFS 1995). Dryland farming occurred to a limited extent on upland and bench areas, as did irrigated agriculture near streams (USFS 1995). Because of the limited transportation network, the incentive to grow surplus crops was limited. Orchards were established in the immediate vicinity of the homesteads, many of which still exist.

The homesteaders soon found the Imnaha country to be less hospitable than originally perceived. The remoteness and difficulty in obtaining supplies and getting animals to market, coupled with a depression of livestock prices and harsh winters in 1918 and 1919, were too much for many of the small operators to bear (USFS 1998d). By 1919, only 5% of the original homesteaders remained on their claims on the Wallowa National Forest (Straton and Lindeman, as cited in USFS 1995). Some of the 160-acre homesteads reverted back to federal ownership, while the more established, larger livestock operators purchased the remainder.

Current commercial development in the Imnaha subbasin is restricted to the small town of Imnaha (population 25), which consists of a cafe, store and tavern, gas station, motel, and GTE field office (USFS 1998d). Community buildings include an elementary school (the historical "bridge" school), library, post office, and church. There are also home-based businesses and a privately owned lodge and outfitter and guide services.

Private residences are scattered along the river corridor, including the Imnaha River Woods subdivision, a housing development located near the upper third of the drainage. Hydrologists have expressed concern over the amount of bank armoring adjacent to dwellings and structures, fearing that the riprap will alter downstream flow regimes and channel morphology (T. Carlson, Wallowa-Whitman National Forest, personal communication, April 12, 2001). Current land use regulations passed by the Wallowa County Planning Commission restrict the sale of land for subdivision. In general, the pattern of settlement and use of private land within the watershed has not changed much since the 1940s, and many descendents of the original settlers still reside in the Imnaha Valley.

Grazing

The first domestic livestock to be grazed in the Imnaha were owned by the Joseph band of the Nez Perce. The tribe first grazed horses in the canyon lowlands circa 1730–1750. The Nez Perce acquired cattle sometime after 1840 (Wallowa County and NPT 1993) and began grazing them with their bands of Appaloosa (Mays 1992). It is estimated that the Nez Perce were grazing as many as 500–650 head of cattle in the Imnaha by the late 1840s (Chalfant 1974; Womack 1996, as cited in WWNF 1998). By 1877, the tribe was running between four and five thousand head of livestock in the lowlands (Skovlin and Thomas 1995).

The Imnaha subbasin (and most of Wallowa County) was one of the last areas in Oregon to be settled by Euroamerican livestock producers (Wallowa County and NPT 1993). Its remoteness and rugged topography caused most westward-bound stockmen to bypass or ignore the area. Upon their eventual discovery of the Imnaha, the early settlers contributed considerable numbers of domestic livestock to Indian herds and effectively diluted the once dominant Nez Perce stock. Although some of the settlers attempted to raise livestock for profit, the majority relied on cattle, sheep and horses for subsistence purposes. Cattle and sheep were raised for food and clothing, while horses were generally raised for power and transportation.

Shortly following the Nez Perce Tribe's exile from the Imnaha, the settlers brought large numbers of sheep to the subbasin, augmenting the already growing number of domestic ungulates. The number of sheep and cattle continued to grow through the 1890s and into the 1900s. Cattle were emphasized initially, but by 1911 were far outnumbered by sheep (Figure 15) (WWNF 1995). While it is unknown whether the data in Figure 15 represent actual or permitted livestock, it *is* known that the data are for animals on National Forest lands only and do not include livestock operations within the private sector. Numbers of livestock during the late 1890s and early 1900s therefore likely exceeded those shown in 1911 (WWNF 1995).

Sheep were grazed heavily in the Imnaha subbasin from the early 1890s until around 1920 (Mays 1992, Skovlin and Thomas 1995, WWNF 1995). Concern for the condition and loss of range arose during the early 1900s, and resulted in the institution of grazing restrictions by the USFS in 1910 (Mays 1992).

Figure 15. Historical livestock numbers on the Wallowa National Forest (WWNF 1995).

The legacy effects from grazing practices of the late 1800s and early 1900s caused intense competition for grass between the livestock operators. Soon all the best or most accessible ranges and pastures were overgrazed (Wallowa County and NPT 1993). By 1930, most riparian areas had lost their native grasses and woody vegetation (Wallowa County and NPT 1993). Defoliation of ridges, upland meadows, and side hills contributed to excessive sedimentation in stream channels during spring runoff and following summer storm events and caused many of the streams to "run brown with mud" (Wallowa County and NPT 1993).

Concern for the land by livestock producers who had seen the Imnaha in its prime soon mounted. Associations were formed, and with the assistance of the USFS, grazing in the subbasin was reduced. As stated by Wallowa County and the Nez Perce Tribe (1993), "only the people present during the years of fierce competition for rangeland can appreciate the improvements that have occurred since the early thirties." The improvements were driven in large part by passage of private and federal land regulations in 1994 and again in 1997 that set forth certain rules governing land use activities and development. Within the regulations was a record of decision signed in 1995, which formally terminated sheep grazing in the subbasin. The primary goal of the removal of sheep from the area was to reduce potential interaction between domestic and bighorn sheep. The HCNRA was grazed through the 1996 season, at the end of which all allotments occurring in the area became vacant. The Eagle Cap Wilderness Area was grazed through the end of the 1998 season and became vacant in 1999 (D. Bryson, Nez Perce Tribe, personal communication, May 2001).

Livestock, specifically sheep, grazing public ranges have been reduced to 15% of the highest number grazed historically (Wallowa County and NPT 1993). Currently there are 27 active allotments (Figure 16) and 5 administrative horse pastures within the Imnaha watershed. Term grazing permits issued to individual permittees specifies the authorized number of livestock and period of use to be grazed within the allotment. The allotments may be divided into various pastures through which the livestock are rotated. See Appendix B for more details on the number of livestock and season of utilization of the allotments in the Imnaha subbasin. The allotments support grazing at a level of approximately 37,900 animal unit months (Mays 1992).

Management approaches designed at improving vegetative cover, retaining soil and protecting streams are employed by both the USFS and permittees (WWNF 1999). A downward trend in AUMs has occurred in recent years and an upward trend in the number of cross fences, exclosures and off-stream water developments constructed in or near riparian areas. The Wallowa-Whitman National Forest has recently excluded 3 miles of stream (a total of six miles of fence) from livestock, and has completed 38 upland exclosures, ensuring protection of springs, seeps, wetlands, intermittent draws, perennial nonfish-bearing streams, ephemerals, and ponds (J. Platz, Wallowa-Whitman National Forest, personal communication, May 2001). The USFS has also planted coniferous and deciduous trees along 19 miles of stream channel.

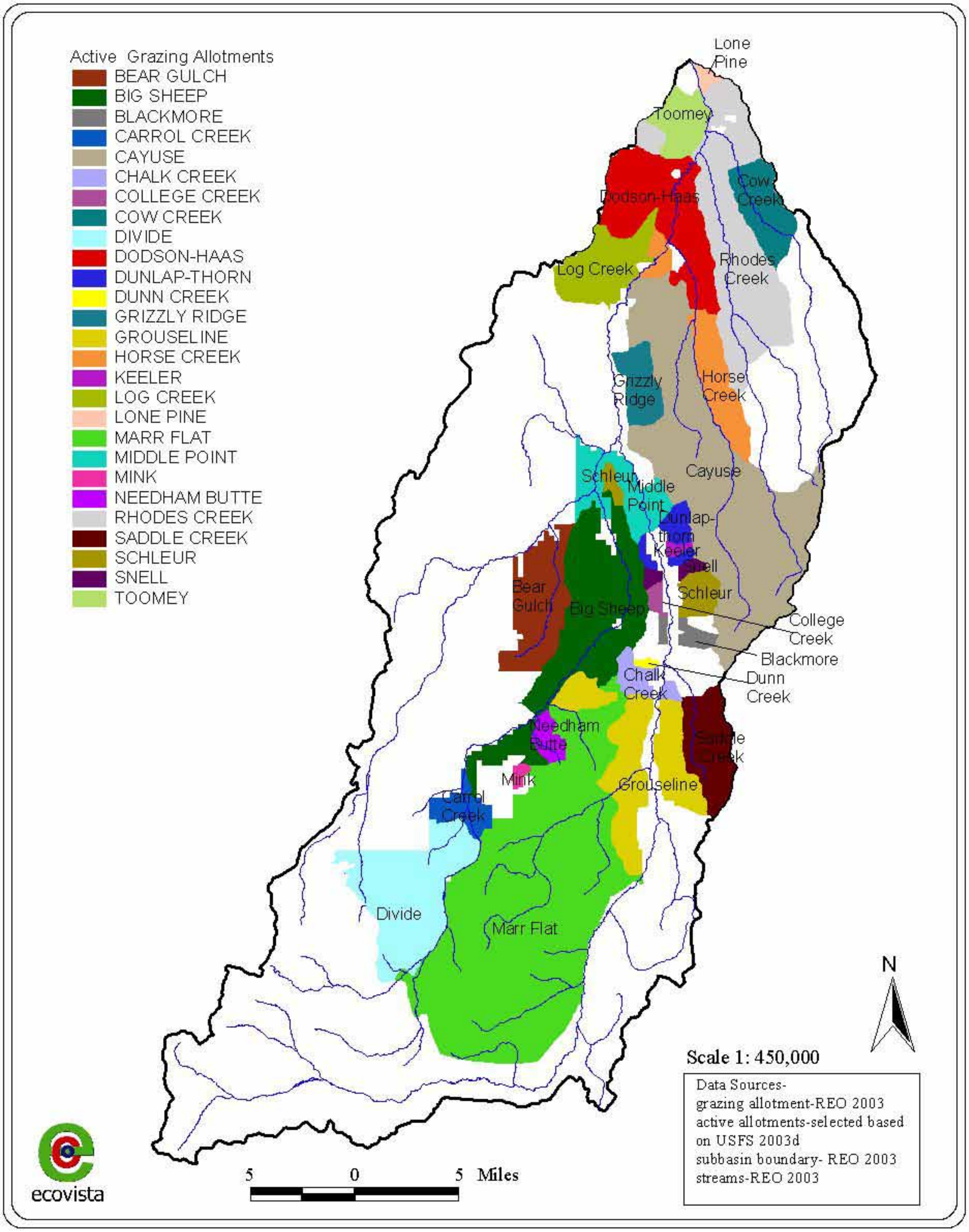

Figure 16. Active grazing allotments in the Imnaha subbasin.

Despite restoration efforts, legacy effects from the extensive historical grazing pressure in the Imnaha persist and can still be seen around seeps, springs and some stream segments where the native fescue plant communities were removed, streambanks disturbed, and soil compacted (WWNF 1998, Ashe et al. 2000). Grazing and cattle allotments in the Grouse, Big Sheep and Little Sheep watersheds have contributed to reduced water quality (increased nutrients) and fish habitat degradation (reductions in shade-providing vegetation). Feedlots, located on private lands along Little Sheep Creek and the upper and lower mainstem Imnaha, contribute varying amounts of nutrients to surface water (NPT et al. 1990), most notably following localized, high-intensity thunderstorms (B. Smith, ODFW, personal communication, April 12, 2001). The impacts of this pollution on the aquatic environment are, however, considered to be short in duration and scope due to the volume and velocity of flows in the affected areas (B. Smith, ODFW, personal comm

Transportation

Transportation systems in the Imnaha have developed in response to population growth and associated supply and demand for goods and services. The extent of the transportation network has, however, been limited by the remoteness and ruggedness of the drainage. Roads established along the mainstem Imnaha River, Big Sheep and Little Sheep creeks during early settlement remain in use today, although they have been improved.

The Joseph band of the Nez Perce Tribe was the first to construct transportation networks in the Imnaha. Their trail systems, which were built along stream channels, ridges, and hillslopes, provided access to hunting, fishing, and root gathering areas (Haines 1955). The Nez Perce trails were often dirt paths clear of vegetation. They also used fire to aid in travel corridor maintenance and construction (e.g., Haines 1955, USFS 1995).

Homesteaders who had settled in the subbasin in the late 1800s constructed roads in areas that required the least development, such as along ridgetops or stream bottoms (USFS 1998b). The early settlers also relied on the preexisting Nez Perce trail system to access hunting and grazing (sheep) areas in the higher-elevation portions of the subbasin (USFS 1998d). There were two primary dirt roads/trails in and out of the town of Imnaha at this time; one connected Imnaha with Joseph and Enterprise via Findley Buttes, Trail, Camp, and Big Sheep creeks, while the other road followed the main channel upstream to the Pallette Ranch area and then on up to Joseph. Because of limited use and narrow size neither road likely represented significant risk to Imnaha fisheries or fish habitat (Mays 1992).

Early roading in the Big Sheep Creek subwatershed began in 1902 with the construction of a stage route from what is now the Zumwalt road to the Midway stage stop, and eventually to the town of Imnaha (USFS 1995). A road from the Divide area to Salt Creek Summit, and eventually to Tenderfoot Mine in the Eagle Cap Wilderness was also constructed circa 1902–1905, connecting the upper portions of the Big Sheep Creek subwatershed to the Wallowa Valley (USFS 1995).

Early transportation systems were not limited to roads. A considerable demand existed for a Snake River travel corridor to be established between Lewiston and the Eureka Mine, a claim staked in 1898 downriver from the mouth of the Imnaha (for information about mining, see p. 57). The copper ore smelted at the site represented a potentially lucrative commodity to downriver interests, and justified the construction of steamships capable of navigating the "writhing" Snake River from Lewiston to the Imnaha (Carrey et al. 1979). The steamer *Imnaha* was built to service the Eureka Mine with supplies for construction and mining operations, and made fourteen successful trips from Lewiston to the mine before sinking in 1903. The loss of the *Imnaha* was significant since the ship was carrying machinery essential for the mills operation. The Eureka Mine subsequently shut down circa 1906 (Carrey et al. 1979).

The Enterprise/Joseph area was connected to Wallowa and La Grande, Oregon, in 1909, following completion of the Enterprise Line of the Union Pacific Railroad (Wallowa County and NPT 1993). This provided a market for large tracts of virgin timber present in Wallowa County. Railways were also used to access Wallowa County forests and transport the logs to nearby mills (Wallowa County and NPT 1993). Completion of the railroad also greatly influenced the development of the agricultural economy by providing farmers and ranchers a railhead from which to quickly and efficiently move livestock, grain and other produce to Northwest markets (USFS 1995).

Improvements to the Midway/Imnaha stage line occurred circa 1905–1910 (USFS 1995). The new road followed the Little Sheep Creek channel, roughly paralleling the course of the present Imnaha Highway. Construction of this road is significant since it laid the foundation and general location for State Highway 350, which is considered to have significant effects on channel function, hydrology, and fish habitat quality and quantity of Little Sheep Creek (e.g., USFS 1994a; 1995; 1998a). The 1905–1910 road also opened up more portions of the subbasin for development, as it deviated considerably from the location of the original road, as shown in the following quote (USFS 1995):

> Turning up Rail Canyon, the track crossed the head of Threebuck Creek, down Coyote Creek to Big Sheep Creek, thence up Big Sheep for approximately 4.5 miles. The road then switchbacks up the steep slope to Marr Flatt, across Marr Flatt to Road Canyon, down the bottom of this draw to Grouse Creek, and then down the bottom of Grouse Creek to the Imnaha River. It is hard to imagine this road being less tortuous than the Midway stage road.

In 1935, the Little Sheep Creek road to Imnaha was opened to the public. In the late 1950s and early 1960s, Oregon State Highway 350 was paved.

Development and improvement of existing road networks elsewhere in the Imnaha occurred between the 1940s and 1960s (Mays 1992, Wallowa County and NPT 1993). The era is described as one of "massive road building" for timber harvest in Wallowa County (Wallowa County and NPT 1993). Roads were paved, widened, and networks expanded to provide access to timber sales, pastures for grazing, and areas for ranch development. Although the relative density of road networks was low, some of this construction came at a cost to the environment. A common road construction practice by the USFS and other entities was to sidecast the excess or "overburden" material as the road was being built (Mason et al. 1993). Invariably, much of this material would enter stream channels due to the inherently steep gradient common to the drainage. For example, during the winter of 1952–1953, road construction activities along the Imnaha River (Road 3955) triggered a rockslide approximately 15 miles above the town of Imnaha. The deposition of material posed a serious barrier to fish migration, albeit partial, for at least two years (Beamesderfer et al. 1996). The USFS now endhauls this material to designated dumpsites (Wallowa County and NPT 1993).

From the late 1970s to 1985, the miles of road constructed on the Wallowa-Whitman National Forest doubled from 4,350 miles to over 8,700 miles (McIntosh et al. 1994). Currently, 1,292 miles of open and closed roads exist in the Imnaha watershed (USFS 2000). Of these, 834 miles occur on lands administered by the Wallowa-Whitman National Forest, and 438 miles occur on private, state, and Bureau of Land Management (BLM) lands (USFS 2000) (Figure 17).

The overall road density for open and closed roads (all management jurisdictions) is 1.52 miles of road per square mile of land (USFS 2000). On that portion of the watershed not administered by USFS, the road density (open and closed) is 1.53 miles of road per square mile, compared with USFS-administered land where it is 1.57 miles per square mile (land area includes unroaded wilderness). Road densities in USFS-managed *non*wilderness areas may be higher than in other areas of the watershed. Generally, road densities on federally administered lands fall within the Forest Plan Standards and Guidelines of fewer than 2.5 miles of open roads per square mile of land.

In two subwatersheds of the Imnaha, road densities are considerably higher than the road density for the watershed as a whole (USFS 1998b). The Gumboot subwatershed has 3.2 miles of open road per square mile of land, while the upper Imnaha (near RM 55) subwatershed has 3.66 miles of open road per square mile of land (see section 1.5.2 for details).

Sections of the upper and lower Imnaha River road that were built in the floodplain or along unstable areas directly above the channel have contributed to problems throughout the drainage. Road failures, landslides, sedimentation, channelization, and reduction/elimination of riparian habitat are among the effects the upper and lower Imnaha road have had on aquatic resources (e.g., Thompson and Haas 1960; Mays 1992; USFS 1998a,b). The Imnaha road infrastructure was considerably disrupted following the 1997 flood event, necessitating reconstruction efforts throughout much of the subbasin (USFS 1998b). As a result of the 1997 flood, sections of the USFS Road 39, upper and lower Imnaha River Road (county jurisdiction), associated bridges, and adjacent residential property were damaged. The county roads and bridges have since been reconstructed. This often involved riprap, rechannelization of the Imnaha River, and rock barb placement (USFS 1998).

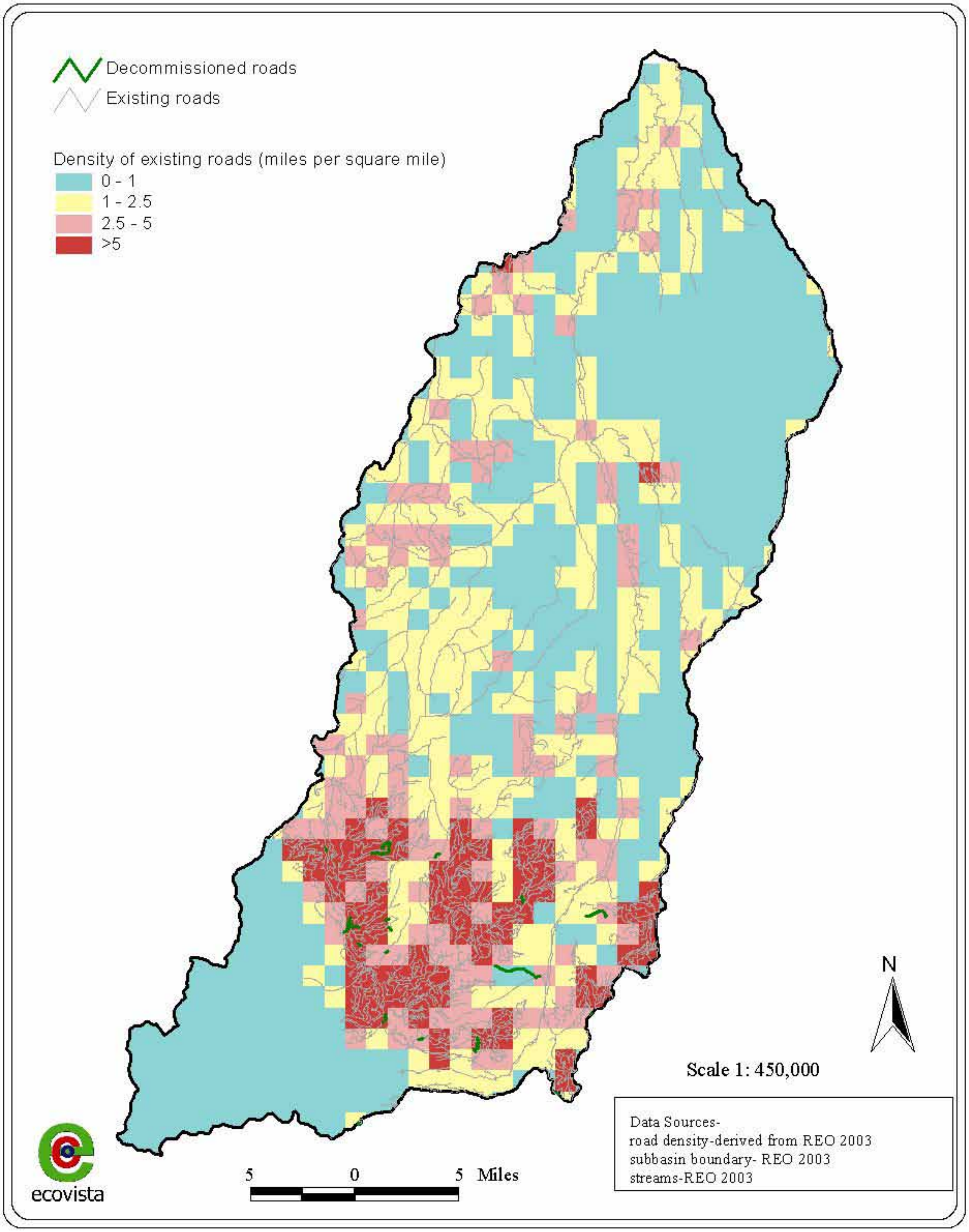

Figure 17. Road densities in the Imnaha subbasin.

Because of the scale of the 1997 flood, much of the repair work was designed to fortify the infrastructure in anticipation for the occurrence of an event of similar magnitude. This work, combined with the permitted and nonpermitted reconstruction/protection efforts by local landowners has detrimentally influenced channel morphology and hydraulics in some areas of the subbasin (e.g., USFS 1998b). Because of its Wild and Scenic Status, the Imnaha should be managed to flow unregulated (USFS 2001). Flood damage reparation and preventative maintenance by landowners has necessitated enforcement action by the Environmental Protection Agency on at least one occasion (USFS 2001).

In response to sedimentation, wildlife harassment, and access concerns, the USFS has closed, decommissioned, relocated, and restricted access on several roads and/or road segments on federally administered lands. In 1990 and 1991, the Wallowa-Whitman National Forest closed 6.4 miles of road, obliterated 3.0 miles, and seeded 26 acres of roadbed (USFS 1998a). Road-obliteration projects have occurred in the Ferguson, Big Sheep, and West Fork Carrol creek subwatersheds. Many of the decommissioned roads were located in draw bottoms where timber was skidded to landing areas. Road relocation and reconstruction projects, designed to ameliorate sedimentation to streams, have occurred throughout the subbasin, including a five-mile section of USFS Road 3900 between the Imnaha River and Lonesome Saddle (USFS 2000). Road 3900 was completely rebuilt following the 1997 flood. Seasonal road use restrictions between October and December are implemented to protect soils and wildlife habitat, minimize harassment of wildlife, maintain adequate bull [elk] escapement, and promote quality hunting. These seasonal restrictions, otherwise known as Cooperative Travel Management Areas or Green Dot Closure Areas, are those roads *not* marked by a carbonite stake with a green dot at the road intersection.

Since 1989, USFS road maintenance has been performed every one to seven years, depending on circumstances and road use (USFS 1998b). In 1990, a full-time position was established at the Wallowa Mountains Engineering Zone to coordinate the Access and Travel Management Program, including annual maintenance (USFS 2000).

Timber Harvest

Euroamericans have harvested timber across most of the forested parts of the Imnaha since their arrival to the subbasin in the middle to late 1800s. The timber in Wallowa County has been logged over at least once—and much of it as many as three times (Wallowa County and NPT 1993).

The amount of timber cut by the early Imnaha settlers was minimal, primarily because of the lack of an established transportation system. Timber to be used in cabin, barn, and corral construction had to be felled relatively local to the homestead or during winter since the early pioneers lacked sufficient transportation networks and power to log remotely. As described in *The History of Wallowa County* (as cited in Wallowa County and NPT 1993),

> The usual procedure…was to fell the trees and buck them into lengths usually of 16 feet six inches, skid or drag them with a team of horses to a sled road, then load them on to a sled pulled with one or more teams of horses.

The early logging practices removed essentially all mature and high-grade ponderosa pine, Douglas-fir, and western larch (Wallowa County and NPT 1993) growing in or near homestead locations. Similarly, much of the mature, high-quality riparian timber floatable to downstream locations was harvested during this era (National Research Council 1995). To meet community needs, small-scale milling operations were located in the more populated areas of the subbasin; however, due to the limited transportation network, it was not realistic or profitable to mill more than was locally demanded (Wallowa County and NPT 1993, USFS 1995).

Development of the Eureka Mine and townsite in the early 1900s required timber harvest. A sawmill, purchased in Portland, Oregon, was set up and cut a reported 350,000 board feet of lumber for construction of the smelter and other camp buildings (Carrey et al. 1979). This included a two-story hotel, grocery store, post office, and the smelter. Local ranchers salvaged timbers from the Eureka site following its closure in 1906 (Carrey et al. 1979). The USFS bought the remaining lumber and used it for trail bridge construction.

With the arrival of the railroad to Enterprise in 1909, the market for locally harvested timber suddenly expanded. This expansion was also driven by the construction of timber mills in Minam, Wallowa, and Enterprise during the following two decades (Wallowa County and NPT 1993). The East Oregon Lumber Company, located in Enterprise, became operational in 1916 but was totally destroyed by fire in 1919. A new mill was constructed and became operational in the mid-1920s. Forests in the Imnaha subbasin, and specifically those in the Sheep Creek subwatershed, contributed timber to the estimated 300 million board feet cut in Wallowa County between 1910 and 1930 (Wallowa County and NPT 1993). It was also during this era that many of the mature and high-grade tree species were harvested, leaving behind species of little economic value at the time, such as grand fir, lodgepole pine, subalpine fir, and Engelmann spruce (Dunn et al., as cited in Wallowa County and NPT 1993).

Advances in timber harvest technology (specifically tractor skidders) were determinant factors during the 1930s and 1940s. Tractor skidders came into use in the late 1930s and early 1940s, replacing the slower and less powerful horse logging systems of the 1910s and 1920s (USFS 1995). Although the tractor skidders were capable of moving greater volumes of timber, they were underpowered and, like horse logging, required draws or gentle downhill slopes for skidding. The heavy tractor, combined with the compactable soils of the moist draws, often caused water quality problems, which were given little consideration until the late 1960s (USFS 1995). A partial list of significant timber harvest activities during the 1940s within the Big Sheep Creek subwatershed is shown in Figure 18.

Even-aged timber management practices gained momentum in the late 1950s in response to the increased demand for timber products (USFS 1998b). Clearcutting, shelterwood cuts, seed tree cuts, and regeneration cutting were common harvest methods applied on National Forest lands, including the Gumboot, Nesbit Butte, Blackhorse Ridge, and Harl Butte areas (USFS 1998b). The first prescribed clearcut in the subbasin was implemented in the Gumboot Butte area in the late 1950s (USFS 2000). Extensive commercial harvest operations in the Big Sheep Creek subwatershed were also initiated in the 1950s, and they included selective harvest and partial removal of overstory trees (USFS 1998a).

The momentum initiated during the 1950s continued into the next decade (Figure 19), as an estimated 20% of the basin contained saw lumber in 1960 (OWRB 1960, as cited in Beamesderfer et al. 1996). Timber harvest was designed in part to “manage” the condition of stands on Wallowa County National Forest lands. Three decades of previous management had produced overstocked, nondiverse, and even-aged forests. Imnaha timber was described by Boise Cascade foresters as “a mixture of second-growth ponderosa pine, somewhat mixed age classes of Douglas-fir and Western Larch (tough heavy to second growth), even-aged stands of Lodgepole pine and Grand Fir, and Engelmann Spruce ranging from old growth to very young stands to multi-aged stands” (Dunn et al., as cited in Wallowa County and NPT 1993).

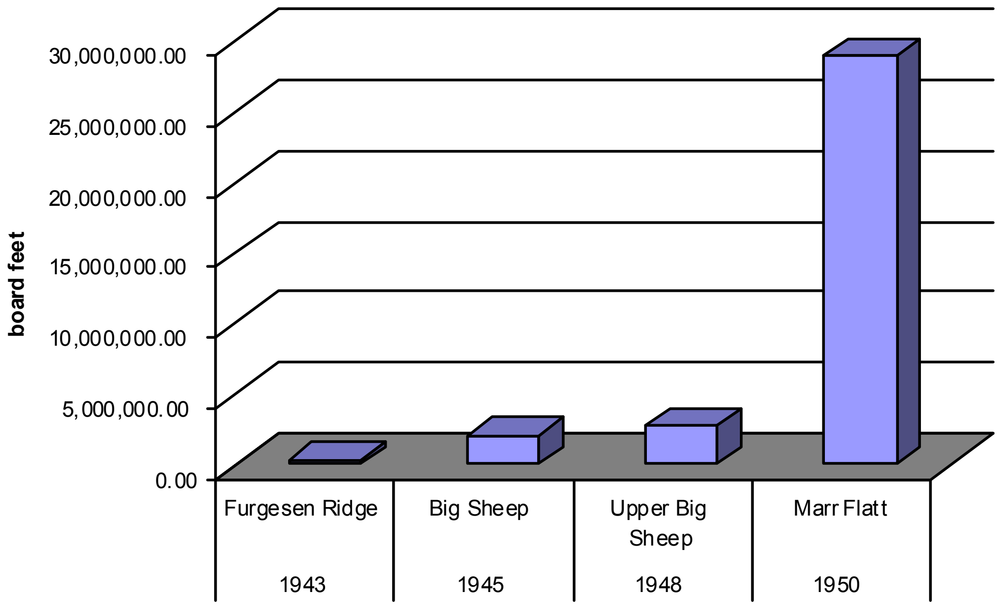

Figure 18. Volumes of timber harvested from significant sales in the Big Sheep Creek watershed (1943–1950) (data presented in USFS 1995).

Regeneration cutting continued in the Big Sheep Creek drainage in the 1970s (USFS 1998a). The scale of cutting was considerably greater than it was for the previous decade and entailed primarily shelterwood and seed tree type cutting. Regeneration cutting also occurred between the Gumboot Creek watershed and Harl Butte (USFS 1998b). Establishment of the HCNRA in 1975 (PL 94-199) significantly modified harvest practices in 68% of the subbasin. Uneven-aged harvest techniques were imposed on the areas where harvest was permitted (USFS 1998b). These restrictions were, and continue to be, designed to protect and enhance wildlife habitat, recreation, or scenic values.

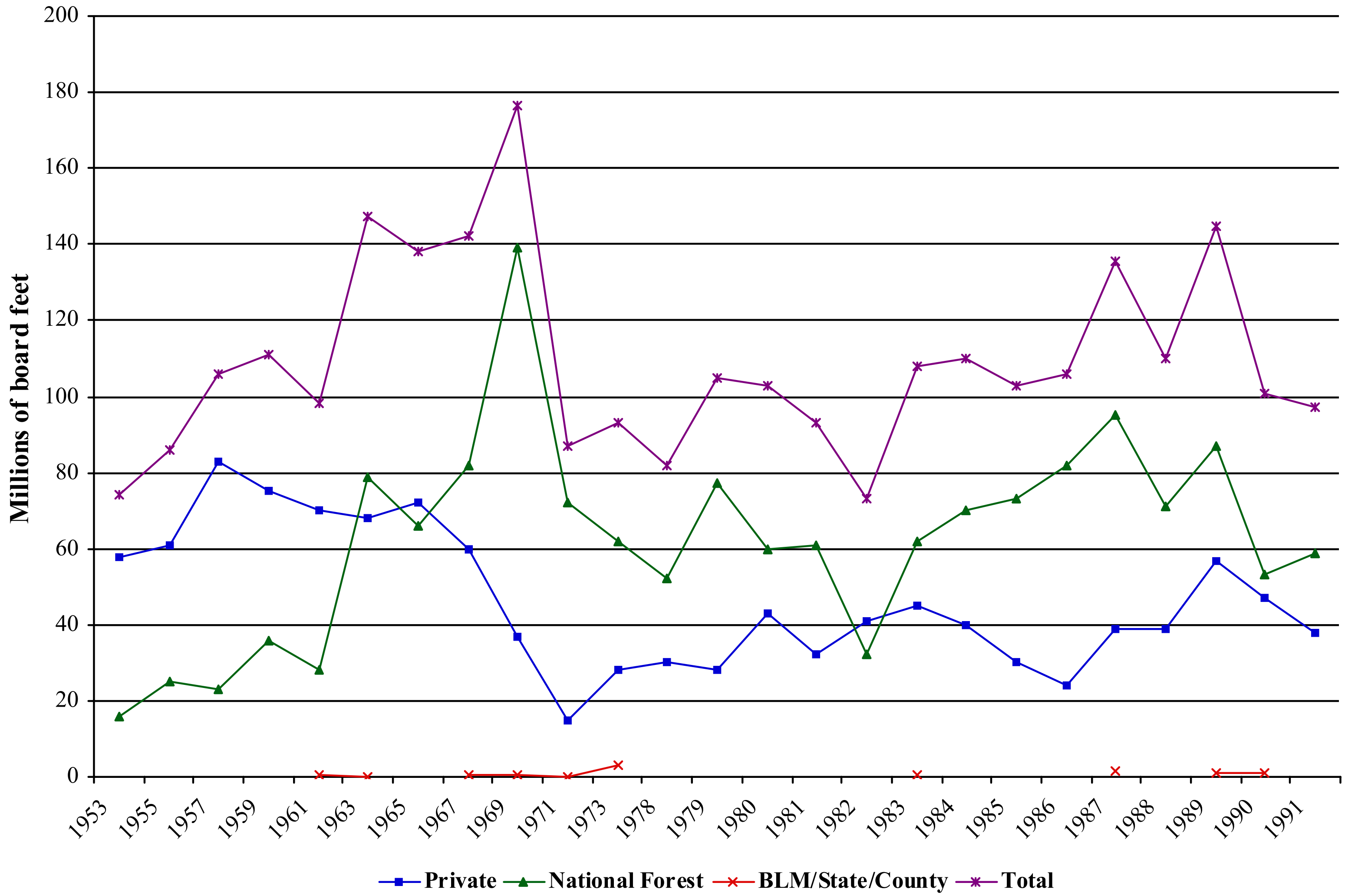

Figure 19. Wallowa County timber harvest (*Wallowa County Land Use Plan* and *State of Oregon Timber Harvest Report*, as cited in Wallowa County and NPT 1993).

Insect infestation, wildfire, and salvage logging were common themes of the 1980s. Timber throughout the entire subbasin was affected by a widespread infestation of the Engelmann spruce bark beetle in the early 1980s (USFS 1998a; 1998b). Salvage logging of the timber killed or damaged by the beetle and by subsequent windthrow occurred at an extensive scale from 1982 to 1987 (USFS 1998b). Timber continues to be salvage logged in response to bark beetle infestations, although techniques differ from those two decades prior. In 1989, a large wildfire (the Canal Fire) prompted salvage logging of burned timber on several thousand acres in the Sheep Creek drainage. Total area harvested within the Big Sheep Creek watershed between 1989 and 1992 was approximately 10,791 acres, 2,003 of which were clearcut and 8,788 of which were partial cut (USFS 1998a).

A switch from commodity production to natural resource management and conservation defined the 1990s. Timber harvest on the Wallowa Whitman National Forest had declined from nearly 80,000 million board feet in the late 1960s, to 1,200 million board feet in the 1990s (USFS 1998d). The change was largely driven by federal legislation designed to protect and enhance ecosystem health, in response to precipitous declines in fish and wildlife populations. Prior actions, such as the establishment of the Eagle Cap Wilderness in 1964, the designation of the HCNRA in 1975, and designation of the Imnaha as a Wild and Scenic River in 1988, had already limited timber harvest in the subbasin. Endangered Species Act (ESA) listings for chinook salmon in 1992, 1994 federal land use regulations, ESA listings for bull trout in 1998, and various high priority watershed designations combined to drastically reduce timber harvest on USFS lands within the Imnaha River watershed. Between 1989 and 1997, the total acreage harvested from the subbasin (excluding the Sheep Creek subwatershed) was approximately 1,127 acres, of which only 14 acres were clearcut and 822 partial cut (USFS 1998b). In 1992, all clearcutting in the Imnaha was eliminated on National Forest lands, and the practice of salvage logging insect-infested trees was modified. In 1994, federal land use regulations were established, establishing standards for the management, utilization, and disposal of natural resources by timber harvesting (36 CFR Ch. 11, 292.46). The 1994 regulations stipulate that timber may only be harvested to protect and enhance ecosystem health, wildlife habitat, or recreational and scenic uses and that trees may only be selectively harvested. In 1994–1995, the *Regional Forester's Eastside Forest Plan Amendment* formally prohibited timber harvest in riparian habitat conservation areas. In 1998, the Forest Supervisor issued a two-year moratorium on timber harvest, other than hazard tree removal, within the HCNRA (USFS 1998d).

Today, harvest only occurs in USFS Management Area 1 on the Wallowa Valley Ranger District and USFS Management Area 11 in the HCNRA (Figure 20 and Figure 21). These two management units comprise 21% of the watershed, or 57,913 acres. The units are located in the southern portion of the subbasin and are characterized by flat ridge tops and timbered draws (USFS 2000). Many of the timbered stands (27,152 acres) in the Imnaha subbasin are less than 30 years old, a result of insect infestations, windstorms, harvest, and fire. For example, the 1989 Canal Fire in the Big Sheep Creek subwatershed consumed considerable portions of the upper drainage, which contributed to the current 9,139 timbered acres that are at or less than 30 years old (USFS 2000).

Special forest product harvesting (e.g., poles, Christmas trees, firewood) is only permitted in Management Units 1, 3, 6, 10, and 11, and only to the extent that it does not adversely impact wildlife or aquatic biota (USFS 1998d). PacFish buffer stipulations prohibit harvesting near streams and other water bodies. Buffers range in size from 300 feet for perennial fish-bearing streams to 100 feet for intermittent streams and other water bodies.

Recent and current timber harvest on private lands has predominately occurred along the lower portions of Imnaha tributaries (USFS 1998d). As much as 800,000 board feet of select cut (specific tree species) timber was harvested from these areas during the late 1980s (USFS 1998d). This volume decreased considerably during the 1990s, primarily due to a depressed market.

Agriculture

The first farmers in the Imnaha subbasin were the subsistence-based Joseph band of the Nez Perce Tribe who tended crops of khouse in the benchland areas, camas in the meadows and wetlands, and huckleberries in the mountains. Their methods of cultivation included the weeding of undesirable species and burning of meadow areas to discourage development of trees or other unwanted vegetation. Fire was also used to encourage the growth of huckleberries.

The early homesteaders also practiced subsistence-based agriculture, although their activities were generally located in the lower portions of the subbasin where the mild climate, fertile valley bottom, and available irrigation water allowed for year-round production of fruits and vegetables (USFS 1998d). The growing conditions in the lower Imnaha produced some of the best and most dependable fruit and vegetables in the region (USFS 1998d). The demand for Imnaha produce spread throughout the surrounding high mountain plateaus and valleys, prompting out-of-basin families to visit the Imnaha and harvest the otherwise unavailable or prohibitively expensive fruits and vegetables (USFS 1998d). It was during this homesteading period that the small family farms and ranches expanded throughout the subbasin.

With the increase in settlement came an increase in livestock production. And, with an increase in livestock production came an increase in the demand for grass and hay. The homesteads soon lined the streams and all other areas near water that seemed capable of supporting agriculture (Wallowa County and NPT 1993). Meadows were cultivated, benchlands cleared and plowed, and bars adjacent to streams planted in hopes of producing grain, hay or vegetables. Flood irrigation was utilized in some areas, and consisted of hand dug ditch systems originating from upstream head boxes on the creeks (USFS 1995). With the exception of the fruits and vegetables, most crops were grown to feed the livestock (USFS 1995).

Today, the primary crops grown in the Imnaha are barley, wheat, and hay (Wallowa County Chamber of Commerce 2001). Channelization efforts to protect cropland and infrastructure (homes, outbuildings, barns, etc.), sediment inputs, and irrigation withdrawals are currently considered to be the main effects of agricultural practices on aquatic resources in the Imnaha (Ashe et al. 2000). Agricultural spraying is minimal (NPT et al. 1990). Although the majority of irrigation withdrawals have negligible effects on the streams and rivers, the Wallowa Valley Improvement Canal significantly affects flows in the Big and Little Sheep Creek watersheds, as it maintains a 120 cubic feet per second (cfs) water right on Big Sheep Creek, Little Sheep Creek, and all associated streams, seeps, or springs (Ashe et al. 2000) (for more information about water development, see the following section).

Water Development

The following discussion is based on information provided in Bliss (2001) and through other sources. Many of the statements regarding the amount of water purportedly used for stock are assumptions, but are included in this document to estimate overall water allocations within the subbasin. The amount of stock and domestic use is not specified in the 1930 decree (*see below)*, and therefore should be considered as amount of water that can be beneficially used for these purposes.

Irrigated agriculture occurred in the Imnaha subbasin with the arrival of the first settlers. In 1930, a decree was recorded completing the adjudication of water rights established prior to the 1906 water code. The decree filed was for 23.16 cfs of water to be diverted from McCully Creek from April 1 through July 31 for irrigation, plus an undefined amount for stock and domestic use, which was estimated to be about 0.09 cfs (Bliss 2001). As shown in Table 7, additional rights were filed over the years for the annual diversion of McCully Creek waters into the Wallowa subbasin for use during different times of the year. The decree of 1905 is considered to be the first water right filed associated with the Wallowa Valley Improvement Canal, which at the time was called Sheep Creek Ditch, granting an undefined contribution of as much as 162.74 cfs from McCully Creek, Little Sheep Creek, and all tributaries crossed by the ditch up to but not including Big Sheep Creek during the months April through July (NPT et al. 1990, Bliss 2001).

A subsequent filing for 33.65 cfs from Big Sheep Creek and again all springs or tributaries along the canal (not including Little Sheep Creek or McCully Creek) was added to the system in 1919 (NPT et al. 1990). Permits were granted in following years that provided for a total right of 114.57 cfs (based on 1877, 1941, and 1976 rights) of water to be diverted from McCully Creek each year between April 1 and July 31 for irrigation. Similarly, annual irrigation rights for 57.79 cfs (based on 1877, 1941, and 1976 rights) of McCully Creek water were granted for use from August 1 through October 15. Between 0.85 and 2.55 cfs of water are used for stock and domestic use from October 16 through March 31, with about 0.18 to 0.27 cfs assigned to McCully Creek diversion 1 (Table 7) (Bliss 2001). The net result of water rights appropriated on McCully Creek is that all water above the canal is diverted year-round, however, due to seepage from the canal and groundwater recharge, there is measurable discharge in Little Sheep Creek, especially in the spring.

Tim Bliss of the Wallowa-Whitman National Forest has conducted an exhaustive evaluation of water rights, water use, and associated allocation of McCully Creek water in an attempt to define watershed boundaries occurring within the National Forest. Findings from the assessment are listed below.

1. The Forest has some stream survey data for McCully Creek above Point A. Terry Carlson, Wallowa Mountains Zone Hydrologist, has estimated *Q* bankfull to be between 110 and 120 cfs, with a range of 91 to 170 cfs, depending on the variables and equations used. This estimate of bankfull flow closely matches water rights of about 114 cfs for the April 1 to July 31 period that are diverted at Point A (see Table 7).

2. Oregon Water Resources Department has not developed Water Availability Tables for McCully Creek. Oregon Department of Fish and Wildlife (ODFW) has not filed for an instream water right on McCully Creek.

3. Domestic use is mentioned on the (4) 1877 water rights and the 1905 right, but the number of households is not. The watermaster indicates that OWRD assumes one household per property. There are four properties on the 1877 rights. If one assumes one property per 160 acres on the 1905 right, there would be 32 properties. Total estimates households would be 36. If one uses the current state allowance of 0.01 cfs per household for domestic use expanded, which includes an acre of lawn and garden irrigation, this right would be only 0.36 cfs[1].

4. Stock use is mentioned on 5 water rights, but the number of livestock is not. If one assumes each of the 32 properties (identified for the estimate for the domestic rights) has 139 cows, there would be 5,000 cows requiring a flow of 0.50 cfs, plus enough water to prevent freezing of the streams and ditches in the winter[1].

5. Information in Table 7 suggests the stream is fully to overappropriated during the irrigation season. This means landowners have the right to divert all flow for irrigation use from April 1 through October 15[2].

6. It is unclear if the stream is fully appropriated during the nonirrigation season. Answers to some questions are needed.

   - Should the upper diversion be treated as a diversion, or as the natural flow of McCully Creek into Prairie Creek? (Locals treat the upper diversion as a natural stream).
   - What is the mean monthly flow of McCully Creek at the upper and lower diversions? Is there any data? (There may be some data for Sheep Creek Ditch).
   - How much water is diverted by the upper and lower McCully Creek diversions in comparison with the estimate of 2.0 cfs needed for domestic/stock use?
   - Should any unappropriated flow during any month continue to flow into Prairie Creek, or be diverted back into the old McCully Creek channel below Sheep Creek Ditch?

7. Bill Knox, ODFW fish biologist comments that the changing of the McCully Creek boundary might complicate efforts to return flow below the two out-of-basin diversions.

8. Rick Lusk, Baker County Watermaster (former Union/Wallowa County Watermaster), comments that the OWRD still treats McCully Creek as part of the Imnaha subbasin; it is part of the Imnaha Decree. Changing the boundary might confuse water rights issues.

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[1] According to OWRD (Debbie Colbert, OWRD, personal communication, January, 2004), the decree does not mention "domestic use expanded," only domestic use. OWRD therefore does not interpret domestic use to include one acre for lawn and garden. This has implications for the assumptions made here regarding total domestic use in the subbasin. (Also, note that domestic use expanded is for ½ acre, not 1 acre.)

[2] According to OWRD (Debbie Colbert, OWRD, personal communication, January, 2004), it is important to note that while the degree of water right appropriation may be determined by adding up water right rates (as was done in statement 5), water rights are also limited to duty (acre-foot of water per acre). Many rights would exceed their duty limitation prior well before exceeding their rate limitation so Table 7 describes the greatest possible amount of withdrawal from rights on this system, assuming no duty limitation.

9. Coby Menton, NRCS, comments that Prairie Creek is on the §303(d) list. The NRCS is studying water delivery from Sheep Creek Ditch (Wallowa Valley Improvement District Canal). A gage was installed on the canal in June 2000 just above the blocked McCully Creek turnout (McCully Creek diversion 2). The low flow was 1.4 cfs on October 17. There is no gage on the upper diversion (McCully Creek diversion 1), which is entitled to divert up to X cfs. The Wallowa Valley Improvement Canal is providing only about 10% of augmented flow of Prairie Creek; the rest of the water is coming from Wallowa Lake/Wallowa River.

10. Ralph Browning, Fish Program Manager, Wallowa-Whitman National Forest, comments that the U.S. Fish and Wildlife Service (USFWS) would like to reconnect the bull trout population in upper McCully Creek with other populations in the Imnaha River subbasin. The National Marine Fisheries Service (NMFS, also known as the National Oceanic and Atmospheric Administration's Fisheries Service or NOAA Fisheries) would like to reconnect the steelhead population in lower McCully Creek with former habitat in upper McCully Creek. The consultation watershed boundary between the Wallowa and Imnaha subbasins includes McCully Creek as part of the Imnaha subbasin. It would appear best to leave McCully Creek in the Imnaha subbasin, even though the watershed delineation protocol suggests otherwise.

Table 7. Summary of rights to divert McCully Creek waters into the Wallowa subbasin (Bliss 2001).

Diversion Rights April 1–July 31	**Diversion Rights August 1–October 15**	**Diversion Rights October 16–March 31**
Decree (1877 rights[1]): 23.16 cfs primary rights from McCully Creek for irrigation, plus an undefined amount for stock and domestic use estimated to be about 0.09 cfs	Decree (1877 rights): 11.58 cfs from McCully Creek for irrigation, plus an undefined amount for stock and domestic use estimated to be about 0.09 cfs	Decree (1877 rights): An undefined amount for stock and domestic use estimated to be about 0.09 cfs plus an undefined flow needed to keep ditches from freezing during the winter. Out of stream domestic use is estimate to be negligible during nonirrigation season. Total use is estimated to be less than 0.18 to 0.27 cfs, 2 to 3 times the estimated minimum.
Decree (1905[2] and 1919[2] rights): Undefined McCully Creek contribution to 162.74 cfs primary rights diverted into Sheep Creek Ditch, including undefined part of 129.09 cfs for stock and domestic use estimated to be about 0.76 cfs. Supplemental 1919 right does not include McCully Creek.	Decree (1905 and 1919 rights): Undefined McCully Creek contribution to 81.35 cfs diverted into Sheep Creek Ditch, including undefined part of 64.54 cfs for stock and domestic use estimated to be about 0.76 cfs. Supplemental 1919 right does not include McCully Creek.	Decree (1905 and 1919 rights): An undefined amount for stock and domestic use estimated to be about 0.76 cfs plus an undefined flow needed to keep ditches from freezing during the winter. Out of stream domestic use is estimate to be negligible during nonirrigation season. Total use is estimate to be less than 1.52 to 2.28 cfs, 2 to 3 times the estimated minimum. Current ditch management limits this to water intercepted north of Ferguson Creek in the winter.
Permits (1941 and 1976[1] rights): 91.41 cfs from McCully Creek, including 2.28 cfs primary rights and 89.13 cfs supplemental rights.	Permits (1941 and 1976 rights): 46.21 cfs from McCully Creek, including 1.14 cfs primary rights and 45.05 cfs supplemental rights.	Permits: No diversion allowed.
Permits (1912[2], 1913[2], 1917[2], and 1921[1] rights): Undefined McCully Creek contribution to 22.21 cfs diverted into Sheep Creek Ditch, including 2.29 cfs primary rights and 19.92 supplemental rights.	Permits (1912, 1913, 1917, and 1921 rights): Undefined McCully Creek contribution to 22.21 cfs diverted into Sheep Creek Ditch, including 2.29 cfs primary rights and 19.92 supplemental rights.	Permits: No diversion allowed.
Total Right: 114.57 cfs from 1877, 1941, and 1976 rights, plus an estimate of 0.85 cfs for stock and domestic use from 1877 and 1905 rights, plus undefined 1905 and 1919 diversion rights for irrigation.	Total Right: 57.79 cfs from 1877, 1941, and 1976 rights, plus an estimate of 0.85 cfs for stock and domestic use from 1877 and 1905 rights, plus undefined 1905 and 1919 diversion rights for irrigation.	Total Right: Estimated to be between 0.85 cfs and 2.55 cfs for stock and domestic use, with about 0.18 to 0.27 cfs assigned to McCully Creek diversion 1 and 1.52 to 2.28 cfs assigned to McCully Creek diversion 2.

[1] 1877, 1921, and 1976 rights are believed to be diverted from the stream diverted at McCully Creek diversion 1, somewhere along the stream as it flows through the Prairie Creek drainage.
[2] 1905, 1912, 1913, 1917, 1919, and 1941 rights are diverted from McCully Creek diversion 2 on Sheep Creek Ditch (Wallowa Valley Improvement District Canal).

Mining

Mining represents one of the earliest resource uses in the subbasin. Gold, silver, copper, and cinnabar mining have all occurred in the Imnaha watershed (USFS 1998, Ashe et al. 2000); however, there has been only a limited amount of precious metals extracted. Accessibility, quality of ores, and the establishment of the HCNRA in 1975 have contributed to minimize mining activity. That which has taken place is generally small-scale prospecting for gold, silver, copper, and molybdenum (Mays 1992). No flow of toxic mine leachates into waters of the Imnaha drainage has ever been reported (Mays 1992).

Mining in the Imnaha was borne from a regional fever sweeping the Northwest during the second half of the 1800s. Many mines in Montana, Nevada, Idaho, and, to a lesser extent, in Oregon, had been paying their way, both for those directly working in them and for those who were bankrolling their operation (Bartlett 1992).

Copper was discovered near the mouth of the Imnaha (although not in the subbasin proper) in the late 1800s and a claim was staked in the summer of 1898 (Bartlett 1992). Development of the claim came from the Eureka Mining, Smelting and Power Company, a copper company composed of "capitalists and well-known smelter men" who planned to build an electric smelter capable of producing 200 tons of copper per day (Carrey et al. 1979). As reported in the Wallowa County Chieftain March 12, 1903 (as cited in Carrey et al. 1979)

> At their Imnaha camp a force of 30 men are now driving extensive tunnels to the bowels of the mountains making mother earth give up her precious metals.

Development of the site included the construction of a townsite, a wagon road, a sawmill, and a transportation corridor between Lewiston and the mine. Access issues eventually proved to be the demise of the Eureka claim, as the developers were unable to construct a boat capable of surmounting the rough water of the Snake River and could not economically justify the construction of roads or rail networks into the remote location.

The Eureka claim spurred other mining activity in the Imnaha. From the 1890s through the 1920s, three gold placer mines were developed in the upper portion of the subbasin, from Skookum Creek to the present site of Ollokot Campground (Mays 1992, USFS 1998d). Hydraulic dredging techniques were employed in the early 1900s as a more efficient technique to work placer gravels. The mine sites produced very little gold over their lifetime, however, and were soon abandoned. The primary effects of the placer and hydraulic mining include redeposition of mine tailings along the streambank and subsequent channelization. Other damage has not been assessed or reported, although Beamesderfer (et al. 1996) contends that mining activities have not severely degraded riverine habitat in the Imnaha.

Metals in the Imnaha were also mined as lode deposits. Unlike placer mining, this approach entails the construction of tunnels to mine the ore as a part of the bedrock. Several horizontal exploratory shafts for copper were dug into the east wall of the Imnaha canyon just above the confluence with the Snake between 1900 and 1905 (Tucker, as cited in Mays 1992). Among the shafts drilled was the Mountain Chief Mine, which tunneled through a fault zone in the ridge separating the Imnaha from the Snake River. It was later determined that the character of the ore was noncommercial, and the relative inaccessibility of the area limited potential profitability.

The shaft, which is visible today, "showed no evidence of mine leakage or other detrimental effects to the fisheries of the Imnaha River" following a 1991 survey by the USFS (Mays 1992).

Mining in the Big Sheep Creek drainage has been limited. Gold, silver and copper prospecting efforts in the late 1800s produced only one silver mine, the Zollman-Wells Mine, located along Quartz Creek, a tributary to Lick Creek (Smith et al., as cited in USFS 1995). The mine has produced limited amounts of precious metals over its lifetime, but continues to operate through annual assessment work that is required to keep the claim active (USFS 1995).

Currently, several small gold prospecting mines are located on the headwaters of the North Fork Imnaha, and on Boner Flat on the North Fork Imnaha. These prospect holes and shafts represent little disturbance to aquatic environments, as they are located away from perennial streams (Mays 1992). The ongoing active metal ore mining in Wallowa County is limited to small "hobby" mines (Ashe et al. 2000), including a certain degree of placer mining in the Imnaha River (Wallowa County and NPT 1993). The current degree of impact from "hobby mining" has not been estimated.

Regulations associated with the establishment of the HCNRA, Eagle Cap Wilderness, and Imnaha Wild and Scenic River Management Plan have limited the establishment of new claims from mineral entry. The remainder of the watershed, although open for mineral entry, is unlikely to be mined as it is composed entirely of basalt, which does not contain a marketable source of minerals.

1.1.1.11 Land Ownership

Approximately 71% of the Imnaha subbasin is under public ownership (Figure 20). The majority of the subbasin lies within the Wallowa-Whitman National Forest, under the management of four Ranger Districts (Eagle Cap, HCNRA, Wallowa Valley, and Pine) (Table 8). The ODFW manages two small parcels of land in the subbasin, the largest of these is along Little Sheep Creek and is where they operate the Little Sheep fish hatchery. BLM lands are primarily grasslands and are utilized for domestic livestock grazing under the provisions of the Taylor Grazing Act (USFS 2003a).

In 2000, the Nature Conservancy purchased a large portion of the Zumwalt prairie at the lower western edge of the subbasin. The land was purchased to preserve its high value to fish, wildlife and botanical resources and its acquisition made the Nature Conservancy the second largest land manager in the subbasin (TNC 2001) (Table 8). Twenty-four percent of the subbasin is privately owned. Most of the lands in private ownership are used for ranching.

The goals and focus of land management in the subbasin varies across and within ownerships. The Wallowa-Whitman National Forest has divided the lands they manage into Management Areas. Each Management area is managed following a strategy developed in the Forest Plan. Strategies for management in the subbasin range from protection as a Wilderness Area to a timber production emphasis (Figure 21). Differences in the focus and goals in land management across the subbasin result in differing ecosystem conditions and levels of protection for the fish and wildlife populations of the subbasin.

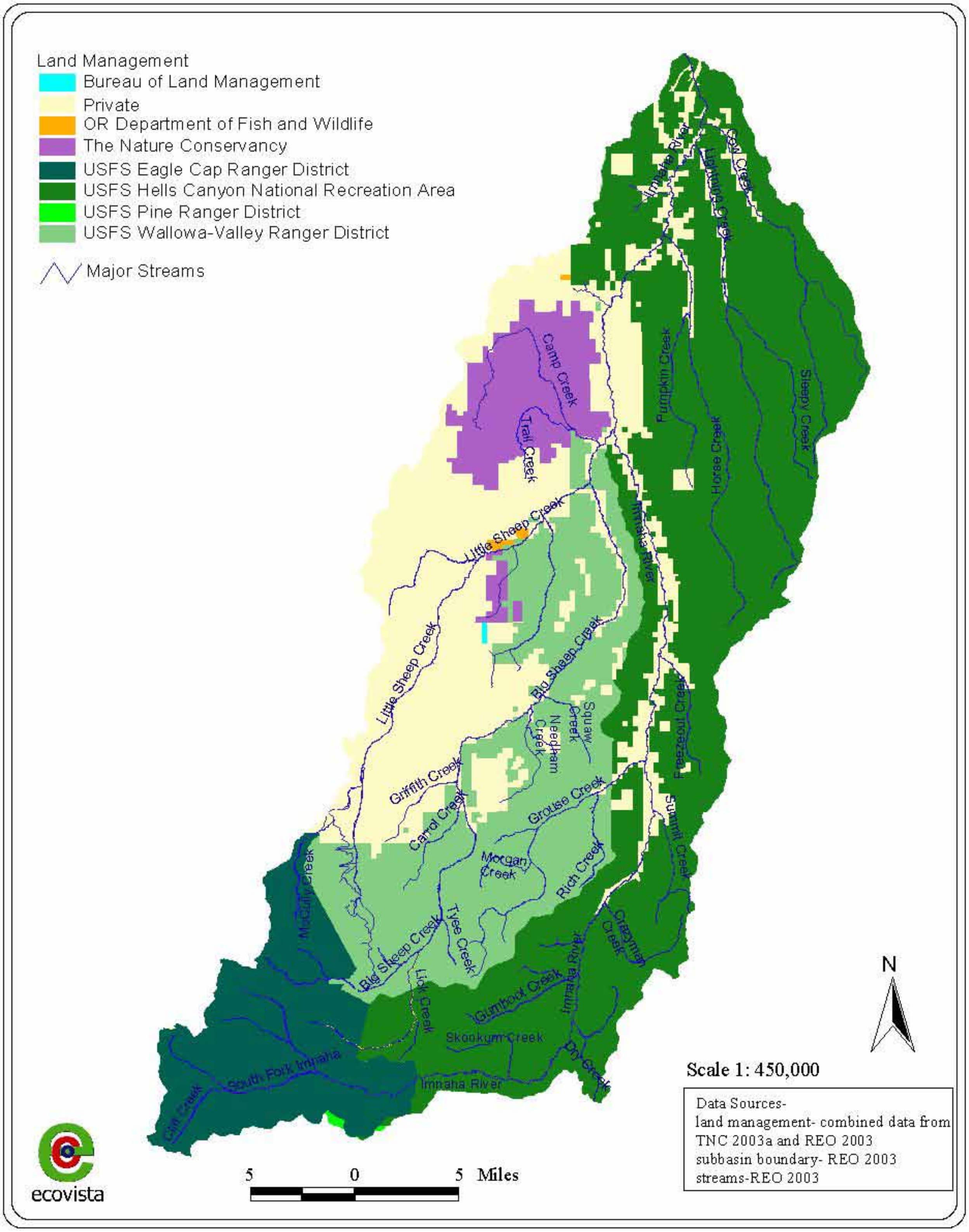

Figure 20. Land management patterns in the Imnaha subbasin.

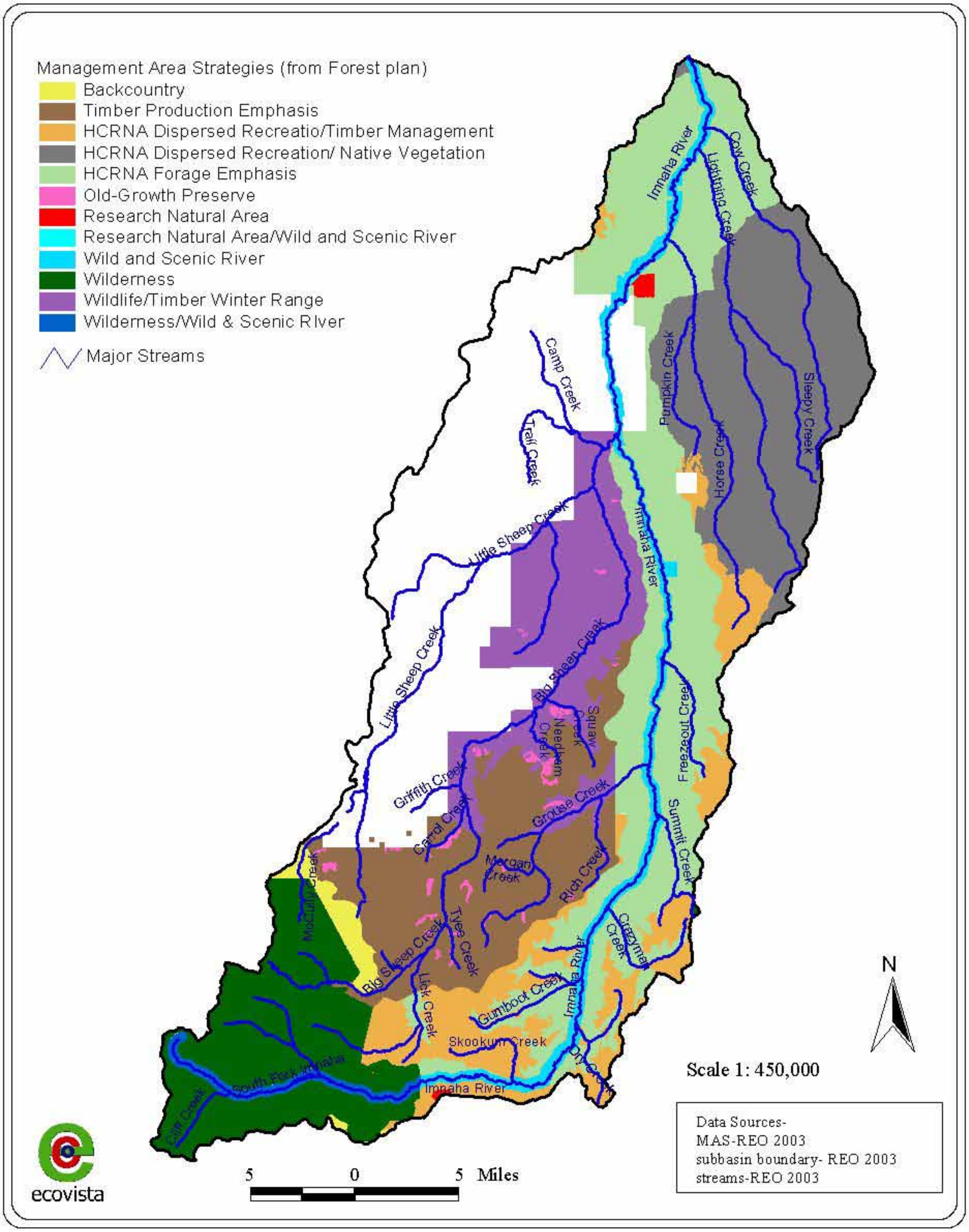

Figure 21. Management area strategies for USFS lands in the Imnaha subbasin.

Table 8. Land management entities in the Imnaha subbasin.

Description		Acres of Land Managed	Percent of subbasin
BLM		158	0.03
ODFW		612	0.11
The Nature Conservancy		28,919	5.32
Private		129,668	23.87
USFS	Eagle Cap Ranger District	58,145	10.71
	HCNRA	223,766	41.20
	Pine Ranger District	319	0.06
	Wallowa Valley Ranger District	101,554	18.70
	Total USFS	383,784	70.66

To assess and account for these differences, a GIS layer containing land protection status was developed for the subbasin (Figure 22). GIS layers depicting land protection status have been developed by the Northwest Habitat Institute, but because of recent changes in the subbasins ownership and management focus, these are no longer accurate. To create the layer, the subbasin was stratified into different ownership/management types and assigned a protection status classification. Protection status classifications were based on those used by both the Natural Heritage Program and GAP (Idaho GAP 2003). Examples of a similar process used in the *Middle Rockies-Blue Mountain Ecoregional Plan* (TNC 2003) were used to help guide the selection of protection levels.

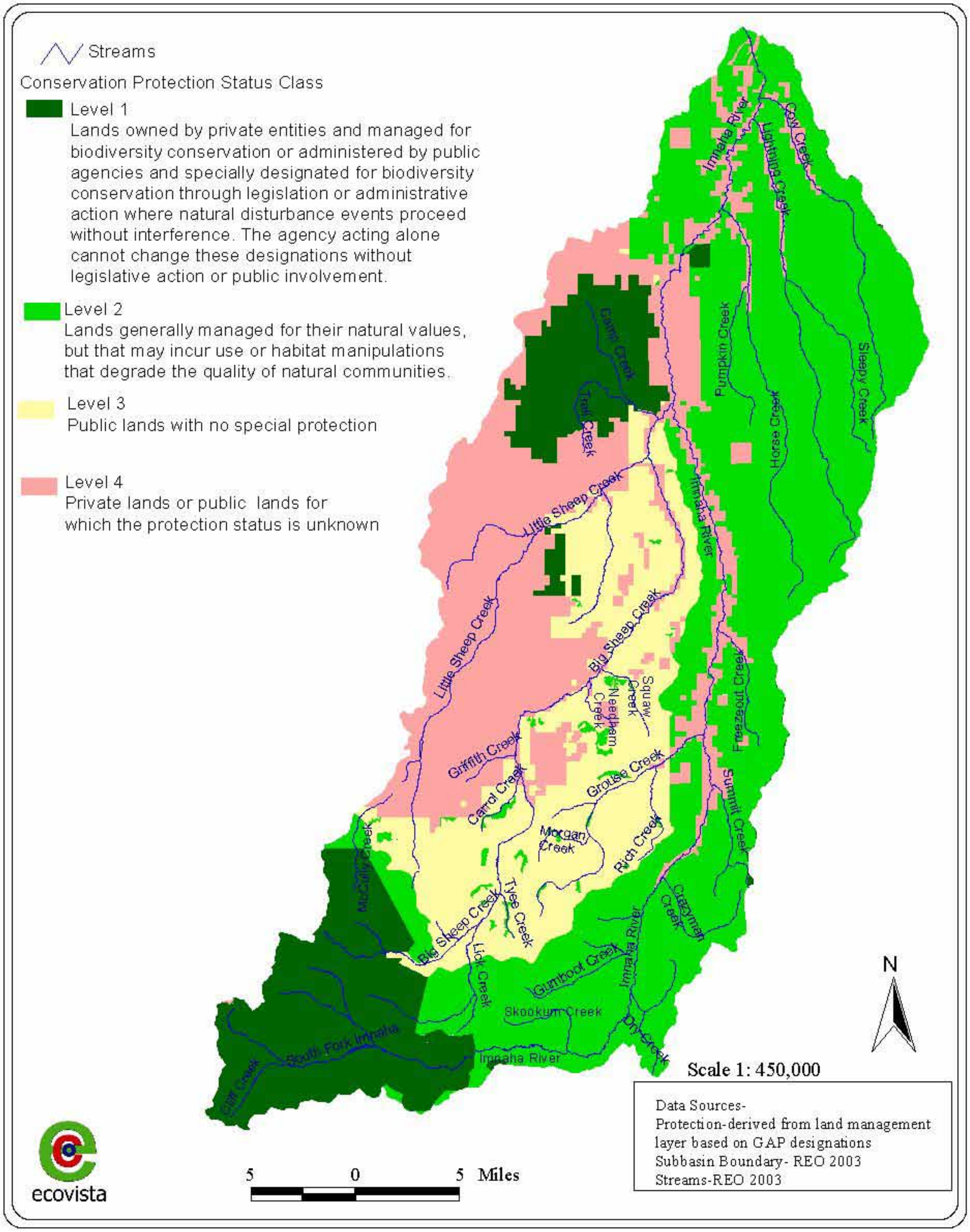

Figure 22. Protection status of the Imnaha subbasin.

1.1.2 Subbasin Water Resources

1.1.2.1 Watershed Hydrography

The Imnaha River subbasin consists of three U.S. Geological Survey (USGS) hydrologic segments of the Snake River in Oregon: the lower Imnaha River (USGS cataloging unit 17060102-08), upper Imnaha River (107060102-09), and Big Sheep Creek (17060102-07). Primary tributaries, starting at the confluence with the Snake River, include Cow, Lightning, Horse, Big Sheep, Freezeout, Grouse, Summit, Crazyman, Gumboot, Dry, and Skookum creeks and the South Fork, Middle Fork, and North Fork Imnaha River (Figure 3).

1.1.2.2 Hydrologic Regime

Current flow data in the Imnaha have been collected from the USGS-maintained gage located near the town of Imnaha (gage 13292000) since 1928 (Table 9). The discharge measured at the gaging station represents 622 square miles, or 72% of the entire subbasin (USFS 1998d). Four other gages, three of which collected only peak flow data, were historically used in the subbasin, yet are no longer in service. These include the Deer Creek station (13291400), the Mahogany Creek station (13291200), and the Gumboot station (13291000) (Table 9). The Imnaha's mean annual discharge at the town of Imnaha is 517 cfs. The highest mean annual discharge (≈830 cfs) occurred during 1996; the lowest mean annual discharge (200 cfs) occurred during the 1977 drought year. Mean monthly flows are shown in Figure 24.

Table 9. USGS gaging summary, Imnaha River basin, Oregon.

Gage Number	Gage Name	Latitude	Longitude	Area (mi^2)	Elevation (ft)	Period of Record
[1]13291400	Deer Creek near Imnaha	45:33:00	116:47:30	2	3,760	1965, 1971–1972, 1974–1976, 1978–1979
[1]13291200 [1]13291200	Mahogany Creek	45:12:15	116:52:05	4	3,740	1965–1972, 1975
13291000	Imnaha above Gumboot Creek	45:11:00	116:52:00	100	3,813	1945–1953
13292000	Imnaha at Imnaha	45:33:45	116:50:00	622	1,941	1929–1998

[1] Peak flows only

Water availability within the Imnaha subbasin is influenced by a major diversion on Big Sheep Creek and various smaller irrigation projects (for information about diversions, see p. 91). There are no known water storage structures large enough to require inspection by the county watermaster because of their potential threat to people or property (S. Hattan, OWRD, personal communication, February 2, 2001).

Peak streamflows in the subbasin usually occur from March through May, while low flows occur August through September, and December through February (USFS 2000). The Imnaha River reached a record high discharge of 20,200 cfs during a rain-on-snow flood event on January 1, 1997 (USGS 2002). The event triggered landslides, destroyed a house (T. Smith, NRCS, personal communication, February 8, 2001), and significantly modified stream channel morphology through mass movements of bedload material (USFS 1998d). The 1997 flood and a similar event that occurred in 1996 were of such magnitude that seral development of the riparian areas and channel development in tributaries has been retarded (USFS 2000). The record low was 16 cfs on November 22–23, 1931 (USFS 1998d). Flood frequency analysis is shown in Table 10.

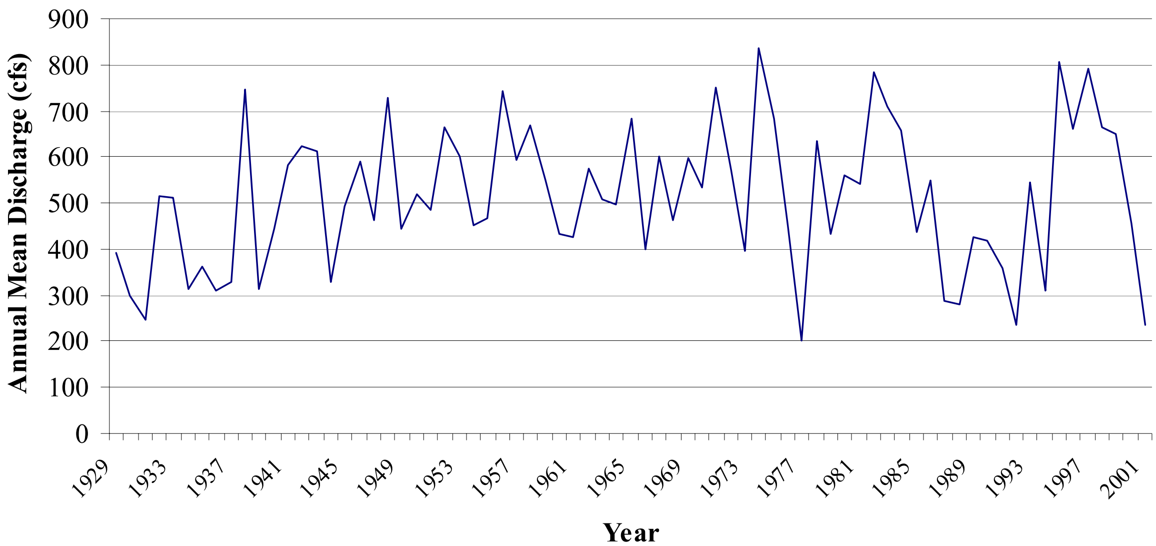

Figure 23. Average annual flows in the Imnaha subbasin (Imnaha gage 13292000) (USGS unpublished data).

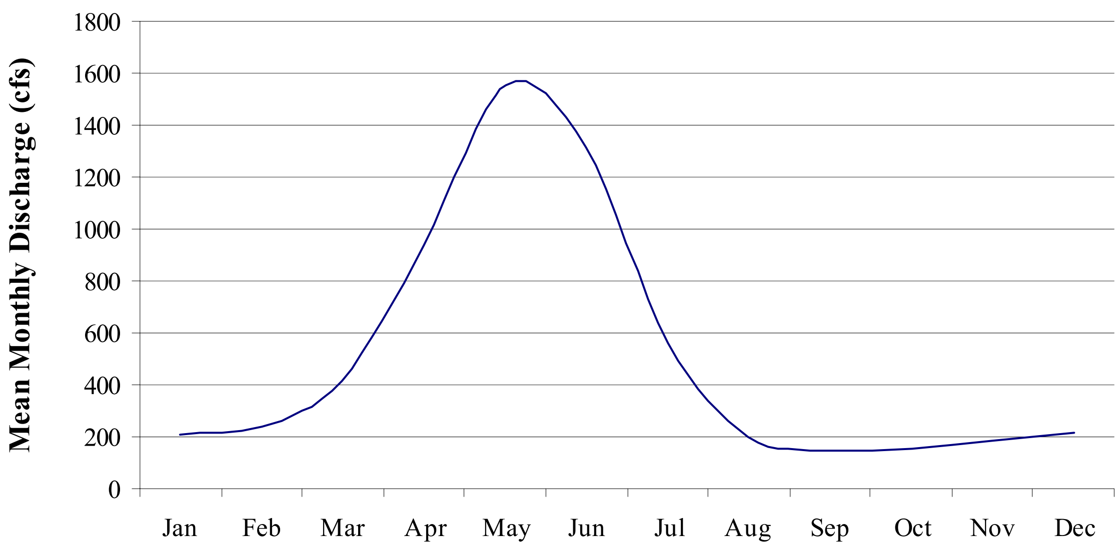

Figure 24. Mean monthly discharge at Imnaha gage 13292000 (1929–2003) (USGS unpublished data).

Table 10. Annual flood flow frequency summary for the Imnaha gage at Imnaha.

Exceedance Probability (%)	Return Period (years)	Expected Flood Flows (cfs) Based on Data from Gage 13292000
99	1	974
50	2	2,607
20	5	4,284
10	10	5,739
5	20	7,435
2	50	10,145
1	100	12,625

1.1.2.3 Water Quality

Water quality standards are benchmarks established to assess whether river and lake quality is adequate to protect fish and other aquatic life, recreation, drinking, agriculture, industry and other uses. Water quality standards are also regulatory tools used by the Oregon Department of Environmental Quality (ODEQ) and the USEPA to prevent water pollution. States are required to adopt water quality standards by the federal Clean Water Act. Standards are subject to approval by the USEPA.

The Clean Water Act also requires states to maintain a list of stream segments that do not meet water quality standards. This list is called the §303(d) list because of the section of the Clean Water Act that makes the requirement. The Clean Water Act requires states to develop water quality goals (called Total Maximum Daily Loads, or TMDLs) along with an implementation plan and schedule to achieve water quality goals for §303(d)-listed water bodies.

The U.S. Environmental Protection Agency approved Oregon's 2002 §303(d) list on March 24, 2003 (http://www.deq.state.or.us/wq/303dlist/303dpage.htm). The §303(d)-listed streams within the Imnaha subbasin, which includes the entire Imnaha River mainstem and some stream reaches in key tributaries (Table 11 and Figure 25), exceed the numeric criteria of the water quality standard for temperature (Table 12). Accordingly, a TMDL is being developed for the Imnaha.

Table 11. Imnaha River watershed §303(d) listings (downloaded May 22, 2003, from ODEQ website, http://www.deq.state.or.us/wq/WQLData/SubBasinList02.asp).

Record ID	Water Body Name	RM	Parameter	Season	List Date
828	Big Sheep Creek	0–28.8	Temperature	Summer	1998
829	Big Sheep Creek	28.8–36.6	Temperature	Summer	1998
9177	Big Sheep Creek	0–28.8	Temperature	August 1–July 15	2002
9183	Crazyman Creek	0–6.7	Temperature	Summer	2002
9186	Dry Creek	0–4.2	Temperature	August 1–July 15	2002
9180	Freezeout Creek	0–8.5	Temperature	Summer	2002
9181	Freezeout Creek	0–8.5	Temperature	August 1–July 15	2002

Record ID	Water Body Name	RM	Parameter	Season	List Date
1185	Grouse Creek	0–17.3	Temperature	Summer	1998
9182	Grouse Creek	0–17.3	Temperature	August 1–July 15	2002
9184	Gumboot Creek	0–7.4	Temperature	August 1–July 15	2002
9176	Imnaha River	0–49.5	Temperature	August 1–July 15	2002
824	Imnaha River	0–49.5	Temperature	Summer	1998
825	Imnaha River	44–72	Temperature	Summer	1998
827	Lightning Creek	0–24.8	Temperature	Summer	1998
9178	Little Sheep Creek	0–29	Temperature	Summer	2002
9179	Little Sheep Creek	0–29	Temperature	August 1–July 15	2002

Table 12. ODEQ criterion used to define where and when the water quality standard for temperature in the Imnaha subbasin is in exceedance. ODEQ uses the 50º F(10º C) for year round bull trout spawning, rearing, and adult presence (http://www.deq.state.or.us/wq/standards/WQStdsImnahaSpawn.pdf).

Imnaha Basin Segments	Application	Dates
Imnaha River upstream to Big Sheep confluence	**Overall Application**	10/15–7/15
(Check individual species[1] distribution maps for specific locations.)	Fall chinook	10/15–6/30
	Spring/summer chinook	N/A
	Summer steelhead	3/15–7/15
	O. mykiss—resident	3/15–7/15
Imnaha River above and including Big Sheep Creek	**Overall Application**	8/1–7/15
(Check individual species distribution maps for specific locations.)	Fall chinook	N/A
	Spring/summer chinook	8/1–5/15
	Summer steelhead	3/15–7/15
	O. mykiss—resident	3/15–7/15

[1] The bull trout temperature criterion (50.0 °F/10.0 °C) applies year-round to bull trout spawning, rearing, and adult presence in areas identified in *Status of Oregon's Bull Trout* (Buchanan 1997). These areas include portions of the mainstem Imnaha River, Big Sheep Creek, and Little Sheep Creek subbasins. The bull trout criterion supercedes the 55 °F spawning criterion.

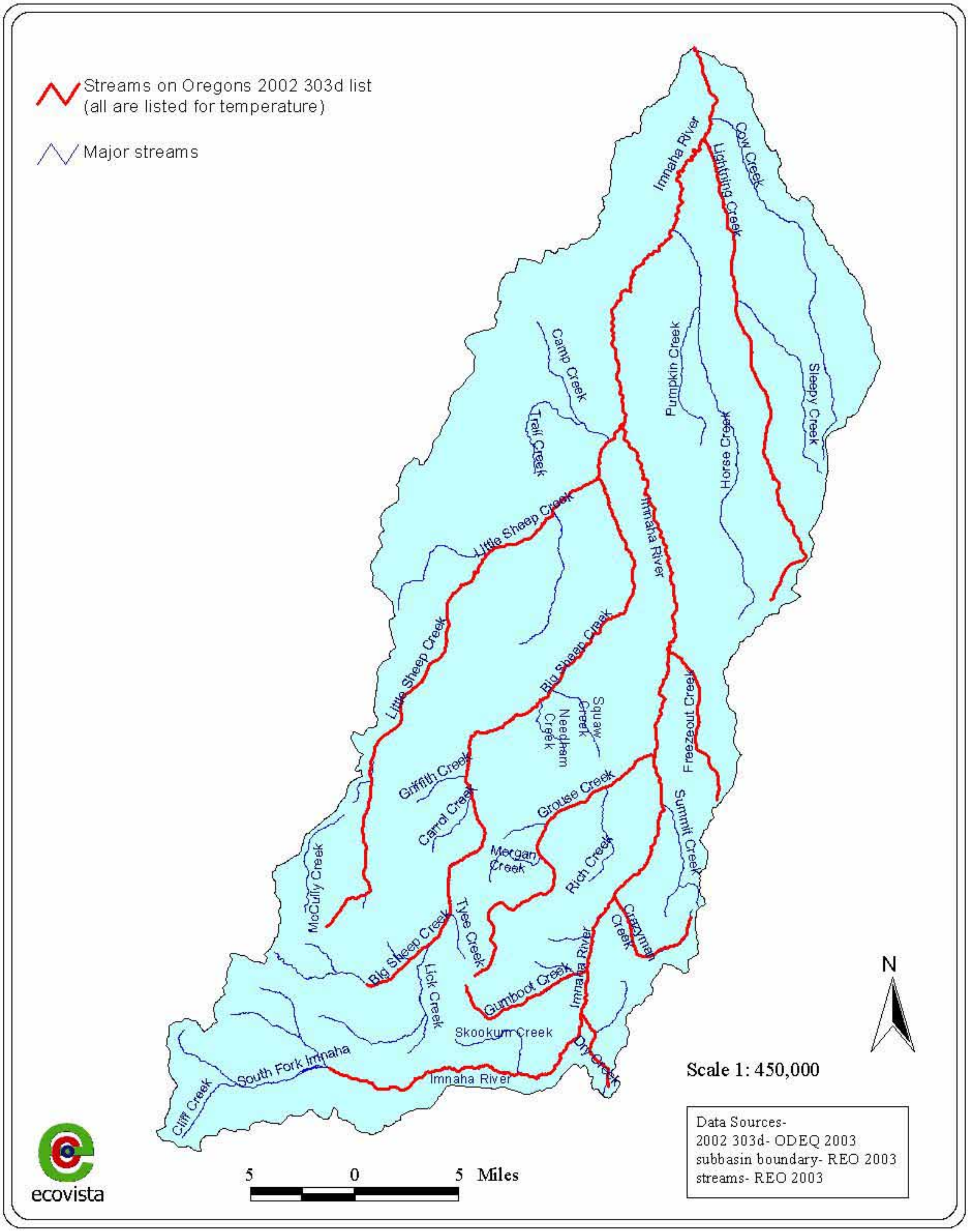

Figure 25. Streams in the Imnaha subbasin listed on Oregon's 2002 §303(d) list.

Criterion used by the USFWS in their assessment of bull trout subpopulations at the watershed scale are presented in Table 13.

Table 13. USFWS criterion to rate habitat function for bull trout subpopulations at the watershed scale

Diagnostic or Pathway	Indicators	Functioning Adequately	Functioning at Risk	Functioning at an Unacceptable Risk
Water Quality	Temperature	7 day average maximum temperature in a reach during the following life history stages: [1,3] incubation 2 - 5EC (35.6-41ºF) rearing 4 - 12 EC (39.2-53.6ºF) spawning 4 - 9EC (39.2-48.2ºF) also temperatures do not exceed 15EC (59º F)in areas used by adults during the local spawning migration	7 day average maximum temperature in a reach during the following life history stages:[1,3] incubation <2EC or 6EC (<35.6ºF or 42.8ºF) rearing <4EC or 13-15EC (<39.2ºF or 55.4-59ºF) spawning <4 EC or 10EC (<39.2ºF or 50ºF) also temperatures in areas used by adults during the local spawning migration sometimes exceeds 15EC (59ºF)	7 day average maximum temperature in a reach during the following life history stages:[1,3] incubation <1EC or >6EC (<33.8ºF or >42.8ºF) rearing >15 EC (>59ºF) spawning <4 EC or > 10EC (<39.2ºF or >50ºF) also temperatures in areas used by adults during the local spawning migration regularly exceed 15EC (59ºF)

[1] 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, Boise, ID.
[3] 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. *In* W.C. Mackay, M.K.

Lower Imnaha Subbasin

The lower mainstem Imnaha River (mouth to Summit Creek) is listed on the ODEQ §303(d) list for summer temperatures. The seven-day moving average of daily maximum temperatures recorded in 1995 below the town of Imnaha was 69.1 °F, with 21 days exceeding temperature standards of 64 °F (ODEQ Data). The only §303(d)-listed tributary occurring in the lower Imnaha subbasin is Lightning Creek. Temperatures recorded in 1993 (65.5 °F) at a USFS monitoring site on Lightning Creek exceeded state standards; however, zone fisheries biologists and hydrologists contend that the current temperature regime to be within the natural potential, given the low-elevation grassland ecosystem, the size of the drainage basin, and limited amounts of riparian modification (USFS 1998d, USFS 2000). Continuous water temperature monitoring data for the years 1999-2003 have been collected in Cow, Lightning, and Horse Creek, as well as the mainstem Imnaha River (at RKM 7) and are provided in Appendix C.

Big Sheep Creek

Water temperatures in the Big Sheep Creek drainage have exceeded State standards on numerous occasions. In the Little Sheep Creek drainage, stream temperatures are considered to be below environmental potential for bull trout, and "functioning at risk" (USFS 2000). Elevated summer stream temperatures are naturally common in the lower-elevation portions of Little Sheep Creek due to its biophysical attributes. The inherently high July/August stream temperatures have been elevated, however, by riparian modification and removal of streamflow. Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000), and have been reduced in upper portions of the watershed by fire, windthrow, and insect infestation. For example, the Little Sheep Creek Highway (including the Loop Road) borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. Compounding this problem are the effects from insect infestations and the Canal Creek Fire of 1989, which have reduced effective stream shade-providing riparian vegetation in the upper portions of the subwatershed.

A sparce riparian canopy along portions of Little Sheep Creek, both before and following fire and insect infestation, has contributed to excessively high stream temperatures. The seven-day moving average of daily maximum temperatures for Little Sheep Creek measured near the confluence in 1999 exceeded 65 °F for the majority of July and the entire month of August (*refer to* Appendix C for continuous water temperature data in Little Sheep Creek, 1999-2001). In 2000, the seven-day moving average was in excess of 65 °F as early as June 18, and exceeded 70 °F between July 21 and August 12. Stream temperatures in 2001 warmed to at least 65 °F during the latter part of June and remained in excess of 65 °F through the first week in September.

Similar to Little Sheep Creek, the lower portion of Big Sheep Creek has inherently high summertime stream temperatures due to its basalt parent material and shrub/grassland vegetation (USFS 2000). Also similar are the land use activities that have exacerbated summer and winter temperature maximums through the reduction of riparian vegetation and cool water inflows. Water withdrawals from Big Sheep Creek into the Wallowa Valley Improvement Canal occur during summer months and may completely divert Big Sheep Creek at certain times. It is unlikely, however, that the cumulative volume from these withdrawals are of a sufficient amount to cool the inherently warm, low-elevation reaches of Big Sheep Creek during summer months (below Coyote Creek). The relationship between water withdrawals and base flow temperatures in Big Sheep Creek currently represents a data gap.

Water temperatures for Big Sheep Creek, approximately 1 mile upstream from the Little Sheep Creek confluence, have been periodically monitored from 1991 through 1993, and again from 1999 through 2001 (*refer to* Appendix C for continuous water temperature data in Big Sheep Creek, 1999-2001 and for monitoring data in Camp Creek, 1999-2003). In 1999, the seven-day moving average for maximum daily stream temperatures near the confluence exceeded 70 °F twice in August, while in 2000 seven-day moving averages were in excess of 70 °F for half of the month of July and the majority of August. Seven-day moving average maximum stream temperatures generally exceeded 70 °F from June 30, 2001, to September 3, 2001. Maximum stream temperatures recorded between July 1 and July 9 were in excess of 77 °F, and were in excess of 75 °F between June 30 and July 12.

Upper Imnaha Subbasin

The mainstem Imnaha, from Summit Creek to the North/South Fork confluence, violates state temperature standards for bull trout and is on the ODEQ §303(d) list. However, despite the high stream temperatures, this area maintains one of the healthiest bull trout populations in the Columbia River system (B. Knox, ODFW, personal communication, January, 2004).

The seven-day moving average of daily maximum temperatures measured in 1993 at Indian Crossing (approximately 4,500 feet elevation) and Nine Point Creek (approximately 3,642 feet elevation) were 56.2 °F and 61.5 °F, respectively, exceeding the bull trout temperature standard of 50 °F (USFS 1998d; *refer to* Appendix C for continuous water temperature monitoring data). In 1999, seven-day moving average maximum stream temperatures at the Indian Crossing monitoring station exceeded 50 °F from July 7 to September 24. The maximum weekly average temperature at the Indian Crossing station was 57°F on August 27, 1999. The seven-day moving average maximum stream temperatures at the Nine Point Creek station were similar to those measured at the Indian Creek Station in that they exceeded the 50 °F bull trout criteria twice in June and from July 2 to September 26 (*refer to* Appendix C for continuous water temperature monitoring data). The maximum weekly average stream temperature at the Nine Point Creek station was 62.4 °F on August 27, 1999. The seven-day moving average of daily maximum temperatures measured by the ODEQ in 1995 at Coverdale Campground was 57.2 °F (ODEQ data). Zone fisheries biologists and hydrologists contend that the inclusion of the upper mainstem Imnaha (from Ollokot Campground to the North/South Fork confluence) on the §303(d) list should be reevaluated given the size of the river and limited riparian modification (USFS 1998b).

Riparian modification is known to have influenced stream temperatures throughout private land parcels bordering the mainstem (roughly from the town of Imnaha upriver to Gumboot Creek) (USFS 2000). Cultivation, farming, and settlement have reduced the occurrence of riparian species in certain areas, and are believed to be primary contributors to stream temperature increases. For instance, stream temperatures below the Imnaha River Woods Development (RM 50–RM 54) have increased following the removal of forest canopy for the establishment of a powerline right-of-way (RM 57–RM 60) (USFS 2000). The modification has shifted a historical cold water to cool water transition zone upriver several miles. In 1992, the seven-day moving average of daily maximum temperatures recorded on Grouse Creek was 65.3 °F (ODEQ data). The moving seven-day maximum stream temperature in Gumboot Creek was 66 °F, measured in 1992 (*refer to* Appendix C for continuous water temperature monitoring data for Gumboot and Grouse Creeks, 1999-2003).

1.1.2.4 Riparian Resources

Riparian communities in the Imnaha subbasin vary by location within the riparian corridor and within the subbasin. Shrubs and grass/forb species generally occur in the primary riparian zone (where water, wet soil types, or hydrophilic plants occur), while shade-providing overstory species such as cottonwood (*Populus* spp.), ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) dominate the secondary riparian zone. Grass forb species generally grade from those that are more tolerant to warm, drier conditions to those adapted to cooler, wetter climates, with an upriver progression.

Subecoregion-specific descriptions of riparian vegetation are provided below. The descriptions are drawn from the Oregon Watershed Assessment Manual (OWAM; 1999), Appendix A, which provides an indication of potential or expected streamside vegetation. The Assessment Manual assumes the species composition to reflect conditions following 120 years of growth with no major natural disturbances and no human-caused disturbances (tree removal, animal grazing, and encroachment of buildings or roads). The information presented below does not include a description of streamside vegetation following infrequent (average intervals of one to many centuries) and major disturbances such as floods, windstorms, wildfire, or earthquakes.

Descriptions are according to valley type (constrained, semi-constrained, and unconstrained). Where available, the OWAM discussions are supplemented with known species composition information provided through either literature review or personal communications.

Average widths of the stream adjacent riparian area (RA1), and (if applicable) upland-adjacent riparian area (RA2) are provided. Dominant species or types (e.g., conifers, hardwoods) of vegetation are described for each zone. Focus is on general pattern with some exceptions noted, such as unstable slopes, wet soils, low terraces, and beaver disturbance.

Streamside vegetation is highly variable and dynamic. Potential streamside vegetation descriptions (below) provide a minimum set of guidelines against which current conditions can be evaluated. Species lists do not comprise a plant community. All of the species listed may not be present together on a site.

Canyons and Dissected Uplands (11g)

Riparian vegetation common to the canyons and dissected uplands of the lower Imnaha consists primarily of low shrubs and grasses with patches of hardwoods and conifers. The shrubs are mainly willows (*Salix* spp.), alder (*Alnus* spp.), currant (*Ribes* spp.), dogwood (*Cornus* spp.), hackberry (*Celtis occidentalis*), and box elder (*Acer negundo*) (USFS 2001; B. Knox, ODFW, personal communication, January, 2004). The grass communities are comprised of brome, carex, and fescue. Where a canopy is present, cottonwood and ponderosa pine are the most common species. The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA), is provided in Table 14.

Table 14. Potential streamside vegetation associated with the Canyons and Dissected Uplands subecoregion 11g (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: hardwoods (willow, cottonwood, and shrubs) Size: medium Density: dense	25–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion.
Semi-constrained	0–50	Type: hardwoods (willow, cottonwood, and shrubs) Size: medium Density: dense	50–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	Type: hardwoods (willow, cottonwood, dogwood, and shrubs). Also aquatic sedge or wolly sedge, shrubby cinquefoil, silver sage, or big sage Size: medium Density: dense	75–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion. In some RA1 areas, woody veg. is absent altogether—herb. veg. exclusive.

Canyons and Dissected Highlands (11f)

Riparian communities common in the Canyons and Dissected Highlands portion of the subbasin include shrub and grass/sedge plant communities in the primary riparian area, and cottonwood, alder, ponderosa pine, and hawthorn in the secondary riparian area. Where the Canyons and Dissected Highlands subecoregion occurs in the Big Sheep Creek subwatershed, the primary riparian zones are dominated by a mixed-age, early seral stage grand fir overstory, with a few ponderosa pine, lodgepole pine, and western larch (USFS 2001). Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations (USFS 2001). The absence of spruce and other overstory species in Big Sheep Creek has resulted in a dominance of 6-to 10-foot-high trees/shrubs along with grasses/forbs (USFS 2001). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA) is provided in Table 15.

Table 15. Potential streamside vegetation associated with the Canyon and Dissected Highlands subecoregion 11f (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	**Type:** mixed (Engelmann spruce, willows, dogwood) and shrubs (mountain alder) **Size:** small **Density:** dense	25–100	**Type:** (Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) **Size:** medium **Density:** sparse	Disease, insects, and fire often suppress one or more tree species.
Semi-constrained	0–50	**Type:** mixed (Engelmann spruce, red alder) and shrubs (pacific ninebark, mountain alder, common snowberry) **Size:** small **Density:** dense	50–100	**Type:** Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) **Size:** medium **Density:** sparse	Disease, insects, and fire often suppress one or more tree species. In some cases, there is no woody veg.—herb.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	**Type:** hardwoods (willow, dogwood, aspen), shrubs (Geyer, Booth, and Lemmon willow; mountain alder, common snowberry; shrubby cinquefoil; silver sage, or big sage), and sedges **Size:** small **Density:** dense	75–100	**Type:** Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) **Size:** medium **Density:** dense	Disease, insects, and fire often suppress one or more tree species. In some cases, there is no woody veg.—herb. (tufted hairgrass, bluejoint reedgrass, or aquatic sedge).

Blue Mountain Basins (11k)

Because only a small portion of the subbasin is defined by the Blue Mountain Basins subecoregion (see Figure 4), there are only limited portions of tributary headwaters bordered by riparian vegetation. For the most part, the riparian vegetation common to these areas is similar to that found in the Canyons and Dissected upland subecoregion (11g). The relative occurrence of streamside vegetation is provided in Table 16.

Table 16. Potential streamside vegetation associated with the Blue Mountain Basins subecoregion 11k (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	**Type:** hardwoods (cottonwood) and shrubs (willows) **Size:** small **Density:** dense	N/A	**Type:** N/A **Size:** N/A **Density:** N/A	
Semi-constrained	0–50	**Type:** hardwoods (cottonwood) and shrubs (willows) **Size:** small **Density:** dense	N/A	**Type:** N/A **Size:** N/A **Density:** N/A	
Un-constrained	0–75	**Type:** hardwoods (cottonwood and aspen) and shrubs (willows) **Size:** small Density: dense	N/A	**Type:** N/A **Size:** N/A **Density:** N/A	Under certain conditions, there are a few potential plant communities with no woody veg. in RA1; they are characterized by herbaceous plants.

Mesic Forest Zone (11l)

Riparian vegetation in the Mesic Forest Zone is similar to that found in the Canyons Dissected Highlands subecoregion in that the primary riparian zone communities are largely comprised of hardwoods and grasses/forbs, while the secondary vegetation consists mostly of conifer species. It is not uncommon to find some higher-elevation riparian plant communities in the Mesic Forest Zone, such as bog-blueberry, or various aquatic sedges. Similarly, the Mesic Forest Zone marks a transition area where various plant communities grade from one biome to the next, such as the change from ponderosa pine and western larch to subalpine fir and lodgepole pine. The Mesic Forest Zone represents the area in the subbasin where riparian community health (measured by stream shading, large woody material in the channel, diversity of vegetation types, and percent ground cover) is the highest (USFS 2001). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA) is provided in Table 17.

Table 17. Potential streamside vegetation associated with the Mesic Forest Zone subecoregion 11l (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	**Type:** hardwoods and shrubs (willows, bog blue-berry, dogwood, mountain alder) **Size:** small **Density:** dense	25–100	**Type:** conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) **Size:** large **Density:** dense	Disease, insects, and fire often suppress one or more tree species. Under certain conditions, there are a few plant communities that have no woody veg. in RA1 and characterized by herb. plants such as aquatic sedge (at higher elevations), queencup beadlily, and widefruit sedge.
Semi-constrained	0–50	**Type:** hardwoods and shrubs (willows, bog blueberry, dogwood, mountain alder, Pacific ninebark, common snowberry) **Size:** small **Density:** dense	N/A	**Type:** Conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) **Size:** large **Density:** dense	(See the cell above but include smallfruit bulrush and beaked sedge to the list of potential herbaceous plants.)

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	**Type:** hardwoods and shrubs (willows, bog blueberry, dogwood, mountain alder, Pacific ninebark, common snowberry) **Size:** small **Density:** dense	N/A	**Type:** conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) **Size:** large **Density:** dense	(See the two cells above but include blue-joint reedgrass to list of potential herbaceous plants.)

Subalpine Zone (11m)

Riparian plant communities in the subalpine zone are largely limited to subalpine fir, lodgepole pine, and whitebark pine (USFS 2001). The trees here are small and unevenly distributed due to the abbreviated growing period and avalanche disturbance (respectively). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA), is provided in Table 18.

Table 18. Potential streamside vegetation associated with the Subalpine Zone subecoregion 11m (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	**Type:** conifers (subalpine fir) and shrubs (willows, mountain alder, Sitka alder, bog blueberry) with ladyfern, arrowleaf, groundsel, and queencup beadlily **Size:** small **Density:** sparse	25–100	**Type:** conifers (grand fir, Engelmann spruce, subalpine fir) **Size:** medium **Density:** sparse	Under certain conditions, there are a few potential plant communities lacking woody veg. in RA1 and characterized by herbaceous plants such as black alpine sedge, showy sedge, and aquatic sedge at higher elevations and queencup beadlily and widefruit sedge in lower areas.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Semi-constrained	0–50	**Type:** conifers (subalpine fir) and shrubs (willows, mountain alder, Sitka alder, bog blueberry) with ladyfern, arrowleaf, groundsel, Holm's sedge, and queencup beadlily **Size:** small **Density:** sparse	50–100	**Type:** conifers (grand fir, Engelmann spruce, and subalpine fir) **Size:** medium **Density:** sparse	(See the cell above but include Holm's sedge and smallfruit bulrush to the list of high-elevation herbaceous plants.)
Un-constrained	0–75	**Type:** conifers (subalpine fir) and shrubs (willows, mountain alder, common snowberry, bog blueberry) meadow vegetation and queencup beadlily **Size:** small **Density:** sparse	75–100	**Type:** N/A **Size:** N/A **Density:** N/A	(See the two cells above but include bluejoint reed-grass and woodrush sedge to the list of high-elevation herbaceous plants.)

1.1.2.5 Wetland Resources

Wetland habitats are relatively rare in the Imnaha subbasin but are most prevalent in the Big Sheep watershed. Approximately 1% or 330 acres of the National Forest land in the Big Sheep watershed is covered by wet meadows. These meadows were likely historically dominated by tufted hairgrass and sedges, although vestiges of tufted hairgrass remain in some of the subbasin's wet meadows. These areas are now more typically dominated by Kentucky bluegrass, timothy, showy aster, cinquefoils, and sedges. Sedge types include pond sedge, meadow sedge, woodrush sedge, Liddon's sedge, and Holm's Rocky Mountain sedge. Hydric areas often contain bistort and California oatgrass. Some of the subbasins wet meadows are extremely degraded and contain mules ears, wollyhead clover, slender rush, groundsel, and twin arnica (USFS 1995).

Wet meadows likely were more extensive in size and distribution, although the change is difficult to quantify. Portions of the Big Sheep Creek watershed on private land have been channelized. These areas are now flood irrigated and farmed and the wet meadow vegetation has been replaced with agricultural crops. Beaver dams may be providing some wet meadow habitat in the lower reaches of Big Sheep Creek (USFS 2003). Condition trends for the subbasins wetlands are estimated as upward (USFS 1995).

National Wetlands Inventory surveys have been completed across most of the subbasin but the surveys have only been digitized 9% of the subbasin. Hard copy quad maps of the wetland inventories were provided to the project team but unfortunately due to time constraints it was only possible to do a cursory review of these maps. The digitized data is for portions of the Big Sheep watershed where wetlands are the most prevalent in the subbasin and may be indicative of the larger trend. The following discussion summarizes the Big sheep data, completing the digitizing of the wetland quad maps was identified as a important step in improving the management of wetland habitats in the subbasin, and was identified as a strategy under Objective 16A in the *Imnaha Subbasin Management Plan.*

These surveys located 147 wetlands in the mid-elevation, western portion of the Big Sheep watershed. The largest of these wetlands was 9.9 acres in size while the smallest was 0.16 acres in size (USFWS 2003b). All of the wetlands were palustrine, a term used for wetlands that have been traditionally referred to as marshes; swamp; bogs; fens; ponds; prairie wetlands; and wetlands associated with streams, rivers, or lakes. Surveyed wetlands fall into the following six classes (based on Cowardin et al. 1979, as cited in USFWS 2003b). Each classification refers to the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. The greatest number of the surveyed wetlands fell into the unconsolidated bottom class, while emergent wetlands covered the largest area (Figure 26) (USFWS 2003b).

Aquatic Bed—Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years.

Emergent—Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens.

Forested—Characterized by woody vegetation that is 6 meters tall or taller.

Scrub-Shrub—Includes areas dominated by woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions.

Unconsolidated Bottom—Includes wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6–7 cm), and a vegetative cover less than 30%.

Unconsolidated Shore—Includes all wetland habitats having three characteristics:(1) unconsolidated substrates with less than 75% aerial cover of stones, boulders, or bedrock;(2) less than 30% aerial cover of vegetation other than pioneering plants; and (3) any of the following water regimes (see below): irregularly exposed, regularly flooded irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded.

The wetlands surveyed by the National Wetlands Inventory in the subbasin exhibit the following five different types of water regimes. These water regimes refer to how much water is present in these systems and at what times. Most of the surveyed wetlands exhibited either a seasonally or permanently flooded water regime, while the largest wetlands were temporarily flooded (Figure 27).

Temporarily Flooded—Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

Seasonally Flooded—Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years.

Semipermanently Flooded—Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

Permanently Flooded—Water covers the land surface throughout the year in all years.

Saturated—The substrate is saturated to surface for extended periods during the growing season, but surface water is seldom present.

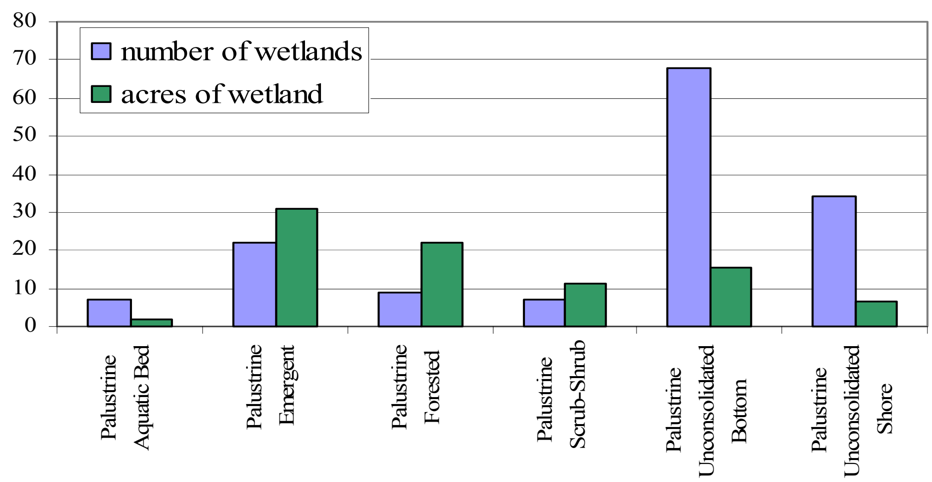

Figure 26. Classes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).

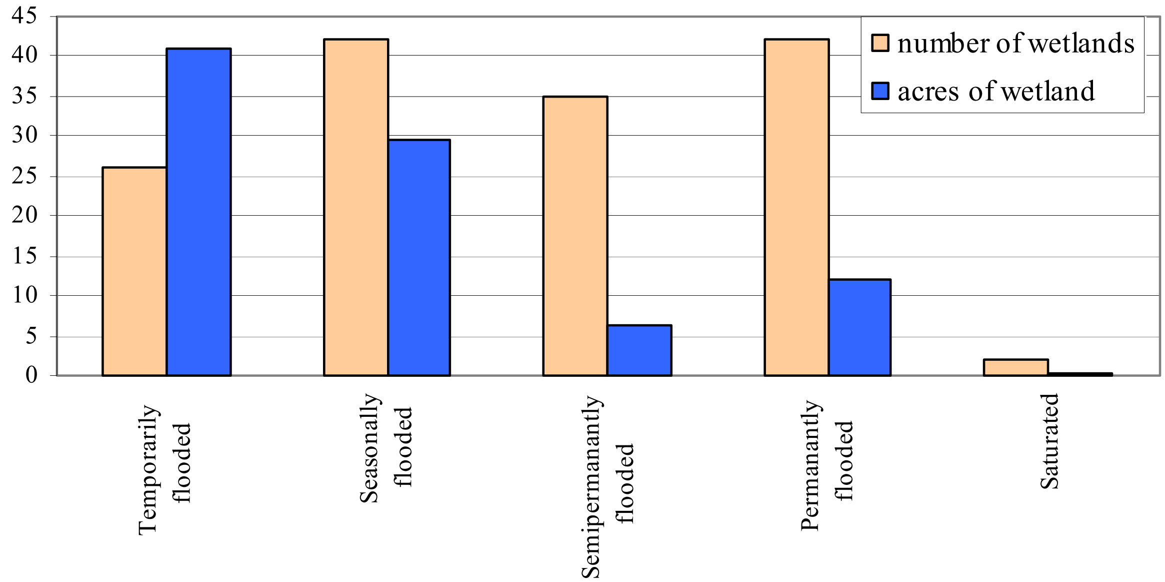

Figure 27. Water regimes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).

1.1.3 Trends in Aquatic and Terrestrial Ecology

The relationships between fish and wildlife species—to each other and to their physical surroundings—are a function of the various environmental processes acting in the watershed and the degree to which the species' environment has been modified. Climate, hydrology, erosion, and fire, are among the most important habitat-shaping process in the Imnaha subbasin. The affect a given process may have on aquatic and terrestrial habitats may be heightened given the degree to which the habitat is in disequilibrium. For instance, the magnitude of effect from a particular storm may be increased if a stream reach has been channelized or its competence to mobilize substrate changed. Similarly, the frequency and magnitude of effect from wildfires may be increased given a change in the condition and/or composition of the timber stand.

The following sections focus on how natural and anthropogenically modified processes affect fish and wildlife communities in the Imnaha. Examination of population trends (if available) at differing scales and/or over different time intervals enables the discussion.

1.1.3.1 Influence of Natural Ecologic Processes on Aquatic Systems

The primary natural ecologic processes influencing the quantity and quality of aquatic habitat in the Imnaha subbasin are climate, hydrology, and erosion, with climate being the only process that is mutually exclusive of the others. Climate dictates the hydrologic regime of the streams and rivers, which in turn affect the amount and form of erosion. We examine the effects of climate on peak and base flows, and discuss how certain areas may be responding differently based on their biophysical characteristics. Also discussed are erosion processes and their influence on aquatic systems.

Macroclimate and Peak Flows

The types of peak flow generating processes that occur naturally in eastern Oregon watersheds include rainstorms, winter and spring rain-on-snow events, spring snowmelt, and cloudburst storms or thunderstorms (Kjelstrom and Moffatt 1981, Kjelstrom 1998, Watershed Professionals Network 2001). The Watershed Professionals Network (2001) evaluated peak flows in the Blue Mountain Ecoregion using the Level III classification scheme developed by Pater et al. (1997) and Kagan (2001). The Watershed Professionals Network (2001) found that the majority (63% of all flows recorded from 55 streamflow stations) of annual peaks in the Blue Mountain Ecoregion occur in the springtime. In the Imnaha, however, the size of the drainage on which flows were gaged incorporated considerable spatial and temporal variability in meteorologic conditions, thereby making it difficult to ascribe a specific peak flow to a particular cause (MacDonald and Hoffman, as cited in WPN 2001). Because of this problem, peak flows relative to the Imnaha were assessed by the Watershed Professionals Network (2001) using data from the Doe Creek gage, located approximately 15-20 air miles from the Imnaha in the neighboring Joseph Creek drainage (see Table 9). Thirty-three percent of peak flows occurred in the winter, while the remaining 67% occurred during the spring.

Based on the results from the Watershed Professionals Network (2001) study, an estimated 15% of the Imnaha subbasin is subject to rain-on-snow events during the winter and spring, while the remaining 85% of the subbasin is dominated by spring snowmelt runoff patterns. Differences in spring snowmelt runoff patterns and rain-on-snow runoff patterns are coincident with an elevational gradient of around 3,600 feet (see Figure 6 and Figure 7) (WPN 2001); however, warm fronts from the west can quickly raise the freezing level to 7,000 feet or above. If these fronts are associated with moisture, rain falling below the freezing level can result in rapid melting of the snowpack and flash flooding (USFS 1998d). If the snowmelt and rain falls on frozen ground, the effects of the storms may be compounded. These storms commonly affect small intermittent and perennial tributaries more than they do the mainstem because of differences in buffering capacities (USFS 1998d).

Natural factors influencing peak runoff include the size and topography of the watershed, amount, form, and distribution of precipitation, soil type, climate, elevation, groundwater characteristics, and vegetation removal through fire, wind, and/or pathogens. In the Imnaha, these differences can be substantial due to the physiographic diversity of the subbasin. Stratification of watersheds by ecoregions/subecoregions is therefore useful when attempting to gage how a specific area would hydrologically respond to various physical activities (i.e., rainfall, fire, human land use activities, etc.). Relevant hydrologic characteristics of subecoregions are shown in Table 19 (see Figure 4 for location of subecoregions). When considering the area influenced by the various flow patterns, the portion of the Imnaha mainstem between Freezeout and Dry creeks contributes significant flow volume during annual peak flow events based on its two-year, 24-hour precipitation and peak flow magnitude. Peak flows generated from rainfall and/or rain-on-snow events are more likely to occur in the lower portions of the subbasin defined by the Canyons and Dissected Uplands subecoregion.

Table 19. Characterization of hydrologic processes in the Imnaha subbasin at the subecoregion level (Watershed Professionals Network 1999).

Subecoregion	2-Yr. 24-Hr. Precip. (inches)	Basin Description	Runoff Patterns of Avg. Monthly Streamflows	Peak Flow Generating Processes	Peak Flow Magnitude	Historical Crown Closure
Canyons and Dissected Highlands	1.4–2.0	Northward orientation	highest in late spring/early summer months	Primarily spring rain, spring rain-on-snow, and snowmelt	10 to 60 cfs/mi^2, with a few less than 10 cfs/mi^2	>30% on north-aspect slopes
Canyons and Dissected Uplands	1.4–2.0	Northward orientation with canyons 2,000–5,000 feet deep	highest in the spring months	Rainfall	6 to 20 cfs/mi^2, with a few greater than 20 cfs/mi^2	<30%
Blue Mountain Basins	1.6–1.8	Basins are areas of depressions and have variable orientation; streams are slow and meandering.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 10 cfs/mi^2, with a few greater than 10 cfs/mi^2	<30%
Mesic Forest Zone	1.8–2.4	These basins are in the higher elevations with varying orientations.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 20 cfs/mi^2, with a few greater than 20 cfs/mi^2	>30%
Subalpine Zone	2.0–2.6	Streams are perennial depending on snowpack; most are headwaters to Imnaha River and Big and Little Sheep creeks.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 20 cfs/mi^2, with a few greater than 20 cfs/mi^2	>30% below alpine zone

Modifications to vegetation represent another factor influencing peak/base flows in the Imnaha subbasin. These changes include the effects of fire, windstorms, and insect/pathogen outbreaks on forest canopies. As discussed in the vegetation section, several large (>100 acres) fires have occurred in the subbasin over the last few decades. Since 1970, over 500 wildfires have occurred in the Imnaha subbasin, 100 of which were located in the Big Sheep Creek subwatershed (USFS 2000). Most recently, the Corral Fire of 2000 burned a considerable portion of the lower river areas (Figure 32). The effects of the 2000 complex on vegetation in the lower subbasin was somewhat ameliorated by the fact that grassland dominates the area, although much of the shrubs and brush in ephemeral draws was lost. The Canal Creek Fire of 1989 was considered to be of significant consequence to peak/base flow regimes in the Big and Little Sheep Creek subwatersheds due to its size (23,846 acres) and amount and type of vegetation burned. The Big Sheep Creek Watershed Analysis (USFS 1995) determined that two of the management units, 7J and 7R, were "functioning at risk" and that management unit 7O was "functioning at an unacceptable risk" with respect to peak flows. The assessment attributes flow problems to the Canal Fire, insect outbreak, and windstorms.

Macroclimate and Base Flows

As discussed in section 1.1.1.6, the Imnaha subbasin is subject to considerable variation in the amount of precipitation it receives. The snowpack and rainfall that occurs in the subbasin over the course of a year is largely what drives streamflow in the subbasin, as only a small percentage of Imnaha tributaries are spring-fed.

Also as described in section 1.1.1.6, considerable interannual variation in precipitation recorded at the various climate stations has occurred, producing both “wet” and “dry” years. In an effort to record these climatic phenomena, the National Climate Data Center (NCDC) has developed a regional drought severity index. The Palmer Drought Severity Index (PDSI) is a meteorological index used to assess the severity of dry or wet weather periods by measuring the duration and intensity of drought-inducing circulation patterns. The index is calculated monthly and is based on the principles of a balance between moisture supply and demand. The index generally ranges from –6 to +6, although values to ±7 may occur. Negative index values indicate dry periods (drought), and positive values indicate wet periods. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months. Since weather patterns can change almost overnight from a long-term drought pattern to a long-term wet pattern, the PDSI can respond fairly rapidly. The drought severity index used for the Imnaha is based on Climate Zone 8, which encompasses the northeastern corner of Oregon and occupies all of Wallowa, Baker, and Union counties, as well as portions of Umatilla and Grant counties (Figure 28).

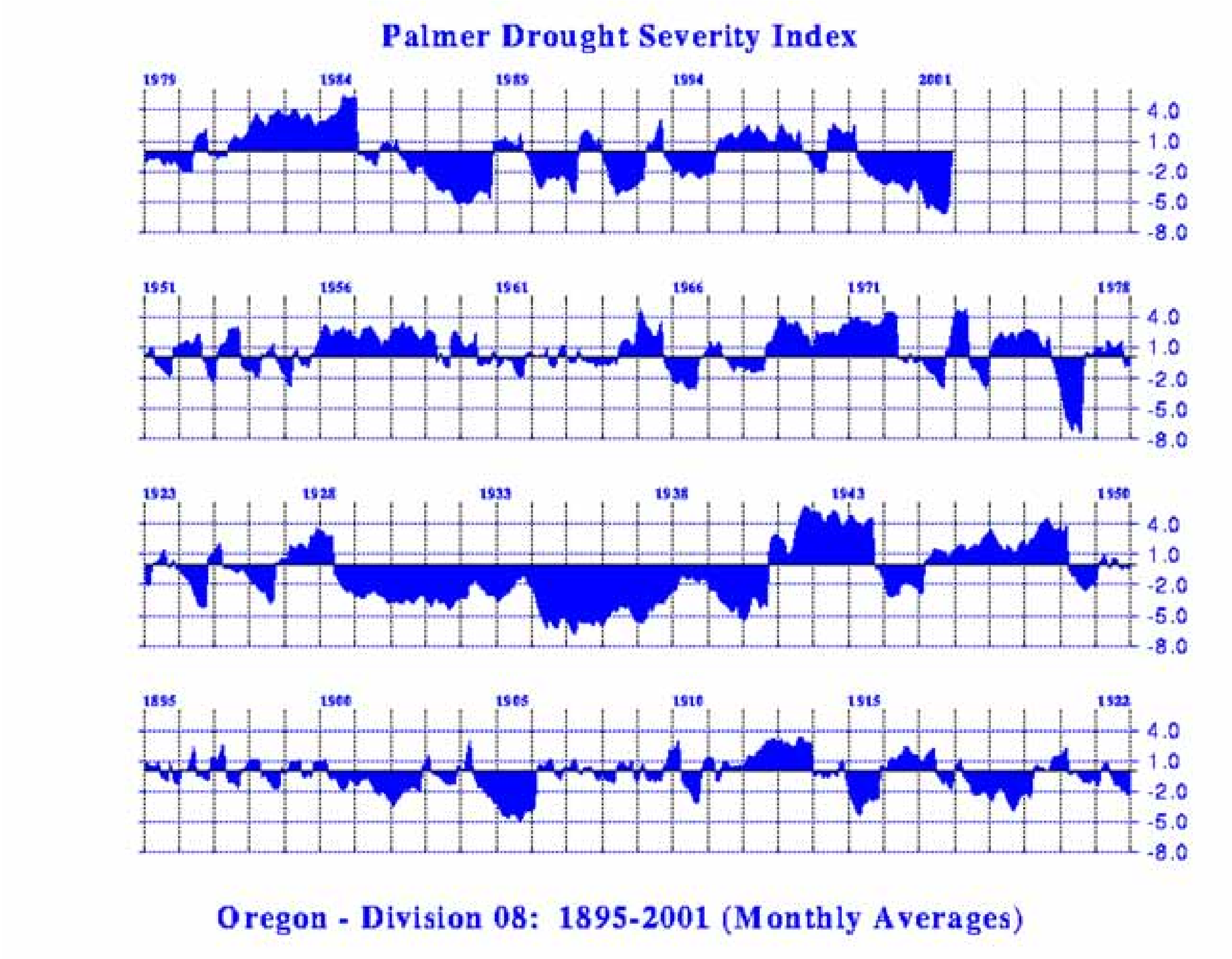

Figure 28. Palmer drought severity index for Oregon Climate Zone 8 (NCDC unpublished data 2001).

The utility of climatic indices, from a fisheries standpoint, provides researchers and resource managers with a perspective of "natural" factors that may be limiting fisheries production. For example, Anderson (as cited in Taylor and Southards 1997) used the Pacific Northwest Index (PNI) to distinguish cool, wet periods in the coastal region from warm, dry ones and then correlated annual spring chinook returns to respective periods (Figure 29). He found a positive relationship between higher returns during wet periods and lower returns during dry periods. While there are undoubtedly human-induced effects on the fish (including dam construction and habitat destruction), Figure 29 indicates that natural variability may be a very significant influence as well and should be considered in any salmon restoration plan.

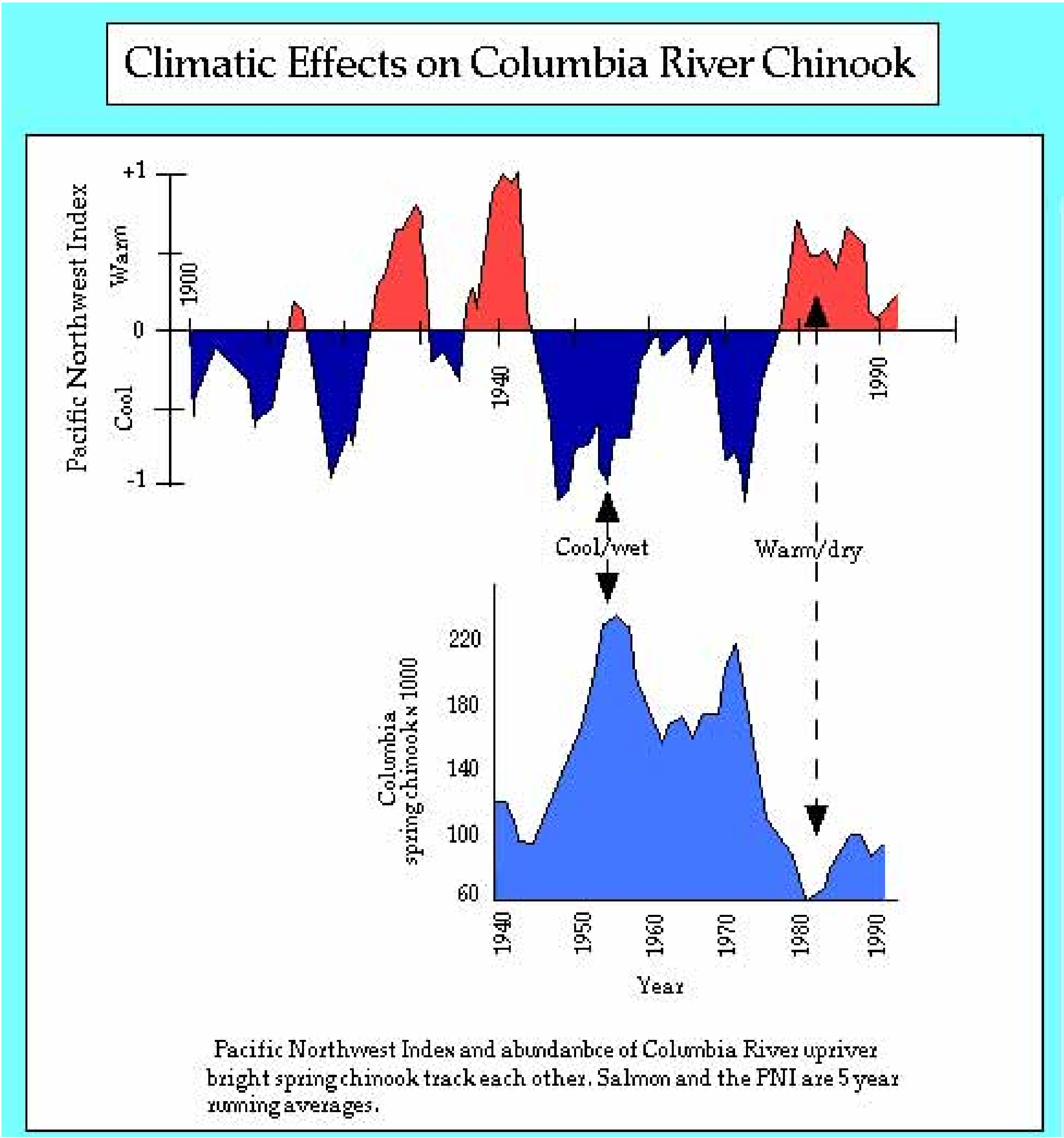

Figure 29. Pacific Northwest Index (PNI) and spring chinook returns for Oregon Climate Zone 1 (coastal) (reproduced from Taylor and Southards [1997]).

The relationship between precipitation and spring/summer chinook returns for the Imnaha is less defined than that demonstrated by Anderson, which is likely due to the fact that the data available for analysis either are not specifically exclusive to the subbasin (i.e., PDSI data relative to the entire Zone 8) or are estimated (i.e., spawn/recruit data). Relationships do exist, however, as shown in Figure 30. For example, "wet" years occur between 1945 and 1948. The number of recruits per spawner responds favorably over the subsequent four-year period (1949–1953), which corresponds to the mean age at return for spring/summer chinook in the Imnaha. A similar trend in recruits per spawner occurs between 1959 and 1963 following a previous wet period (1955–1959). Precipitation–recruitment relationships become less defined from 1968 to 1990. This disassociation may be due to a number of human-induced factors including the construction of Ice Harbor, John Day, Lower Monumental, Little Goose, and Lower Granite dams between 1960 and 1976.

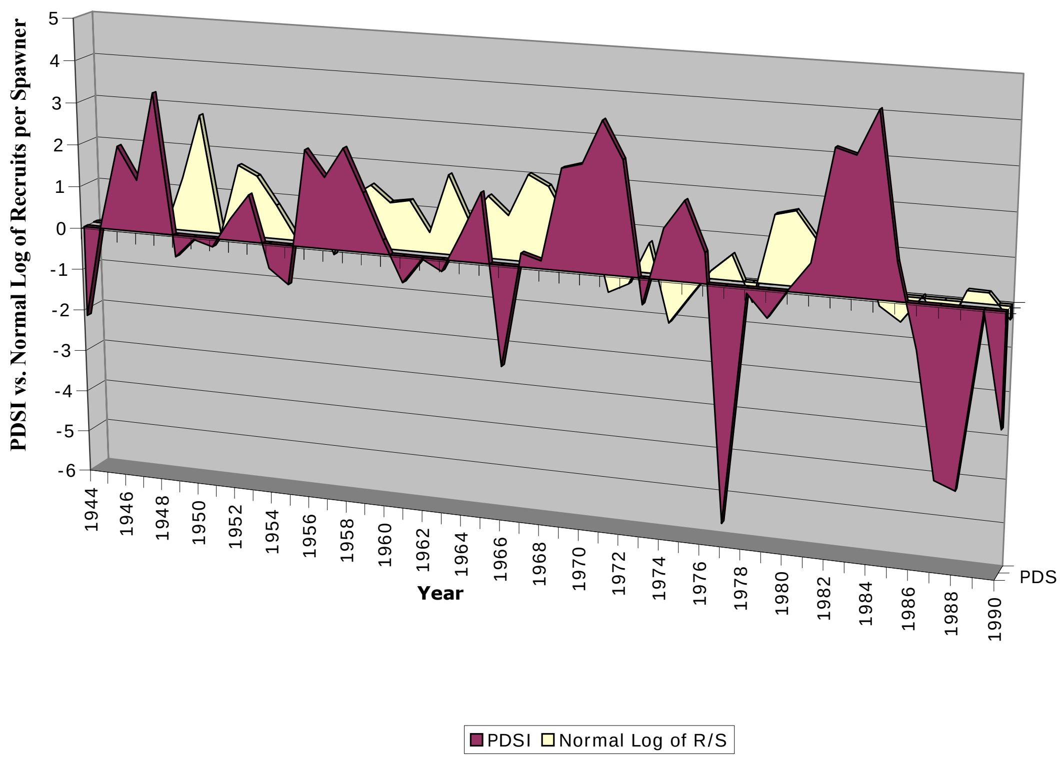

Figure 30. PDSI and spring/summer chinook recruits per spawner relationship for the Imnaha subbasin. (Recruit per spawner data and methods used in its derivation are from Beamesderfer et al. [1996]).

Erosion Processes

The primary vehicle for the transport of sediment in the Imnaha is water. Rainfall, snowmelt, and streamflow each play a function in erosion processes throughout the subbasin, albeit at differing times and levels of magnitude. Mass-wasting, which most often results from supersaturated ground, is also an important mechanism for sediment delivery to streams in certain portions of the subbasin.

As discussed previously, sedimentation rates are naturally higher in the upper portion of the subbasin due to the instability of the barren granite mountain peaks. Primary mechanisms of sediment delivery to aquatic habitats in these areas include debris flows and other processes of mass wasting, which are commonly triggered by thunderstorms or rain-on-snow events (USFS 1993). For example, in August 1992, a thunderstorm triggered a debris flow in a wilderness area tributary to the North Fork Imnaha. A debris fan formed at the confluence of the tributary and North Fork Imnaha, shifting the thalweg of the North Fork and initiating a landslide (USFS 1993). A January 1997 storm also resulted in landslides and debris flows within tributaries to the Imnaha River. High flows and available bedload increased the amount of sediment transported, which contributed to the creation of midchannel and lateral gravel and cobble bars (USFS 1993). This material will continue to move in pulses downstream until stabilized by large woody material (LWM), riparian vegetation, or channel processes resulting in elevated levels of sediment.

Streambank erosion represents another naturally occurring source of fine sediment to streams in the Imnaha subbasin (USFS 2003b). The rate of streambank erosion is accelerated following thunderstorms or winter/spring rain-on-snow events, during which high magnitude flow events scour stored sediment from channels and accrue fines through streambank destabilization. It is common to see “rock flower” in the mainstem during runoff periods. The source of the suspended sediment is from the crushed rock and fine sediment found in terminal moraines located in the uppermost portions of the subbasin. The effects of streambank/channel erosion are most notable in the mainstem Imnaha River below Nine Point Creek, which received the large pulse of bedload following the 1997 Flood (USFS 2003b). Mainstem reaches in this area are classified as “functioning at risk” by the USFS.

Big Sheep and Little Sheep Creek are geomorphologically young systems with active erosion in the oversteepened headwalls of the Wallowa Mountains. Snow avalanches and debris flows occur frequently contributing sediment and LWM to downstream reaches (USFS 1995).

1.1.3.2 Historical Conditions and Processes in Terrestrial Systems

Disturbances processes have worked in conjunction with the geology, soils, topography, and climate of the subbasin (see section 1.1.1 for a discussion of the subbasins physical characteristics) to shape the composition, structure, and distribution of its terrestrial communities. The primary natural disturbance processes in the Imnaha subbasin are fire, disease, insect outbreaks, and grazing. The characteristics and role that these disturbances play in the ecosystem vary depending on the physical features of the landscape and the composition and structure of the vegetative communities that it supports. Changes in these disturbance regimes, through human activities, have altered the ecosystem of the Imnaha subbasin. This section outlines the historical disturbance regime in the subbasin, and section 1.1.3.3, discusses the changes to these regimes and the resultant impacts to the ecosystem since settlement. The discussion of disturbance processes is organized by the WHTs developed by the Northwest Habitat Institute and introduced in section 1.1.1.9.

Climate

Variation in the climate of the subbasin over millennia has helped to shape its terrestrial communities. For tens of thousands of years valley glaciers covered the Imnaha Area. Around 12,000 years before present, these glaciers retreated, but have since advanced and retreated numerous times.

The subbasin and surrounding region is currently in a period of glacial retreat. Glaciers influence the terrestrial ecosystem by removing all vegetation in their path, and upon retreat, they leave behind rocks and soils that determine the patterns of vegetation that eventually emerge. They form ice dams that, when they break, create floods, often of great magnitude (Johnson et al. 1994).

As discussed in sections 1.1.1.4 and 1.1.1.9, both the location of vegetative types and WHTs in the Imnaha subbasin are a reflection of its temperature and precipitation patterns. Climatic events of unusual intensity are an important part of this regime; windstorm and flood are two that particularly impact the Imnaha subbasin.

Windstorms often break or uproot trees where wind is channeled by local topography, and severe windstorms can overturn trees across large areas. Trees in overcrowded stands snap off or break at their root collars in windstorms or uproot, if they are in shallow soils. Trees blown over by winds create conditions that favor other disturbances such as insects and fires. Where only some trees blow over the partial shade of remaining trees promotes shade-tolerant species such as true firs. Windstorms generally favor advance regeneration of true fir species. Windstorms create downed, woody material, important to many wildlife species, but it can also form barriers to the movement of large animals (Johnson et al. 1994).

Flooding is critical to the maintenance of wetland ecosystems. It creates new microsites for colonization and delivers nutrients to the community. Floods also result in erosion and mass wasting, which creates new landforms and adds to the diversity of the landscape. Deposition of these materials to streams can have negative consequences to aquatic plant and animal species, in the short-term but over time this is a necessary process preventing stream channels from becoming scoured. At natural levels, floods, erosion and mass wasting replenishing the gravel, sand and silt in the stream and add to the floodplain soils (Johnson et al. 1994).

Historical Fire Regimes

Fire has always been an integral force for structuring and maintaining the communities of the Imnaha subbasin. The probability of fire in any given place in the subbasin was determined by chance, it position relative to storm building topographic features and the vulnerability of the plant community. Once a fire ignited on the landscape its duration and intensity will depend on topography weather stand structure and fuels (Johnson et al. 1994). Susceptibility to fire, fire characteristics, and return intervals vary by the WHTs in the subbasin. Available data on natural conditions follow.

Montane Mixed Conifer Forests

Fire return intervals ranged from 70 to 150 years with moderate to high intensity fires resulting in stand replacement on 70 to 100% of the affected area. Fires encouraged the persistence of Lodgepole pine, western larch and Douglas-fir (USFS 1995).

Eastside Mixed Conifer Forests

Fire return intervals on these WHTs were highly variable and ranged from 15 to 30 years on warm, dry sites to 150 years on cool, moist sites. In areas of longer fire return intervals, fire intensity was higher and shade tolerant species were more prevalent (USFS 1995).

Ponderosa Pine Forests and Woodlands

Ponderosa pine forests are characterized by a very short fire regime; tree ring data suggest that the average historical fire return interval between fires in the ponderosa pine forests of eastern Oregon was 13 to 18 years (USFS 1995). Fire intensities were low with ground fires periodically burning through stands, removing much of the down woody material and keeping stock levels low. Many stands consisted of park-like stands of mature ponderosa pine at low stocking levels (USFS 1995).

Subalpine Parkland

Historically, these sites had long fire return intervals. Fire intensities were low due to incontinuous fuel loads, but isolated pockets may have experienced heavy mortality because of the low crowns of subalpine fir, the lower branches growing down into the duff layer.

Eastside Grasslands

Historical fire ignitions in these communities typically occurred as a result of late summer and early fall thunderstorms with a return interval of approximately 10 years. Fires burned across the bunchgrass slopes in an interfingering manner, depending on daily temperatures, wind velocity, and the microrelief of the slope. The effects of fire were not uniform; areas of dense, dry, standing biomass burned intensely while the fire moved through other areas of the landscape rapidly, leaving the crowns of grasses alive. Of the three primary bunchgrasses of this WHT, fescue is considered the most sensitive to fire. When burned intensely, grassland areas regress to earlier succession stages where forbs dominate the landscape (USFS 1995).

Historical Insects and Disease

Insects and disease are natural processes that help to shape forests and provide snags and other beneficial features for wildlife. Typical outbreaks on the common tree species of the subbasin are described below.

Defoliation from western spruce budworm outbreaks appeared on a cyclic basis. These outbreaks were heavier at lower elevations and in on stands containing higher levels of grand fir or Douglas-fir. Outbreaks of Douglas-fir tussock moth were also short in duration but since they can feed on older needles, caused heavier defoliation in individual years. Due to a less continuous food source than is common today, outbreaks were short in duration and small in extent. Defoliation seldom resulted in long-term growth or mortality effects (USFS 1995).

Mountain pine beetle, spruce beetle and fir engraver were the major insect forces in lodgepole forests. Mortality from mountain pine beetle generally occurred in suppressed stands of lodgepole pine starting at about 60 years old, and mainly affected large diameter trees. Spruce beetle and fir engraver mortality in Engelmann spruce and subalpine fir occurred regularly but at low intensities, although increased mortality was evident during periods of drought. Bark beetle outbreaks historically were of low intensity and short duration, due to frequent underburning that maintained lower stocking levels and reduced competition (USFS 1995).

Annosus root disease, brown cubical butt rot, Indian paint fungus, laminated root rot, and Armillaria root disease were also agents of natural disturbance in the subbasin historically (USFS 1995). Due to the mixed species and multistoried nature of historical stands, disease did not threaten entire stands but chose selective hosts, resulting in increased structural diversity.

Historical Grazing

Early trappers speak of deer, elk, mountain sheep, antelope, and even bison in the valleys and canyonlands of eastern Oregon (Evans 1991, as cited in Johnson et al. 1994). These animals likely had light to moderate effects on vegetation. Natural predators of these species were varied and numerous and helped keep populations in balance (Johnson et al. 1994).

1.1.3.3 Human Influence on Conditions and Processes in Aquatic Systems

Focal salmonid species in the Imnaha subbasin are most susceptible to mortality during or following excessively high and low flow periods. And while Imnaha salmonids have adapted to the normal high and low flow events, the magnitude and/or frequency of these processes have increased in portions of the subbasin from land use activities, causing a subsequent reduction in the amount and quality of instream habitat. The land use activities affecting peak and base flow processes in the Imnaha are discussed below.

Peak Flow Generating Processes

Excessive flows are especially disruptive to salmonids during incubation and/or fry colonization life history stages, and can effectively scour a channel of cover and/or substrate that are needed by fish during their entire lives. And while peak flows are a normal part of any hydrograph, excessively high flows, such as those that occurred in the Imnaha in 1996–1997, aren't.

Changes in land cover and land use related to forestry, grazing, and irrigated agriculture are those most frequently cited as potentially altering runoff patterns in the Imnaha subbasin and are discussed below.

Timber Harvest

Forestry practices can have substantial influences on the natural hydrograph under certain conditions. Removal of forest canopy from extensive areas within a watershed may result in increased runoff magnitude resulting from rain-on-snow events; it has been shown to produce increased spring snowmelt peak flows in the Rocky Mountains (Troendle and King, as cited in Watershed Professionals Network 1999). Timber harvest and/or stand replacing wildfire influences hydrology by altering the distribution of precipitation that reaches the ground, amount intercepted by foliage, and water storage capacity of local soils (Chamberlin et al. 1991). Harvested areas that may be most susceptible to changes in peak/base flows are those occurring in rain-on-snow areas and that historically had a canopy >30% and currently have a canopy of less than 30% (Watershed Professionals Network 1999).

At the time of this documents preparation, stand structure data of a sufficient resolution in the Imnaha were limited, thereby limiting effective assessment of canopy closure. Information describing stand age (amount of timber <30 years old) on National Forest land was available and provided a surrogate measure for canopy closure (assuming a tree <30 years old will provide ≤30% canopy). A total of 31% of National Forest lands in the subbasin are currently present as stands less than 30 years old (USFS 2001). Past timber harvest, losses to insects and disease, and wildfires have produced stands less than 30 years old on 27,152 acres throughout the upper and lower Imnaha and 9,319 acres in the Big Sheep subwatershed. Of these lands, very few areas are dominated by rain-on-snow runoff patterns (assuming a rain-on-snow elevation of 3,600 feet), and once had a historical crown closure of more than 30%. Many of the USFS administered lands in the Canyons and Dissected Highlands subecoregion and in the Mesic Forest and Subalpine Zones had historical crown closures greater than 30% (north aspect only in the Canyons and Dissected Highlands subecoregion); however, these areas are generally at higher elevations.

If less emphasis is placed on the rain-on-snow elevation zone (i.e., it is more variable), then harvested areas most likely to affect peak/base flow runoff patterns would occur on north-facing slopes in Cow, upper Lightning, and Horse Creeks, the mainstem and its tributaries from Freezeout Creek upriver to Dry Creek, and in the Big and Little Sheep Creek subwatersheds upstream from the confluence of Griffith and Divide Creeks (respectively). Other areas in the subbasin are not known for their forestry potential, as they were, and currently are, dominated by grasses, shrubs, and some hardwoods, making crown closure influence negligible.

Overall, timber harvest *alone* does not appear to have substantially altered the peak or base flows in the Imnaha subbasin; however, finer-scale canopy closure data and subsequent analysis would provide a more in-depth and conclusive assessment of the effects of canopy removal on peak/base flow processes.

Grazing and Agriculture

Past livestock grazing has resulted in the reduction of the amount and variety of upland and streamside vegetation (USFS 2000). These losses may potentially influence runoff and/or water storage processes, which in turn may affect peak and base flows, respectively. The majority of grazing in the Imnaha occurs on National Forest lands, which have been allotted into specific grazing units. In all there are thirty-four allotments for domestic cows, horses, and sheep in the Imnaha subbasin (USFS 2000). In bull trout consultation for the Imnaha subbasin (section 7 assessment), the USFS gaged the condition of peak/base flows in the various allotment units. Peak and base flows in a total of three allotments/allotment groups are functioning inappropriately; however, livestock is related to only one of these designations. Allotments for which peak/base flows are "functioning at risk" but not related to livestock occur in the Carrol Creek/Middlepoint Allotments and in the Bear Gulch Allotment.

Livestock may potentially be impacting peak and base flows in the Marr Flat/Big Sheep/Divide allotment (see Figure 16). Specifically, historical livestock grazing pressure in the Marr Flat and Big Sheep allotments has been problematic with regards to meeting grazing utilization standards, as excessive vegetation removal and soil compaction are evident and have created a concern for increased peak flows (USFS 2000). Problems with base flows in the Sheep Creek watershed are related to water diverted by the Wallowa Valley Improvement District Canal, and not grazing (USFS 2000). According to the USFS (2000), changes in streamflow in the Divide Allotment are related to other factors such as the Canal Creek Fire and are not the result of livestock use, trailing, or trampling.

A commonly used parameter that aids in the definition of where range and/or agricultural practices may potentially affect hydrology is the characterization of hydrologic soil groups (HSGs) that occur across a given landscape (WPN 2001). Grouping soils by their hydrologic characteristics is a means to describe the minimum rate of infiltration obtained for bare soil after prolonged wetting, and provides an indication toward those areas that may be most hydrologically responsive to grazing or agricultural pressures. The definition of a particular HSG does not in itself, however, determine the effects that range and/or agricultural practices may have on flow regimes, although it does provide runoff potential.

Three HSGs are common throughout the Imnaha subbasin. These include B, C, and D soil types, the relative percentage of which differs spatially. B-type HSGs have moderate infiltration rates when thoroughly wetted and range from moderately deep to deep, moderately drained to well-drained (WPN 1999). C-type HSGs tend to have slow infiltration rates when thoroughly wetted. These soils usually have a layer that impedes downward movement of water or have moderately fine to fine-textured soils (i.e., sandy clay loam). D-type HSGs have a very low infiltration rate when thoroughly wetted and represent the HSG with the highest runoff potential. They consist of clay soils with a high swelling potential and are characterized by soils with a high permanent water table, soils with a clay layer near the surface, or shallow soils over near-impervious materials (WPN 1999).

Overall, C-type HSGs are dominant in the subbasin, with B and D HSGs occurring in relatively equal but lesser amounts (Table 20). When considering grazing and agricultural practices at the subecoregion scale, the intensity of both is most concentrated in areas with longer growing seasons (agriculture/range lands were defined using 1998 USGS land use layers (30-meter DEM); any areas defined by the USGS as shrublands, grasslands, pasture, row crops, small grains, or fallow were deemed agricultural/range areas). These are coincident with the Canyons and Dissected Highlands (11f) and Canyons and Dissected Uplands (11 g) subecoregions (see Figure 4 for location). Granted, only a portion of each subecoregion is grazed and a much smaller portion farmed. Nevertheless, subecoregions 11f and 11g represent those areas with the greatest proportional area of range and/or agricultural use and also represent the two areas with the greatest potential for peak flow increases based on HSG infiltration capacities (WPN 1999). Finer scale cover type data (i.e., 30-meter digital elevation model data) and subsequent analysis would provide a more in-depth and conclusive assessment of the effects of grazing and agricultural practices on peak/base flow processes.

Table 20. Area in square miles for hydrologic soil groups of rangeland and/or agricultural ground at the subecoregion-scale in the Imnaha subbasin.

Hydrologic Soil Group	Canyons and Dissected Highlands	Canyons and Dissected Uplands	Blue Mountain Basins	Mesic Forest Zone	Subalpine Zone
B	23.3	65.8	6.4	6.4	5.1
C	32.6	144.6	18.9	8.4	5.7
D	16.6	79.9	8.7	8.1	9.9

Base Flow Depleting Processes

Similar to the various processes or activities that may exacerbate high flows, there are activities that may reduce flows during low flow periods and negatively influence aquatic biota. Water withdrawals and water rights are the primary land use activities in the Imnaha that are most likely to affect salmonids and their habitat during base flow periods.

Water Withdrawals

The Imnaha subbasin has one large diversion and various smaller irrigation projects. No known water storage structures exist large enough to require inspection by the county watermaster because of their potential threat to people or property (S. Hattan, OWRD, personal communication, February 2, 2001).

Water diversions in the subbasin date back to the late 1800s (Wallowa County and NPT 1993). Early diversions enabled people to irrigate and more successfully farm land along streams and in the subbasin's valleys (Wallowa County and NPT 1993). McCully Creek, Big Sheep Creek, Little Sheep Creek, Imnaha River, and their tributaries all had water diverted from them for agriculture (Wallowa County and NPT 1993). Many of the smaller water diversion projects in the subbasin were abandoned during the World War II era, as people left to join the war effort and industrialized agriculture replaced the reliance on canal systems (Wallowa County and NPT 1993). Current water withdrawals are used primarily for livestock and irrigation and are regulated by the county watermaster (USFS 1998a).

The Wallowa Valley Improvement Canal is the only major irrigation diversion in the subbasin (NPT et al. 1990). The project was started in the early 1900s. By the time the project was completed, a canal was built from Big Sheep Creek in the Imnaha subbasin to Prairie Creek in the Wallowa Valley (Wallowa County and NPT 1993). Downstream of the Big Sheep Creek forks, water is diverted from Big Sheep Creek and sent via a canal to Little Sheep Creek (NPT et al. 1990). A diversion dam in Little Sheep Creek leads to a second canal that transports the water to the Wallowa Valley where it is used for irrigation (NPT et al. 1990). Along the course of the canal, water from Big Sheep Creek, Salt Creek, Little Sheep Creek, Redmont Creek, Cabin Creek, Canal Creek, and Ferguson Creek is diverted (USFS 2000). Most of the canal supports populations of resident bull and rainbow trout.

In 1983, three small hydropower production facilities—upper Little Sheep Creek, Canal Creek, and Ferguson Ridge—were constructed along the Wallowa Valley Improvement Canal in the Sheep Creek subwatershed (Mason et al. 1993, USFS 2000). A separate canal, known locally as the "Power Canal", was constructed above the Wallowa Valley Improvement Canal in an effort to obtain the necessary head required for electricity generation. Dropping diverted water rapidly through a penstock to the powerhouse, and then returning flows to the canal generated electricity. The facilities and canal, which were operated and maintained by Joseph Hydro Associates, were eventually removed in 1997 (USFS 2000). During its removal, approximately 3 miles of ditch was dewatered, necessitating a bull trout salvage operation by the USFS and ODFW during which an estimated 600 fish were saved (USFS 2000). The 600 bull trout that were saved from the dewatered ditch were later released into the Wallowa River, above Wallowa Lake (USFWS 2002b).

It has been determined by Forest and Wallowa Zone hydrologists/soil scientists that pond construction within draw bottoms (includes all perennial and intermittent streams) could affect hydrology and flow within watersheds (USFS 2003b). Extensive trough installations on springs located within draw bottoms could be another effect to flow within watersheds. However, based on the quantity of flow intercepted, it is assumed that the effect of trough installations on flow is minor in significance (USFS 2003b). Within this subbasin, a total of 17 ponds and 121 troughs are located within draw bottoms. These are spread over 13 and 29 subwatersheds, respectively (USFS 2003b). Due to the low occurrence of ponds and the small amount of flow that is intercepted from the trough installations, it is assumed that there are immeasurable effects to flow patterns in fish habitat (USFS 2003b).

Water Rights

There are 59 water rights on the Imnaha River mainstem for a total of 37.33 cfs (NPT and ODFW 1990). All rights to divert water in this area drop to ½ of their rate and 1/3 of the duty after August 1. Out of this total, the Lower Snake River Compensation Program (LSRCP) chinook hatchery facility will use 15 cfs in a nonconsumptive manner. There are an additional 69 water rights on tributaries (excluding the Big Sheep system) for a total of 24.98 cfs (NPT and ODFW 1990). There are 18 water rights on Big Sheep Creek for a total of 6.36 cfs and 5 additional water rights on tributaries (excluding Little Sheep Creek) for a total of 1.65 cfs (this does not include the Wallowa Valley withdrawals). There are four additional water rights filed on springs for 0.29 cfs. In Little Sheep Creek, there are 13 claims for 22.47 cfs, 19.6 cfs of which will be used by the LSRCP steelhead facility in a nonconsumptive manner (NPT and ODFW 1990). There are an additional 11 claims on tributaries for 26.55 cfs and 8 claims on springs for 0.41 cfs. This equals a combined water right of 279.61 cfs (including the Wallowa Valley diversions), 34.6 cfs of which is nonconsumptive (NPT and ODFW 1990).

In 1955, the legal means to reserve instream flows was created with the passage of the "minimum stream flow law" (ORS 536.300-310). This law recognizes water requirements of fish and wildlife as a beneficial use of water and establishes a "public water right" to minimum stream flows to be designated by the state Water Resources Board (Nelson et al. 1978). In 1961, minimum flows of 85 cfs were established at the USGS gage in the Imnaha River. Prior to 1987, established minimum flows were not, technically speaking, water rights and could be revised, suspended, or withdrawn by administrative rule. Since 1987, these minimum flows could be converted to legal water rights with a priority date the same as the date the flows were established. Minimum flows were established for Big Sheep and Little Sheep creeks in 1993 (Table 21), but they are ungaged. All minimum flows were converted to instream water rights on February 1, 1989.

Table 21. Minimum instream water rights (cfs) at the confluence of Big Sheep Creek and the Imnaha River (reproduced from Wallowa County and NPT 1993).

Stream	Minimum Monthly Flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Big Sheep	25	25	30	45	45	37	55	55	55	37	37	25
Little Sheep Creek	10	10	13	20	20	13	13	10	10	10	10	10

Erosion (Reproduced from USFS 2003d)

Sediment availability and rerouting has been altered by private land influences on Big Sheep Creek RM 31.9, and lower and middle Little Sheep Creek (predominately livestock grazing, rural home sites, and pasture creation); decreased flows caused by the operation of the Wallowa Valley Improvement District Canal on Big Sheep Creek (RM 31.9–RM 33.7); soil structure (ash deposits) in low-gradient meadow areas within RM 3.4 of Lick Creek; and Canal and Twin Lakes Fires. The Big Sheep Creek Watershed Analysis (USFS 1995) documents accelerated sheet and rill erosion in five subwatersheds (07J, 07O, 07P, 07Q, 07R) as a result of the Canal Fire, Twin Lakes Fire, and timber management. Accelerated gully erosion hazard was noted in subwatersheds 07J, 07O, 07R, again the result of fires and timber management. Landslide and debris flow hazard ratings were found to be at natural levels.

The lower reaches of Big Sheep Creek are deposition zones due to reduced channel gradient. Stream bottom pavement has formed in the absence of “flushing flows” related to the Wallowa Valley Improvement Canal and hydropower operations. In 1997, hydropower operations were ceased. Hydropower operations used to divert water into the irrigation canal during April, May, and June. Without Hydropower operations in the spring, the additional flows in the lower reaches of Big Sheep Creek are available to transport and process sediment.

Percent fines are measured by quantifying the percentage of silts and clays (not sand) within a specific stream habitat unit (pool, riffle, glide). The only data available for this measurement are from RM 0.0 to RM 26.2 of Big Sheep Creek, obtained in a 1991 stream survey. The range of percent fines found between RM 0.0 and RM 26.2 for all habitat types was 8 to 20%. The average percent fines for Big Sheep Creek between RM 0.0 and RM 26.2 in riffle habitats were 7%. Big Sheep Creek was resurveyed during the 2003 field season. The percent fines data was obtained using the Wolman pebble count method. This information was not available for incorporation into this assessment.

Because of the mixed classification, the lower Imnaha and Big Sheep watersheds have been classified as “functioning at risk”, while the upper Imnaha watershed has been classified as “functioning appropriately”.

1.1.3.4 Human Influence on Condition and Processes in Terrestrial Systems

Fire

Most Native American groups are thought to have used fire to manipulate the environment for improved hunting, growing crops, livestock grazing, clearing trails for travel and to fireproof villages and campsites (USFS 1995). The extent and intensity of these manipulations is unclear but undoubtedly they had an impact on the ecosystem of the Imnaha subbasin. Early settlers also used fire to clear land and promote nonforest vegetation. This practice irreparably altered the vegetation in many areas of high settlement density (Johnson et al. 1994).

Wildfire suppression in the Imnaha subbasin has occurred since the early 1900s (USFS 2003d). It was employed primarily in attempt to protect settlements and timber resources. This practice has severely impacted the composition and structure of the subbasins vegetative communities and increased their susceptibility to other disturbances including insects and disease. The intensity and nature of these changes varies with the WHTs of the subbasin (see section 1.1.1.9 for WHT descriptions).

Impacts of Fire Suppression and Current Fire Regime

In Montane and Mixed Conifer Forest WHT, the exclusion of wildfire from stands has allowed late seral species tolerant of shade (grand fir, Engelmann spruce, and subalpine fir) to develop multi-layered structures at the expense of early seral species (western larch, ponderosa pine, lodgepole pine). Increased amounts of living and dead vegetative material have accumulated in the understory. Spacing between overstory trees has been reduced creating an overstocked condition. These stands are at risk to damage from wildfires, and are more susceptible to insect and disease damage due to overstocked, multi-layered conditions. Consequently, forest stand health has declined (USFS 1995, 2003d).

Fire suppression in the ponderosa pine WHT of the subbasin has resulted in a shift from the open, park-like stands of ponderosa that once dominated to denser stands of shade-tolerant Douglas-fir where this species can survive. In areas of this WHT that are too arid to support Douglas-fir, stands of ponderosa have become denser and more multistoried (USFS 1995). These changes have reduced forage production in these stands and reduced their suitability for to support livestock or grazing wildlife (USFS 1998d).

Fire suppression has dramatically lengthened the fire return interval in the Subalpine Parkland WHT. Whitebark pine woodland fire intervals in the Columbia Basin varied from 50 to 300 years before 1900. The current "average" whitebark pine stand will burn every 3,000 years or longer because of fire suppression. During wet cycles, fire suppression can lead to tree islands coalescing and the conversion of parklands into a more closed forest habitat. Fire suppression can also contribute to the expansion of treed areas into surrounding subalpine grasslands (IBIS 2003).

The Upland Aspen WHT in the subbasin occurs as a seral stage in areas where conifers are climax. Aspen reproduces vigorously by root suckers following fire (USFS 1998d). With fire suppression and change in fire regimes, the Aspen Forest habitat is less common than before 1900 (IBIS 2003).

In the Interior Grassland WHT of the lower subbasin, fires are rarer but tend to be more intense than historical fires because of the buildup of dry, dense litter in the grass bases (Johnson et al. 1994). Because of past fire suppression efforts, only 26% of grassland habitat in the HCNRA burned between 1970 and 1994. Historically in this time period, it is likely all 300,000 acres of grassland within the HCNRA would have been burned, with most areas having burned twice (USFWS 2003a).

Fuel Model Distribution and Properties

Fuel models are a general method for describing fuel properties and can help predict fire ignition and behavior based on tree size class, fuel depth, and moisture of extinction. Fuel models have been identified and mapped on the National Forest lands within the subbasin (Figure 31). Private lands are not mapped but best estimates indicate that fuel models 2 and 8 best represent these lands. Fires burning in fuel models 9 or 10 are of greatest concern to the land managers of the subbasin. Fires burning in these areas can have much higher intensities with more long-term ecological impacts and be much more difficult to suppress. Currently, a greater extent of the forested areas in the subbasin can be classified as Fuel Models 9 and 10 than were present historically (USFS 1998d). Wildfire intensities have increased dramatically over historical levels (USFS 1995).

Since 1970, over 500 wildfires have occurred in the Imnaha subbasin, resulting from lightning strikes or human activities. Figure 32 shows the locations and year burned of fires greater than 100 acres in size on the National Forest portion of the subbasin. Table 22 lists fires over 100 acres that burned with high or medium intensity on the National Forest portion of the subbasin since 1970. The numbers and sizes of fires that have burned on private land is unknown but are expected to be similar in number and distribution as those on the National Forest lands (USFS 2003d).

Table 22. Wildfires over 100 acres with high- or moderate-intensity burns (USFS 2003d).

Year	Fire Name	High Intensity (acres)	Medium Intensity (acres)
1986	Grouse Creek	78	45
1986	North Fork Dry Creek	40	20
1986	Pumpkin Creek	1,712	856
1989	Gumboot	60	30
1989	Lookout	127	119
1989	Canal Fire	5,996	3,323
1989	Summit Creek	3,520	2,112
1994	Twin Lakes	521	3,389
2000	Carrol Creek	330	260
2000	Eastside Complex	1,540	3,484
2001	Horse Creek	0	2,803
Totals		**13,924**	**16,441**

Some of these fires have seriously damaged portions of the subbasin for instance. The 1989 Canal Fire that burned the upper portion of the Big Sheep watershed damaged riparian areas and degraded fish habitat (USFS 1995).

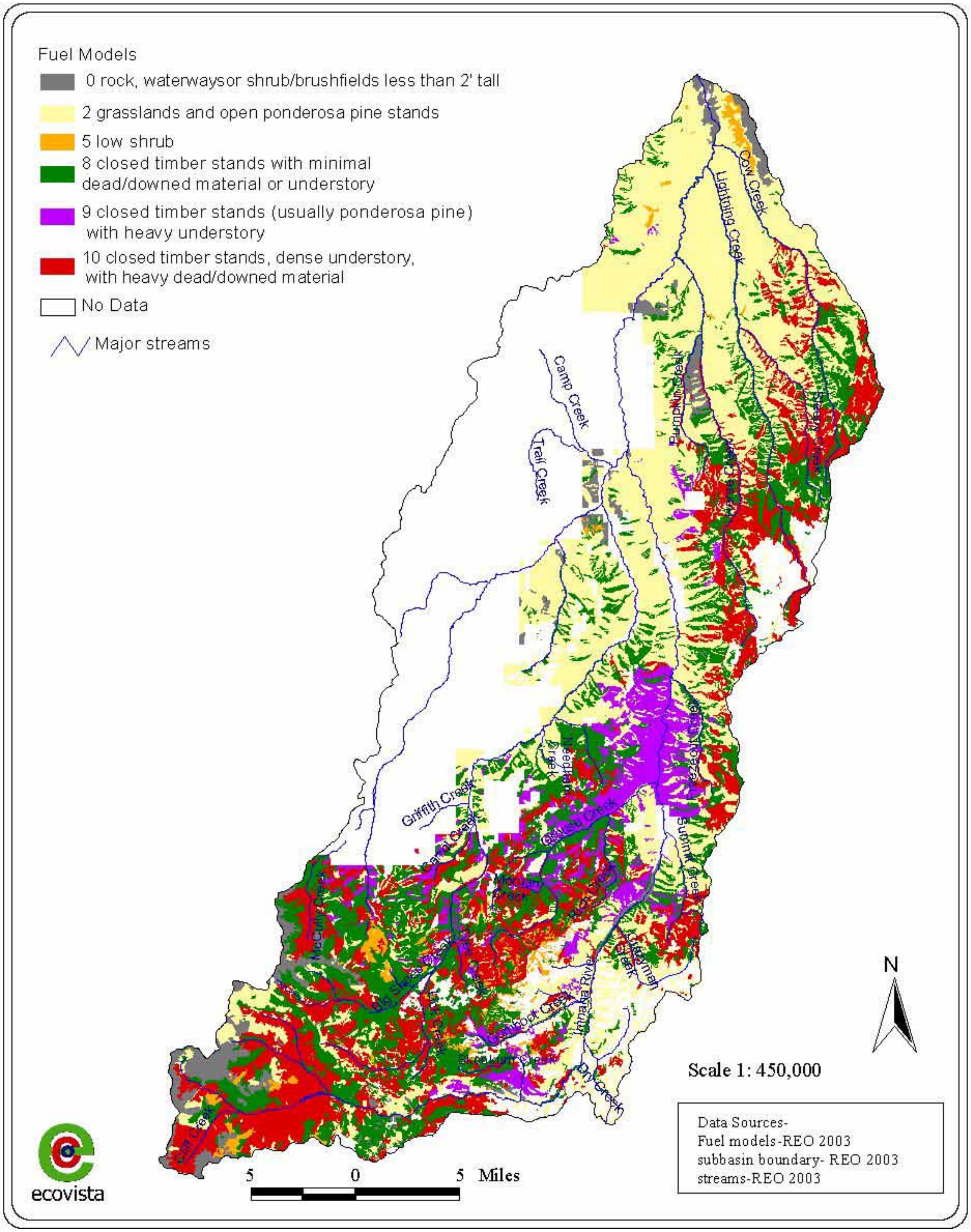

Figure 31. Current fuel models of the Imnaha subbasin.

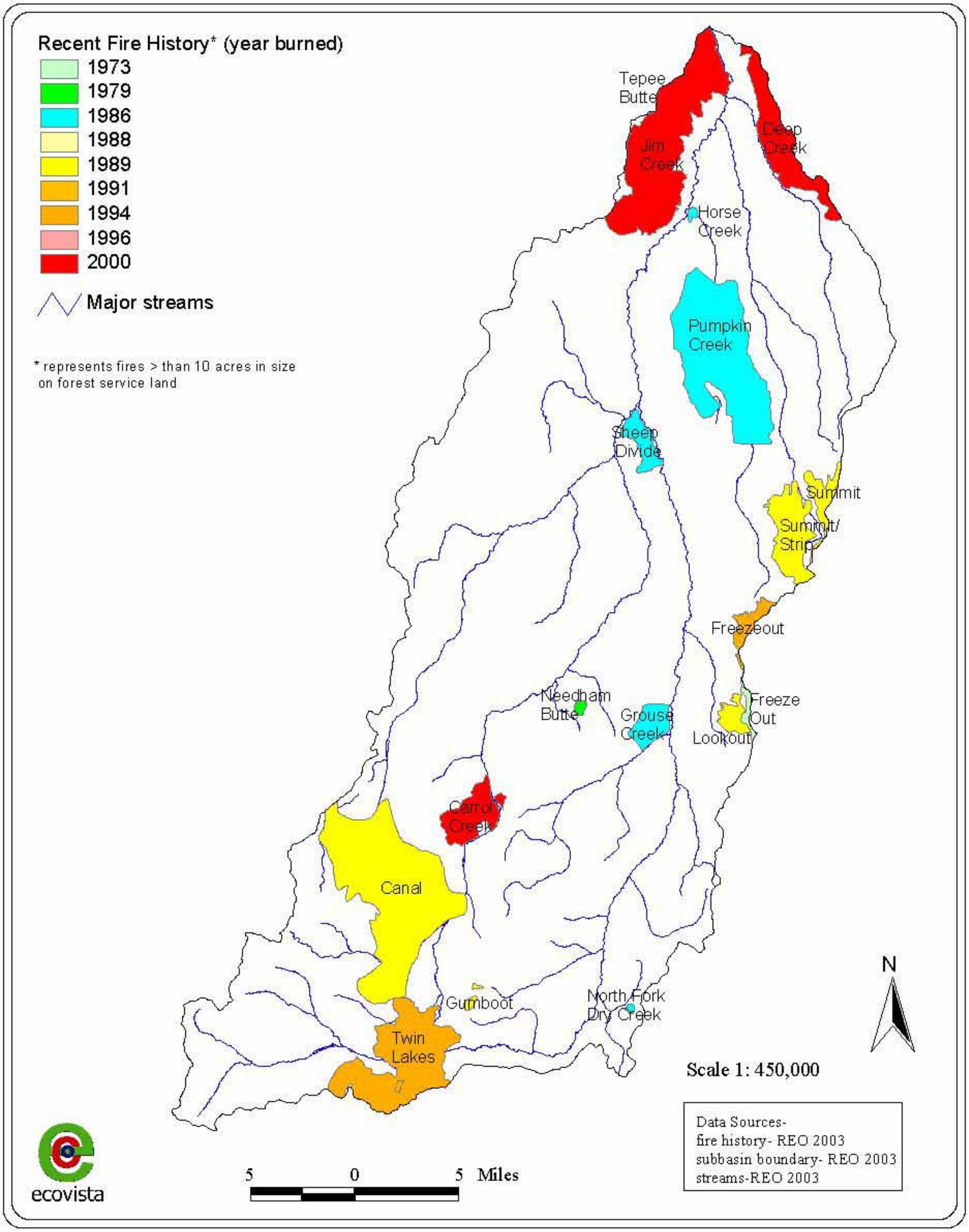

Figure 32. Location and year of occurrence of recent large fires (> 10 ac) in the Imnaha subbasin.

Managers in the subbasin are looking for ways to reduce the impacts of fire suppression on the ecosystem and restore vegetative stands to more natural conditions and fire regimes. Minimal-impact suppression tactics have been employed in the subbasin since 1989. A prescribed natural fire program has been implemented within the Eagle Cap Wilderness since 1982 and within the Hells Canyon Wilderness since 1985. On February 4, 1994, a Prescribed Natural Fire Environmental Assessment was approved and addressed the program on the Wallowa-Whitman National Forest. Prescribed fires will be consulted on a project by project basis, often included as part of a vegetative management proposal (USFS 2003a).

Insects and Disease

Increased stocking levels and the replacement of early seral species with grand fir, Douglas-fir, and Engelmann spruce has resulted in an increase in insect and disease damage over historical levels. Grand fir-dominated sites were historically found as isolated stands on wetter sites, resulting in a discontinuous distribution. Fire suppression has resulted in increased abundance and continuity of grand fir stands (USFS 1995).

The increased supply and distribution of host species has resulted in increased defoliation by western spruce budworm, a greater incidence of bark beetle outbreaks and root rots when compared with historical levels. Especially on drier sites where trees are more susceptible to stress during drought conditions (USFS 1995).

Timber Harvest

Timber harvest in the subbasin has concentrated on removing large trees usually the early seral species—western larch and ponderosa pine (USFS 2003d). In conjunction with fire suppression these activities reduced the abundance of these species in the subbasin and further contributed to the development of overstocked stands of shade tolerant species.

Grazing

Heavy grazing in the late 1800s and early 1900s caused structural and compositional changes to some of the grassland communities of the subbasin. These disturbed communities are simpler in composition and dominated by either annual grasses or forbs in early seral stages seral stages. In disturbed fescue communities, densities of fescue decrease while perennial forbs and annual grasses increase (Johnson et al. 1994). These effects are especially pronounced on the more gentle slopes of the ridge tops, benches and bottomlands. For instance on the benches of the Imnaha Canyon Kentucky bluegrass, red threeawn, annual bromes (cheatgrass, Japanese brome, rattlesnake brome) and goatweed all may be found in large patches (Johnson et al. 1994). Historical heavy grazing has also increased the susceptibility of portions of the subbasin to invasion by noxious weeds.

Introductions of Noxious Weeds and Exotic Plant Species

Areas where herbaceous cover has been removed or disturbed provide the most potential and actual sites for infestation by noxious weeds. Weed infestation sites include roadways, rock pits, timber harvest areas and where grazing, fire, or mining have disturbed the soil, trailheads off-road vehicle use sites, dispersed recreation campsites and locations where heavy vehicular traffic occurs (USFS 2003a). Recent inventories for noxious weeds in the subbasin conducted by the

Wallowa-Whitman National Forest have detected the presence of 14 species of noxious weeds (Table 23). The areas that have been surveyed are well distributed across the subbasin but there are many areas that still need to be surveyed (G. Yates, USFS personal communication 2003). Noxious weeds are not yet as well established in the Imnaha subbasin as they are in many other parts of the Columbia Basin.

Table 23. Areas infested with noxious weeds documented in recent surveys of portions of the Imnaha subbasin.

Common Name	Scientific Name	Acres Infested	Priority
Bugloss	*Anchusa* sp.	11,278	High
Canada thistle	*Cirsium arvense*	738	Low
Dalmatian toadflax	*Linaria dalmatica*	3	Low
Diffuse knapweed	*Centaurea diffusa*	88	High
Hoary cress-whitetop	*Cardaria draba*	129	High
Medusahead rye	*Taeniatherium caput-medusae*	26	Low
Poison hemlock	*Conium maculatum*	2	Low
Scotch broom	*Cytisus scoparius*	115	—
Scotch thistle	*Onopordum acanthium*	198	Low
Spotted knapweed	*Centaurea maculosa*	49	High
Tansy ragwort	*Senecio jacobaea*	1	High
Yellow hawkweed	*Hieracium pratense*	0	—
Yellow starthistle	*Centaurea solstitialis*	71	High
Yellow toadflax	*Linaria vulgaris*	4	—

1.1.4 Regional Context

1.1.4.1 Relation to the Columbia Basin

The Imnaha subbasin is located near the center of the Columbia Basin, in the farthest northeast corner of Oregon (Figure 1). It is one of the smallest of the 62 subbasins delineated by the NPCC, for use in the subbasin planning process, 16 subbasins are smaller while 45 are larger. The Imnaha River joins the Snake at RM 191.7, approximately 48 river miles upstream from Lewiston and 3.4 miles upstream of the Salmon River confluence.

1.1.4.2 Relation to the Province

The Columbia Basin has been divided into 11 provinces by the NPCC to aid in the subbasin planning process. The grouping of subbasins into provinces was based on physical similarities between subbasins. The Imnaha subbasin is one of four subbasins in the Blue Mountain Province; it is bordered to the west by the Grande Ronde subbasin and to the east by the Snake Hells Canyon subbasin (Figure 1).

1.1.4.3 Relation to Other Subbasins in the Province

As discussed previously, the Imnaha subbasin shares the Blue Mountain Province with three other subbasins—the Grande Ronde, the Snake Hells Canyon, and Asotin Creek. Together, the three subbasins provide aquatic resources of considerable regional and national significance.

Similar to the other subbasins, the Imnaha has a semi-arid climate and a snowmelt-driven hydrograph. The topography of all four subbasins is similar in that all are defined to some extent by deeply incised river canyons. None of the subbasins are densely populated. Factors that are commonly cited in the four subbasins as limiting resident and anadromous salmonid production include water withdrawals, channel modification, geomorphic instability, compromised riparian function, sedimentation and out-of-basin effects.

1.1.4.4 Unique Qualities of the Subbasin

Aquatic Qualities

The Imnaha subbasin provides a substantial component of the total spawning and rearing habitat available to imperiled fish species in the Snake River Basin. Because of this, the Imnaha represents one of the most productive subbasins in the Snake River ESU and Blue Mountain ecological province with relation to summer steelhead, spring/summer chinook, and bull trout. According to StreamNet fish distribution data, although the Imnaha subbasin comprises only 0.4% of the area of the U.S. portion of the Columbia Basin it contains 2.7% of reaches used by steelhead for spawning and rearing (Table 24). It also possesses a disproportionate amount of the reaches used for spawning and rearing habitat by spring/summer and fall chinook. Although distribution information for bull trout is not available from StreamNet (2003) across the entire U.S. portion of the subbasin the Imnaha provides a disproportionate amount of the habitat in the Blue Mountain Province. The Imnaha subbasin comprises almost 14% of the Blue Mountain Province, yet contributes almost 26% of the reaches used by bull trout for spawning and rearing in the province (Table 24).

Table 24. Comparison of reaches used by fish species of concern in the Imnaha subbasin (IS) vs. the Blue Mountain Province (BMP) and the U.S. portion of the Columbia Basin (CB) (based on StreamNet 2003[1]).

Species	Use Type	U.S. portion of CB (mi of stream)	BMP (mi of stream)	IS (mi of stream)	% of CB distribution within IS	% of BMP distribution within IS
Spring/ summer chinook	Primarily spawning and rearing	4,113.7	298.7	66.2	1.6	22.2
	Primarily rearing and migration	2,736.8	546.6	80.1	2.9	14.7
	Primarily migration	1,900.1	56.2	0.0	0.0	0.0
	Total spring/summer chinook distribution	**8,750.6**	**901.5**	**146.3**	**1.7**	**16.2**
Steelhead	Primarily spawning and rearing	11,836.4	1,770.7	325.0	2.7	18.4
	Primarily rearing and migration	1,456.8	539.5	25.5	1.8	4.7
	Primarily migration	2,965.1	51.1	17.0	0.6	33.3
	Total steelhead distribution	**16,258.3**	**2,361.3**	**367.5**	**2.3**	**15.6**
Fall	Primarily spawning and rearing	1,272.1	224.3	17.6	1.4	7.8

Species	Use Type	U.S. portion of CB (mi of stream)	BMP (mi of stream)	IS (mi of stream)	% of CB distribution within IS	% of BMP distribution within IS
chinook	Primarily rearing and migration	285.2	0.0	0.0	0.0	0.0
	Primarily migration	1,092.6	6.2	0.0	0.0	0.0
	Total fall chinook distribution	**2,649.9**	**230.5**	**17.6**	**0.7**	**7.6**
Bull trout	Spawning, rearing, or resident	NA[2]	325.4	83.8	NA	25.8
	Migration	NA	520.4	106.7	NA	20.5
	Total bull trout distribution	**NA**	**845.8**	**190.5**	**NA**	**22.5**

[1]StreamNet data was collected at the relatively coarse 100,000 scale, and data quality is dependent on level of survey effort and reporting. Finer scale information may be available in some locations; StreamNet data was used due to its widespread availability in the Columbia Basin.
[2]NA-Not available, bulltrout distribution was not available across the entire Columbia Basin

Terrestrial Qualities

Grasslands

The extent of grassland habitats lost in the Imnaha subbasin has been less significant than in the rest of the Blue Mountain Province or Columbia Basin, and the Imnaha now provides a greater percentage of the distribution of this WHT than it did historically (Table 25 and Table 26). Conversion of grassland habitats in the neighboring Grande Ronde subbasin to agriculture has likely affected dispersal and migration patterns for many grassland dependent species in both subbasins (see Appendix D for maps of the current and historical distribution of the major WHTs in the subbasin).

- The Zumwalt Prairie, in the western portion of the subbasin, is one of the best remaining examples of Palouse bunchgrass prairie in North America. The Zumwalt Prairie supports the highest known concentrations of breeding hawks and eagles in North America and populations of the endangered Spalding's catchfly. Columbian sharp-tailed grouse, once extirpated from Oregon, have been reintroduced on the Zumwalt Prairie (TNC 2002).
- The canyon grassland habitats of the Imnaha subbasin support one of the largest and healthiest Rocky Mountain bighorn sheep herds within Oregon. The lower Imnaha River is a major lambing area for the herd, and the upper Imnaha River area is part of a migration corridor (USFS 1995).

Forests

Due in large part to the high level of protection and relatively low level of disturbance many of the forest communities in the Imnaha subbasin are in better condition than other forests in the region. The Imnaha provides a greater percent of the Montane and Eastside Mixed Coniferous Forests in the Columbia Basin than it did historically (Table 26). Fire suppression and timber harvest have altered the composition and structural makeup of these forests, but these alterations are thought to be less pronounced in the Imnaha subbasin, as a result of harvest restrictions in the wilderness and uneven-age management prescriptions on the HCNRA (USFS 2003a).

- The Wallowa Mountains have been identified as one of Oregon's important bird areas. Reasons for this designation include its comprising the entire range of spruce grouse in Oregon, being the only area with regular confirmed breeding of pine grosbeak in Oregon, and comprising the entire breeding range of the Wallowa rosy-finch (Hunter 2003).
- The upper Imnaha subbasin may form part of a unique ecological corridor linking the Wallowa and Blue Mountains with the Rocky Mountains (USFS 2000a). This corridor may be critical in maintaining the genetic viability of populations of wide ranging forest species. Edelmann and Copeland (1999) found that the corridor was likely the only suitable travel corridor linking subpopulations of wolverine in Oregon and Idaho.

Table 25. Comparison of the historical and current distribution of wildlife habitat types (WHTs) in the Imnaha subbasin (IS), the Blue Mountain Province (BMP), and the Columbia Basin (CB) (based on data from NHI 2003).

WHT	Historical Distribution of WHT			Current Distribution of WHT		
	CB (acres)	BMP (acres)	IS (acres)	CB (acres)	BMP (acres)	IS (acres)
Eastside (Interior) Grasslands	20,696,084	1,293,214	330,562	6,013,723	919,701	275,555
Alpine Grasslands and Shrublands	675,865	25,065	9,927	2,612,993	133,242	28,365
Montane Mixed Conifer Forest	6,887,884	108,947	16,627	11,535,522	283,929	52,661
Eastside (Interior) Mixed Conifer Forest	19,085,891	522,894	96,042	23,620,021	1,136,847	162,903
Montane Coniferous Wetlands	0	0	0	295,923	3,193	420
Ponderosa Pine Forest and Woodlands	16,788,196	1,090,459	47,649	8,758,550	676,902	25,154
Lakes, Rivers, Ponds, and Reservoirs	1,131,394	9,430	3,226	1,620,589	9,915	82
Agriculture, Pasture, and Mixed Environs	0	0	0	23,349,523	389,527	1,189
Herbaceous Wetlands	703,346	1,985	0	942,303	11,321	16
Shrub-Steppe	39,198,948	657,154	6,452	35,794,864	397,314	50
Lodgepole Pine Forest and Woodlands	10,670,749	113,662	4,715	3,625,771	2,894	0
Western Juniper and Mountain Mahogany	1,716,153	11,664	0	3,618,291	954	0
Urban and Mixed Environs	0	0	0	1,131,534	16,042	0
Eastside (Interior) Riparian Wetlands	839,509	43,926	248	672,859	1,972	0
Eastside (Interior) Canyon Shrublands	0	0	0	360,302	67	0
Upland Aspen Forest	1,384,410	13,401	248	1,338,518	0	0
Subalpine Parklands	2,399,693	86,611	30,277	1,110,484	0	0

Table 26. Changes in percentage of wildlife habitat types (WHTs) distribution in the Columbia Basin (CB) and Blue Mountain Province (BMP) contributed by the Imnaha subbasin (IS) (bold figures indicate an increase in contribution from historical to current) (based on data from NHI 2003).

WHT	% of historical WHT distribution in CB within the IS	% of current WHT distribution in CB within the IS	% of historical WHT distribution in BMP within the IS	% of current WHT distribution in BMP within IS
Eastside (Interior) Grasslands	**1.60**	**4.58**	**26**	**30**
Alpine Grasslands and Shrublands	1.47	1.09	40	21
Montane Mixed Conifer Forest	**0.24**	**0.46**	**15**	**19**
Eastside (Interior) Mixed Conifer Forest	**0.50**	**0.69**	**18**	**14**
Montane Coniferous Wetlands	—	0.14	—	13
ponderosa pine Forest and Woodlands	0.28	0.29	4	4
Lakes, Rivers, Ponds, and Reservoirs	0.29	0.01	34	1
Agriculture, Pasture, and Mixed Environs	—	0.01	—	0
Herbaceous Wetlands	0.00	0.00	0	0
Shrub-Steppe	0.02	0.00	1	0
Lodgepole Pine Forest and Woodlands	0.04	0.00	4	0
Western Juniper and Mountain Mahogany	0.00	0.00	0	0
Urban and Mixed Environs	—	0.00	—	0
Eastside (Interior) Riparian Wetlands	0.03	0.00	1	0
Eastside (Interior) Canyon Shrublands	—	0.00	—	0
Upland Aspen Forest	0.02	0.00	2	—
Subalpine Parklands	1.26	0.00	35	—

Biodiversity and Endemism

Two recent regional assessment efforts have identified portions of the Imnaha subbasin as being areas of regional conservation importance based on high biodiversity and/or the presence of rare or endemic organisms. The Interior Columbia Basin Ecosystem Management Project (ICBEMP) mapped centers of biodiversity and endemism/rarity, across the interior Columbia Basin in 1994. In 2003, the Nature Conservancy used the SITES model to develop a conservation portfolio for the Middle Snake-Blue Mountain Ecoregion. These regional efforts, which help to establish the importance of the Imnaha subbasin in efforts to protect and restore the fish and wildlife species of the region, are discussed in the following section.

ICBEMP Centers of Biodiversity and Endemism

As ICBEMP project expert panels of agency and nonagency scientists were convened between October 1994 and May 1995 to identify areas of rare and endemic populations of plant, invertebrate, and vertebrate species (ICBEMP 1997). The panels of experts produced maps showing areas having unusually high biodiversity, and areas containing high numbers of rare or locally or regionally endemic species (Figure 33 and Figure 34). The centers of concentration were developed at the coarse scale, in a short time frame and were mostly based on the panel's personal knowledge of areas and species locations. There developers suggested that they be considered a first approximation of identifying areas with particularly diverse collections of rare or endemic species, or areas with high species richness. Centers of concentration might be candidates for research natural areas or other natural area designations pending further local assessment and refinement (ICBEMP 1997). Twenty-one percent of the subbasin was identified as a center of plant biodiversity (Table 27). These areas occurred in the high Wallowa Mountains and in areas on the east side of the subbasin that border the Hells Canyon subbasin. Twenty percent of the Imnaha subbasin was selected as a center of plant endemism and rarity (Table 27). These areas roughly correspond with those selected as centers of plant biodiversity, the Wallowa Mountains and Hells Canyon area. Areas selected as centers of animal endemism and rarity occur in the Zumwalt prairie area of the subbasin and extend into the Wallowa Mountains.

Table 27. Areas selected as centers of biodiversity or centers of endemism and rarity in the Imnaha subbasin.

Interior Columbia Ecosystem Management Project Designation	Area of Imnaha subbasin selected (acres)	% of Imnaha subbasin selected
Centers of Biodiversity—Plants	114,826	21
Centers of Biodiversity—Animals	0	0
Centers of Endemism and Rarity—Animals	175,546	32
Centers of Endemism and Rarity—Plants	110,248	20

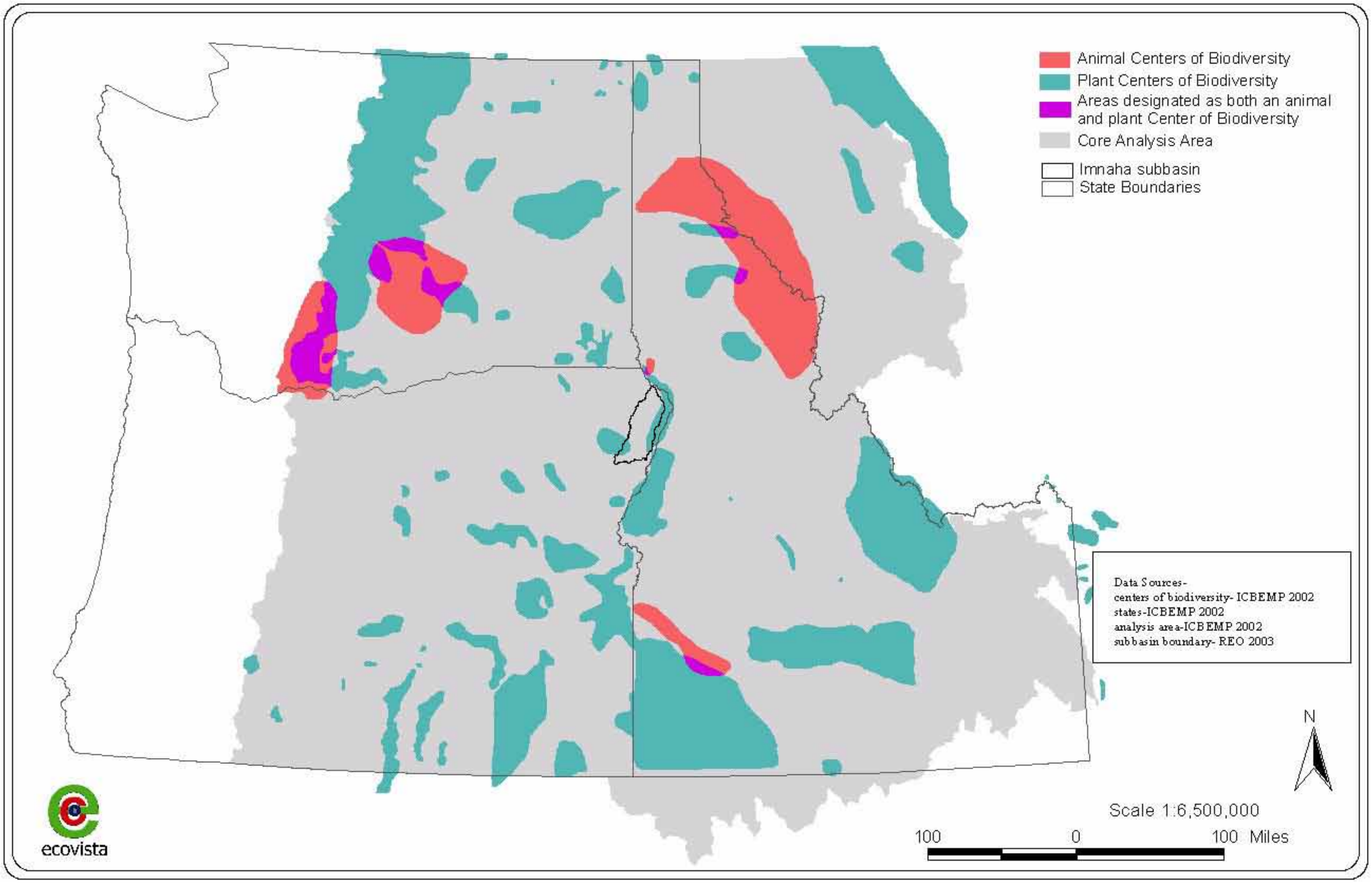

Figure 33. Centers of biodiversity in the ICBEMP analysis area and the Imnaha subbasin.

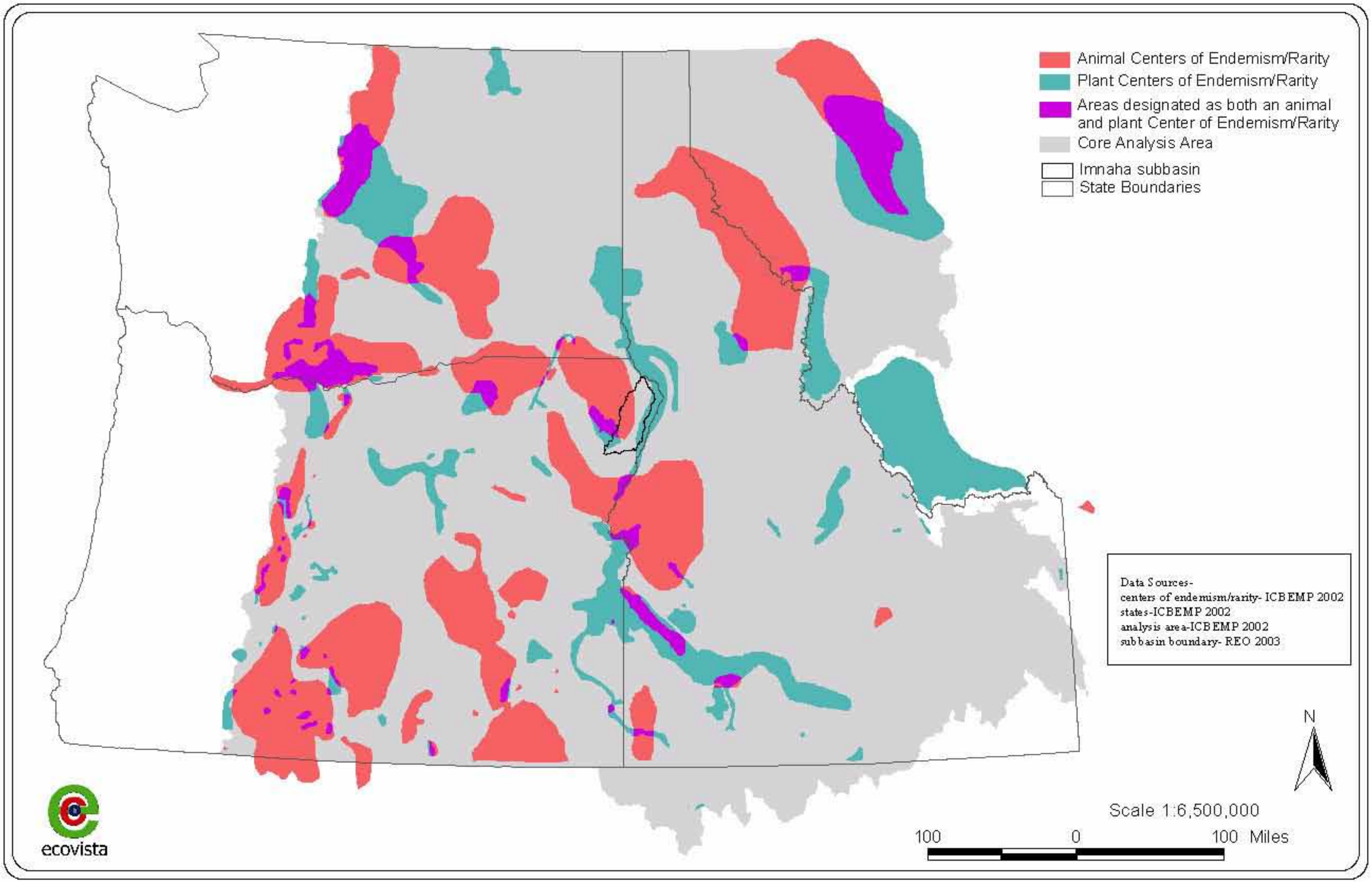

Figure 34. Centers of endemism and rarity in the ICBEMP analysis area and the Imnaha subbasin.

The Nature Conservancy's Sites Model

The Nature Conservancy has recently completed an ecoregional conservation plan for the Middle Rockies-Blue Mountain Ecoregion, which covers 81,587 square miles (52,215,958 acres) in Oregon, Idaho, Montana, and a small part of Washington. The Imnaha subbasin is contained within this ecoregion. The goal for the Middle Rockies-Blue Mountains ecoregion conservation plan was to identify the suite of conservation sites and strategies that will ensure the long-term survival of all viable native plant and animal species and natural communities in the ecoregion. Due to the complexity of the Middle Rockies-Blue Mountains ecoregion, a site selection model was used to help design a portfolio that will achieve this goal in the most cost effective manner possible. The site selection model used in this project is an optimization model that applies a combination of simulated annealing and iterative improvement to the portfolio design problem (SITES). The simulated annealing used by SITES is a minimization method, where biodiversity is a constraint and the goal is to minimize the cost or size of the portfolio. The model was run at the 6th field HUC scale (TNC 2003).

Preparing to run the SITES model involves three main steps:

- Identifying the conservation targets that will help to maintain the biodiversity of the area
- Identifying the desired representation of the conservation targets in the ecoregion
- Identifying the costs and suitability of protection of different areas

Conservation Targets

The Middle Rockies-Blue Mountain Planning Team utilized a coarse filter/fine filter approach to biodiversity conservation. The coarse filter is a community-level conservation strategy whereby natural community types are used as conservation targets to represent 85 to 90% of species and ecological processes, in a community. However, given current knowledge, this ecosystem approach cannot be counted on to maintain and protect all biodiversity. Some species, especially the rarest, will fall through the pores of the coarse filter. Therefore, a fine filter of rare species conservation planning is needed as a complement (Noss and Cooperrider 1994, as cited in TNC 2003).

The Nature Conservancy planning team selected 978 coarse and fine filter conservation targets for the Middle Rockies Blue Mountain Ecoregion (Table 28). Most data, such as the distribution of all plant and animal species targets in the ecoregion, were obtained from the four state Natural Heritage programs. Species are classified into five classes based on their global distribution G1=critically imperiled globally, G2=imperiled globally, G3=globally rare or uncommon, G4=globally widespread and apparently secure, G5=globally widespread and secure. The following conservation ranks were considered in the selection of conservation targets from this database:

- All G1, G2, and federally listed species were included.
- G3 species were considered individually.
- G4 and G5 species were included if the species were declining over all or part of their range, the populations were disjunct from distant ecoregions, or they were endemic.

Data obtained from other sources included the predicted distribution maps for wide-ranging birds and mammals such as the greater sage-grouse, wolverine, gray wolf, and lynx were obtained from the state GAPs. The distribution data for wide-ranging fish were obtained from StreamNet. Aquatic community distribution data were developed by the planning team using a physically based classification model that was applied in a GIS to represent aquatic communities in the ecoregion (TNC 2003).

Representation Goals

The Nature Conservancy planning team developed conservation goals for the representation of each target element or surrogate in the portfolio. Portfolio representation goals were developed based on three primary factors:

- Distribution of the targets across the ecoregion
- Number of occurrences or amount of area occupied
- Degree of endangerment for the conservation target

Table 28. Type, distribution sources, and representation goals for the 978 coarse and fine scale conservation targets selected for the Middle Rockies-Blue Mountain Ecoregion SITES run.

Conservation Targets	Number of Targets	Source of Distribution Data	Representation Goal for Portfolio
Fine Filter Targets			
Plant	127	EOR[1]	Dependent on conservation rank and degree of endemism
Terrestrial Animals	54	EOR[1]	Dependent on conservation rank and degree of endemism
		GAP models	20% of distribution per section for species of high conservation concern, 10% for others
Aquatic Animals	33	EOR[1]	Dependent on conservation rank and degree of endemism
		StreamNet	Dependent on rarity and degree of historical decline
Rare Plant Communities	55	EOR[1]	Dependent on conservation rank and degree of endemism
		6th field HUC	Dependent on degree of rarity
Total Fine Filter Targets	**269**		
Coarse Filter Targets			
Aquatic Macrohabitats	207	Modeled	Dependent on Abundance of type in Ecoregion
Riparian Plant Communities	209	Modeled	10% of distribution
Nonriparian Plant Communities	293	GAP cover types	Dependent on biodiversity and rangewide distribution and ecoregional abundance
Total Coarse Filter Targets	**709**		
TOTAL TARGETS	**978**		

[1] EOR = Element Occurrence Record database that is maintained by state Natural Heritage Programs/Conservation Data Centers

Cost and Suitability

The following are factors considered in determining the cost and suitability of conservation of terrestrial habitats for the Middle Rockies-Blue Mountain Ecoregional Plan:

- The conservation suitability of private land was considered to be somewhat lower than the same area of public land. Cost would rise faster as private land area increased in a 6th field HUCs than for a similar increase in public land area.
- The Nature Conservancy Planning Team wanted the model to choose areas of public land that were less roaded. So. they chose a parameter that would cause the first few roads in a 6th field HUC to dramatically increase the cost, but the rate of increase declines beyond a certain density threshold. In other words, it is the first roads that decrease the suitability the most and, after a point, the cumulative effect of additional roads becomes less.
- The opposite is true of private land. They did not want the model to automatically shy away from private la.nd, they chose a parameter where a low level of roads and converted land does not dramatically increase the cost (decrease suitability). The cost rises slowly at first for private land, but more rapidly as the percentage of converted and roaded land increases in a 6th field HUC.

Several factors were considered when rating the cost and suitability of conservation in aquatic habitats:

- ICBEMP aquatic integrity scores
- Dams within the HUC
- Length of the §303(d)-listed segment within the HUC
- Number of point sources within the HUC

To account for the relatively low cost of continuing to protect areas with existing protection, 6th field HUC watersheds that were completely or partially contained by a protected area greater than 25 acres in size were locked into the portfolio selection (i.e., these areas were always selected in the development of the conservation strategy) (TNC 2003).

SITES Outputs

The model begins by generating a completely random portfolio. Next, it iteratively explores trial solutions by making sequential random changes to this portfolio. Either a randomly selected selection unit (6th field HUC watershed), not yet included in the portfolio, is selected, or a selection unit already in the system is deleted. At each step, the new solution is compared with the previous solution, and the best one is accepted.

The modeled solution constituted the first draft of the conservation portfolio. The Nature Conservancy planning team and an independent review team then reviewed the first draft and modified it based on personal experience in the ecoregion. The final recommended portfolio encompasses 37% of the ecoregion and meets the representation goal for over 90% of the terrestrial community targets, aquatic community targets, invertebrate species targets, and federally listed targets (TNC 2003).

Imnaha Subbasin's Contribution to Selected Conservation Portfolio

Eighty-nine percent of the Imnaha subbasin was selected as part of the conservation portfolio for the Middle Rockies-Blue Mountain Ecoregion (Figure 35). This is a reflection both of the areas biological importance and the large amount of land in the subbasin that is protected. Because of the low cost of continuing to protect these areas, they were locked into the conservation portfolio. Areas selected for the Middle Rockies-Blue Mountain conservation portfolio within the Imnaha subbasin contributed to meeting the representation goals for 24 fish and wildlife species target, 19 rare plant species targets, and 25 rare plant association or habitat type species targets (Appendix E).

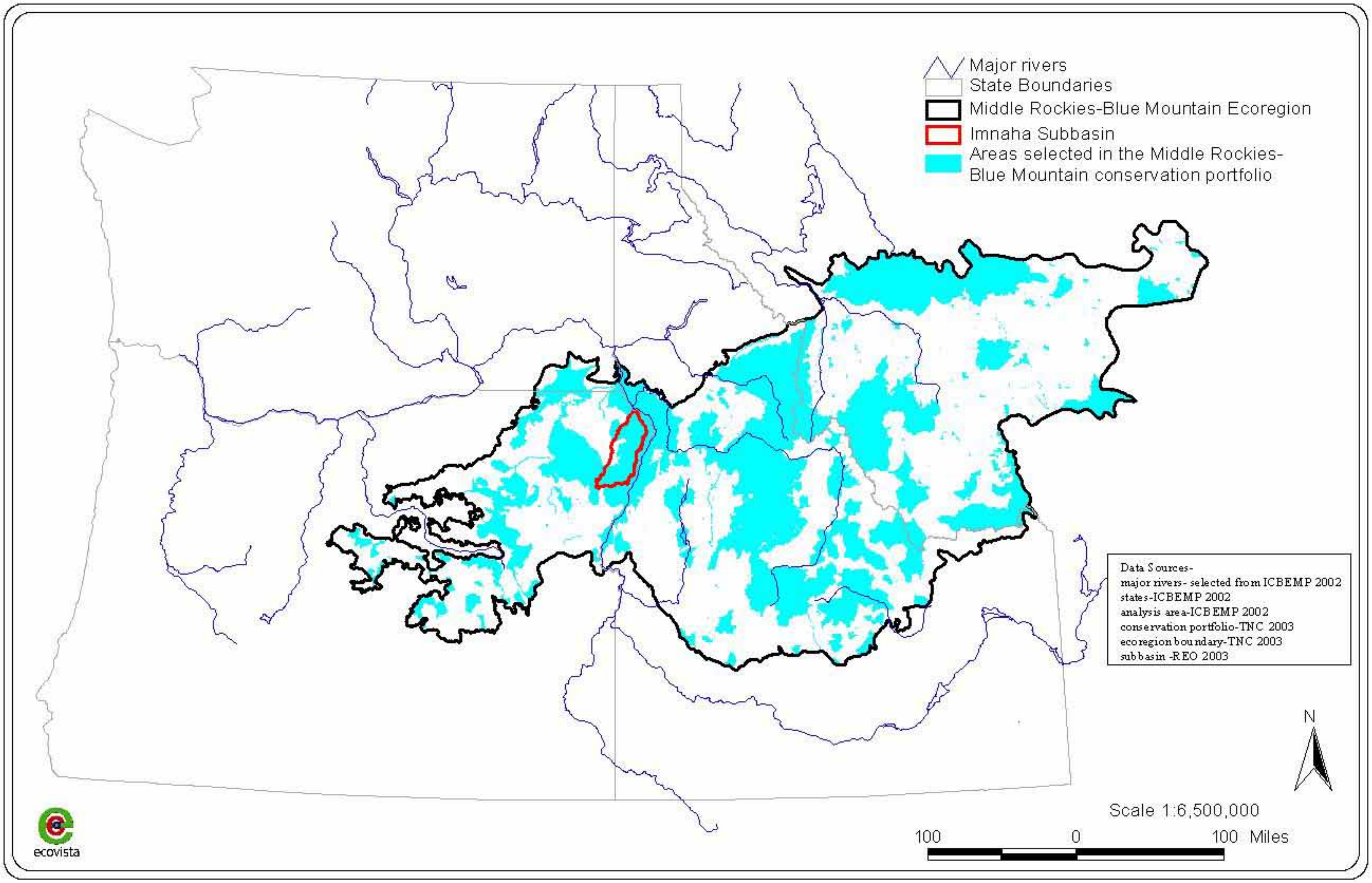

Figure 35. Areas selected for the Middle Rockies-Blue Mountain conservation portfolio.

1.1.4.5 NMFS Evolutionarily Significant Units

The Imnaha subbasin falls within the evolutionarily significant unit (ESU) designated by the National Oceanic and Atmospheric Administration's Fisheries Service (NOAA Fisheries, also known as the National Marine Fisheries Service or NMFS) for the Snake River. The listed ESU includes all natural populations of fall- and spring-run chinook salmon and summer steelhead in the mainstem Snake River and any of the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, Salmon River, Asotin Creek, and Clearwater River.

1.1.4.6 USFWS Designated Bull Trout Planning Units

The Imnaha subbasin has been defined by the USFWS as one of three core areas within the Imnaha-Snake Rivers Bull Trout Recovery Unit. For the purposes of recovery planning, a core area represents the closest approximation of a biologically functioning unit (USFWS 2002b). Based on survey data and professional judgment, as well as Kostow (1995) and Buchanan et al. (1997), the Imnaha-Snake Rivers Recovery Unit Team has also identified local subpopulations of bull trout that currently exist within each core area (USFWS 2002b). In the Imnaha Core Area (which is entirely in Oregon), local subpopulations include the Imnaha River (above the mouth of Big Sheep Creek), upper Big Sheep Creek (above the Wallowa Valley Improvement diversion and in the canal), lower Big Sheep Creek (below the Wallowa Valley Improvement diversion), Little Sheep Creek, and McCully Creek. Proposed critical habitat sub-units (CHSUs) for bull trout populations within the Imnaha subbasin include approximately 285.6 stream km (177.4 mi) or 18.6% out of the approximately 1532 stream km (952 mi) in this subbasin (Table 29).

Table 29. Proposed bull trout Critical Habitat Subunits (CHSUs) in the Imnaha subbasin (USFWS 2002b)

Imnaha	**Proposed CH**	**Big Sheep**	**Proposed CH**
Bear Creek	Mouth to rkm 0.4, rm 0.3	Big Sheep Creek	Mouth to rkm 65, rm 40.4
Blue Creek	Mouth to rkm 0.4, rm 0.3	Lick Creek	Mouth to rkm 15.1, rm 9.4
Cliff Creek	Mouth to rkm 6.7, rm 4.2	MF Big Sheep Creek	Included in Big Sheep Creek
Imnaha River	Mouth to rkm 115.3, rm 71.6	Salt Creek[1]	Mouth to rkm 1.9, rm 1.2, then upstream from WVIC 0.5 rkm, 0.3 rm
MF Imnaha	Mouth to rkm 1.3, rm 0.8	**Little Sheep**	**Proposed CH**
NF Imnaha	Mouth to rkm 9.7, rm 6	Cabin Creek	Mouth to rkm 0.4, rm 0.3
Soldier Creek	Mouth to rkm 0.4, rm 0.3	Little Sheep Creek	Mouth to rkm 41.7, rm 25.9, then upstream from WVIC 0.9 rkm, 0.6 rm
SF Imnaha	Mouth to rkm 9.2, rm 5.7	Redmont Creek	Mouth to rkm 1.8, rm 1.1, then upstream from WVIC 0.5 rkm, 0.3 rm
McCully	**Proposed CH**		
McCully Creek	WVIC upstream 10.8 rkm, 6.7 rm		

1/ Salt Creek represents an addition to CHSUs previously identified in USFWS 2002b

1.2 Species Characterization and Status

1.2.1 Species of Ecological Importance

1.2.1.1 Species Designated as Threatened or Endangered

Federal

In 1973, the Endangered Species Act (ESA) was passed, building on and strengthening the provisions of the Endangered Species Preservation Act of 1966, the Endangered Species Conservation Act of 1969, and the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; USFWS 2004).

The purpose of the ESA is to "conserve the ecosystems upon which threatened or endangered species depend" and to conserve and recover listed species. Under the law, species may be listed as either "threatened" or "endangered". Endangered means that a species is in danger of becoming extinct throughout all or a significant portion of its range. Threatened means that a species is likely to become endangered within the foreseeable future. All species of animals and plants are eligible for listing (Kilpatrick 2001).

The ESA makes it illegal for any person subject to the jurisdiction of the United States to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered species of fish or wildlife, within the United States without authorization from the responsible federal agency. The Interior Department's USFWS and NOAA Fisheries (or NMFS) jointly administer the act. The USFWS administers terrestrial, fresh water species, and migratory birds, while NMFS administers marine species (Kilpatrick 2001). Eight species listed as threatened under the ESA occur or potentially occur in the subbasin and three additional species are candidates under consideration for listing (Table 30). Federal concern species that have been identified for Wallowa County are listed in Appendix F.

Table 30. ESA-listed or candidate species known to or that potentially occur in the Imnaha subbasin.

Status	Common Name	Scientific Name
Threatened	Bald eagle	*Haliaeetus leucocephalus*
Threatened	Bull trout	*Salvelinus confluentus*
Threatened	Chinook (spring/summer and fall)	*Oncorhynchus tshawytscha*
Threatened	Gray wolf	*Canis lupus*
Threatened	Lynx	*Lynx canadensis*
Threatened	MacFarlane's four o'clock	*Mirabilis macfarlanei*
Threatened	Spalding's catchfly	*Silene spaldingii*
Threatened	Steelhead	*Oncorhynchus mykiss*
Candidate	Columbia spotted frog	*Rana luteiventris*
Candidate	Slender moonwort	*Botrychium lineare*
Candidate	Yellow-billed cuckoo	*Coccyzus americanus occidentalis*

State

The State of Oregon also maintains a list of threatened and endangered fish and wildlife, in order to help fulfill the State of Oregon's policy of preventing the serious depletion of any indigenous species (ORS 496.012). The Oregon Endangered Species Rules (OAR 635-100-100 to 635-100-130) allow for the classification of native species as threatened or endangered and the implementation of appropriate measures to recover them. Two species list by the State of Oregon as endangered, and three species listed by the State of Oregon as threatened occur or potentially occur within the Imnaha subbasin (Table 31).

Table 31. Species that occur or potentially occur in the Imnaha subbasin that are listed as threatened or endangered by the State of Oregon.

Oregon Status	Common Name	Scientific Name
Endangered	American peregrine falcon	*Falco peregrinus anatum*
Endangered	Gray wolf	*Canis lupus*
Threatened	Bald eagle	*Haliaeetus leucocephalus*
Threatened	Chinook salmon	*Oncorhynchus tshawytscha*
Threatened	California wolverine	*Gulo gulo luteus*

Status of Federally or State Listed Endangered or Threatened Species

American Peregrine Falcon

The American peregrine falcon (*Falco peregrinus anatum*) was federally delisted on August 20, 1999, due to accomplishment of recovery goals. It is still considered endangered by the State of Oregon, but change in this status is being considered. The bird has made a remarkable comeback in Oregon after being considered extirpated in the 1960s. In 1994, there were 37 known nest sites in the state that produced 60 young.

A *Pacific States Peregrine Recovery Plan* was completed in 1982 for the Pacific Recovery Zone. The plan identified certain recovery objectives that needed to be met in order to have a self-sustaining population. The recovery objective for the Imnaha and surrounding area is to have two breeding pairs. In response to these goals, the Wallowa-Whitman National Forest began placing young peregrine falcons at potential nest sites in 1987 to establish a nesting pair. National Forest monitoring of these efforts has led to the detection of three natural peregrine nests on the forest. None of these nests sites occurred in the Imnaha subbasin. However, potential nest site habitat for peregrine falcons occurs in the Imnaha River corridor and at Marble Mountain (USFS 1998d). Cliffs above Big Sheep Creek were rated for their potential use as peregrine eyries. No sites received a high rating, and nesting potential in this area is thought to be low (USFS 1998d). Foraging habitat for peregrine falcons in the subbasin is abundant (USFS 1995).

Bald Eagle

Because of concern over declining populations of bald eagle (*Haliaeetus leucocephalus*) primarily due to habitat destruction, human-caused mortality, and DDT-caused eggshell thinning, the bald eagle was designated as threatened in the conterminous (lower 48) states on March 11, 1967, under a law that preceded the ESA of 1973. On July 4, 1976, the USFWS officially listed the bald eagle as a national endangered species under the ESA. In July 1995, the USFWS upgraded the status of bald eagles in the lower 48 states to threatened. The USFWS is currently evaluating the bald eagle for delisting (USFWS 2003c). The bald eagle has been selected as a focal species for this assessment. Information on the bald eagle's habitat use and status in the Imnaha subbasin can be found in section 1.2.9

Bull Trout

The USFWS published a final rule listing the bull trout (*Salvelinus confluentus*) in the Columbia River distinct population segment (DPS) as a threatened species under the ESA (Federal Register Volume 63, p. 31647). The rule became final on July 10, 1998. The USFWS has proposed critical habitat for bull trout for the Klamath River and Columbia River Distinct Population Segments (DPS) and is currently reviewing public comments and developing a draft economic analysis on the proposed rule. Additionally, the FWS has developed a draft recovery plan for the Klamath, Columbia, and St. Mary-Belly Rivers DPS's and is undergoing review and revision on those plans. Both the bull trout final critical habitat designation and final recovery plan are expected to be completed in 2004. Bull trout have been selected as a focal species for this assessment. Information on this species' habitat use and status in the Imnaha subbasin can be found in section 1.2.6.

Chinook

Snake River spring/summer chinook was listed as a threatened species in 1992, 57 FR 14653. The ESU includes all natural populations of spring/summer-run chinook in the mainstem Snake River downstream of Hells Canyon Dam and any of the following subbasins: Tucannon, Grande Ronde, Imnaha, and Salmon. Some or all of the fish returning to several of the hatchery programs are also listed, including those returning to the Tucannon River, Imnaha River, and Grande Ronde River hatcheries, and to the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River. Critical Snake River spring/summer chinook habitat was designated in December 1993, 58 FR 68543 and10/25/99 64 FR 57399. Essential Fish habitat was identified on December 19, 1997.

Snake River fall chinook (Oncorhynchus tshawytscha) was listed as a threatened species under the Endangered Species Act in 1992, 57 FR 14653. The ESU includes all natural populations of fall-run chinook in the mainstem Snake River and any of the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, and Salmon River, and Clearwater River. Critical habitat was designated in December 1993, 58 FR 68543.

Both the fall and spring/summer races of chinook have been selected as a focal species for this assessment. Information on their habitat use and status in the Imnaha subbasin can be found in section 1.2.3.

Columbia Spotted Frog

The Columbia spotted frog (*Rana luteiventris*) has been a candidate for listing since December 14, 1992 (Federal Register, Volume 57, 59257; HCNRA). In Oregon, the Columbia spotted frog is found in parts of the Cascade Mountains and throughout areas of eastern Washington. The subbasin and surrounding areas provide suitable habitat for the species, but its presence is not well documented. An observation of Columbia spotted frog in the Middle Snake subbasin was reported to the Oregon Natural Heritage Program in 1992; the observation occurred within a mile of the Imnaha subbasin boundary (ONHP 2003).

Lynx

The Canada lynx (*Lynx canadensis*) was listed as a threatened species by the USFWS on March 24, 2000 (65 FR 16051) (ODFW 2003a). The USFWS recently completed a reevaluation of the original listing in which the agency considered changing the listing of lynx to endangered. However, the USFWS concluded that this change was not warranted and the lynx remains listed as threatened. Critical habitat has not been designated for the lynx (ODFW 2003a).

County Court records of bounties paid for predators between 1899 and 1922 indicate that lynx once existed in Wallowa County, but densities or numbers cannot be determined from these records. A lynx was shot on the Imnaha River in 1969. Soon after, the species was believed to have been extirpated from Oregon until a documented trapping occurred near Heppner in 1994. Over the past decade, numerous unconfirmed sightings have been recorded, suggesting that lynx may still inhabit portions of the interior Blue Mountains region but in extremely low numbers (USFWS 2003a).

Recent surveys have attempted to establish the presence of lynx in the subbasin without success. Hair snare surveys have been conducted in the Big Sheep Creek and upper Imnaha River watersheds each year from 1999 to 2001. Similar surveys were conducted throughout the Blue Mountains region, as well as in the rest of Oregon; no evidence of lynx occupancy was detected. Snow tracking surveys from snowmobiles and/or cross-country skis were conducted in the Big Sheep Creek watershed each year between 1992 and 1994. Track surveys were reinitiated in 1999 and 2000. Additionally, remote-controlled camera stations baited with road-killed ungulates and furbearer trapping lure were operated in the Wallowa Mountains each winter between 1992 and 1994. Although predator tracks and photos were recorded during these survey efforts, no lynx were identified along any of the routes/stations (USFWS 2003a).

In accordance with the interagency LCAS (Ruediger et al. 2000), the USFWS, BLM, and USFS have cooperated to identify lynx analysis units (LAUs) in Idaho where suitable habitat for lynx is present. These LAUs encompass forested lands that meet vegetation characteristics and elevation limits described in the LCAS, and they extend from the northern panhandle of Idaho to the Snake River plain in the south, east to the Wyoming boundary. Three LAUs have been delineated in the Imnaha subbasin; these LAUs follow the boundaries of the three major watersheds: lower Imnaha, upper Imnaha, and Big Sheep Creek (USFWS 2003a). Collectively, the LAUs encompass the entire Imnaha subbasin.

In the northern Rocky Mountains, the majority of lynx occurrences are associated within Rocky Mountain Conifer Forest. Within this type, most of the occurrences are in moist Douglas-fir (*Pseudotsuga menziesii*) and western spruce/fir forest. Most of the lynx occurrences are in the 1,500- to 2,000-meter (4,920- to 6,560-feet) elevation class (McKelvey et al. 2000). Canada lynx habitat includes a mosaic of early seral stages that support snowshoe hare populations and late seral stages of dense old growth forest that provide ideal denning and security habitat. The results of an analysis of lynx habitat conditions conducted by the Wallowa-Whitman National Forest are displayed in Table 32.

Each of the lower Imnaha and Big Sheep Creek LAUs currently contains more than 30% unsuitable habitat. This is above the threshold for lynx habitat outlined in the LCAS. It is anticipated that this number will decrease and threshold criteria will be met in the near future as regenerating stands reach sufficient stature for use by lynx as foraging habitat. The Eagle Cap Wilderness is believed to be core lynx habitat although lynx are not known to occur there (USFWS 2003a).

Table 32. Disposition of lynx habitat within the Imnaha subbasin (USFWS 2003a).

LAU	Primary Forage		Marginal Forage		Denning		Unsuitable		Total acres of lynx habitat in LAU (Total acres in LAU)
	Acres	% of total lynx habitat	Acres	% of total lynx habitat	Acres	% of total lynx habitat	Acres	% of total lynx habitat	
Upper Imnaha	4,077	12	1,723	5	22,597	69	4,499	14	32,896 (177,984)
Lower Imnaha	500	3	467	3	11,097	62	5,960	33	18,024 (147,136)
Big Sheep	1,069	7	1,513	10	7,620	52	4,499	31	14,701 (218,692)
Total	**5,646**	**9**	**3,703**	**6**	**41,314**	**63**	**14,958**	**23**	**65,621**

MacFarlane's Four O'Clock

MacFarlane's four o'clock (*Mirabilis macfarlanei*) is a long-lived herbaceous perennial with a deep-seated thickened root. It has bright pink funnel-shaped flowers up to 1 inch long and 1 inch wide, the flowers occur in groups of 3 to 7.

MacFarlane's four o'clock was originally listed as endangered in 1979 (44 FR 61912). Due to the discovery of additional populations and ongoing recovery efforts, the species was downlisted to threatened in March 1996. MacFarlane's four o'clock is endemic to the low-elevation grassland habitats in the Imnaha, Snake and Salmon river canyons of Wallowa County, Oregon, and Idaho County, Idaho. It is currently found in 11 populations in Idaho and Oregon. Two of the 11 known populations of MacFarlane's four o'clock occur along the lower Imnaha River (USFWS 2000).

Slender Moonwort

The slender moonwort (*Botrychium lineare*) is a candidate species (66 FR 54808). The USFWS published a 12-month finding for a petition to list this small perennial fern. The USFWS determined that sufficient information is currently available to support a finding that listing slender moonwort is warranted but precluded by other higher priority actions (66 FR 30338; USFS 2003a)

Slender moonwort has widespread but spotty distribution and is currently known from northeastern Oregon, northern Idaho, Montana, California, Colorado, Quebec, and New Brunswick. Habitat for the species is deep grass/forb meadows with lodgepole pine and/or

Engelmann spruce forest. It tends to occur in areas that are moist in the early season but dry out by midsummer. The species has not been documented in the subbasin. The two known occurrences of the species in Oregon occur west of the subbasin in the Lostine and Hurricane creek drainages. However, potential habitat for this species has been identified in the upper Imnaha river corridor, from the boundary of the Eagle Cap Wilderness downstream to where private land is encountered and in the Duck Lake/Twin Lakes area of the subbasin's upper rim (USFS 2003a).

Spalding's catchfly

Twelve observations of Spalding's catchfly, sometimes referred to as Spalding's silene, (*Silene spaldingii*) have been documented in the subbasin by the Oregon Natural Heritage Program. These sightings all occur within the Little Sheep Creek drainage. The largest populations are protected on land recently purchased by The Nature Conservancy in the Camp Creek drainage, but five are on private land and one is located on land administered by the BLM (ONHP 2003). Another population of Spalding's catchfly is reported by the USFWS to occur in the upper Imnaha River watershed (USFWS 2003a).

Steelhead

Snake River steelhead was listed as a threatened species in 1997, 62 FR 43937. The ESU includes all naturally spawned populations of steelhead in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, downstream of Hells Canyon Dam. Major tributary subbasins of this ESU are the Tucannon, Clearwater, Grande Ronde, Imnaha, and Salmon Rivers. Critical habitat for the ESU was designated in February 2000, 65 FR 7764 but has since been removed. On April 30, 2002, the United States District Court for the District of Columbia adopted a consent decree resolving the claims in the National Association of Homebuilders, et al. v. Evans, Civil Action No. 00-2799 (CKK) (D. D.C., April 30, 2002). Pursuant to that consent decree, the court issued an order vacating critical habitat designations for a number of listed salmonid species. NOAA Fisheries expects to propose revised critical habitat designations in the spring of 2004. Steelhead were selected as a focal species for this assessment. Information on steelhead habitat use and status in the Imnaha subbasin can be found in section 1.2.5.

Wolf

Wolves (*Canis lupus*) are considered to have been extirpated from Oregon by 1972. Due to the current success of gray wolf reintroduction by the USFWS in central Idaho and Yellowstone National Park, the numbers of wolves and the range they cover are expanding.

Numerous recent wolf sightings have been reported in Oregon; however, only three of these reports have been verified. These wolves were either killed (one was illegally shot, the other hit by a car) or returned to Idaho. The subbasin contains healthy ungulate populations and a large wilderness, both of which provide requirements sufficient for wolf habitation. It is anticipated that, with continual expansion of the wolf population in Idaho, resident wolves may become established in the area in the near future. Oregon's Fish and Wildlife Commission identified a 14-member state-appointed citizen committee in 2003 to help study all the issues surrounding wolves in Oregon and to recommend management actions that will be used if a permanent population establishes itself. The status of wolves in Oregon was recently changed from endangered to threatened under the ESA (USFWS 2003a).

Wolverine

Though not federally listed, the California wolverine (*Gulo gulo luteus*) is listed as threatened in Oregon under the state ESA. The wolverine was never common in Oregon and does not occur in high densities anywhere in its range.

Ten wolverine sightings in the subbasin (or within 1 mile outside) were reported to the Oregon Conservation Data Center between 1979 and 1992. The reliability of these reports ranges from fair to good. Most of the observations occurred in the high-elevation areas of the Eagle Cap Wilderness, but three of the sightings were at more moderate elevations near the center of the subbasin (ORNHIC 2003). The Wallowa-Whitman National Forest undertook a large effort to survey for wolverine and lynx from 1991 through 1994. Winter track counts were conducted mostly by snowmobile and skis in a variety of habitats and elevations. Bait stations with remote sensing camera were also used. The surveys detected the presence of wolverines in the watershed but indicated that they were very rare (USFS 2003d).

Yellow-Billed Cuckoo

The yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is a candidate species. In 2001, the USFWS determined that sufficient information is currently available to support a finding that listing the yellow-billed cuckoo is warranted but precluded by other higher priority actions (USFWS 2002a).

Only 22 sightings of yellow-billed cuckoo have ever been reported in eastern Oregon (Gabrielson and Jewett 1970, Csuti et al. 2001, Oregon Natural Heritage Program 2002, all cited in USFS 2003a). Most of these sightings occurred in large riparian areas in Lake, Harney, and Malheur counties (HCNRA). In 1980, a yellow-billed cuckoo was sighted in the town of Imnaha. This is the only recorded observation of the species in the subbasin (Oregon Natural Heritage Program 2002). Suitable habitat is not thought to occur in the subbasin.

1.2.1.2 Species Recognized as Rare or Significant to the Local Area

Oregon Sensitive Species

A sensitive species classification was created under Oregon's Sensitive Species Rule (OAR 635-100-040), to encourage actions that will prevent additional species from having to be listed as threatened or endangered. Sensitive species constitute those naturally reproducing native animals that may become threatened or endangered throughout all or any significant portion of their range in Oregon. Factors considered in listing species as sensitive include the potential for natural reproductive failure because of limited population numbers, disease predation or other natural or manmade factors, imminent or active deterioration of range or primary habitat, overutilization, and inadequate existing state or federal regulations or programs for species or habitat protection (ODFW 2003b). Oregon sensitive species with habitat in the Imnaha subbasin are listed in Table 33.

Sensitive species are broken into four categories defined below:

Critical—Species for which listing as threatened or endangered is pending or those for which listing as threatened or endangered may be appropriate if immediate conservation actions are not taken. Also considered critical are some peripheral species that are at risk throughout their range and some disjunct populations.

Vulnerable—Species for which listing as threatened or endangered is not believed to be imminent and can be avoided thorough continued or expanded use of adequate protective measures and monitoring. In some cases, populations are sustainable and protective measures are being implemented; in others, populations may be declining and improved protective measures are needed to maintain sustainable populations over time.

Undetermined Status—Species for which status is unclear. They may be susceptible to population decline of sufficient magnitude that they could qualify for endangered, threatened, critical, or vulnerable status, but scientific study would be needed before a judgment could be made.

Peripheral or Naturally Rare—Peripheral species refer to those species whose Oregon populations are on the edge of their range. Naturally rare species are those that had low population numbers historically in Oregon because of naturally limiting factors. Maintaining the status quo is a minimum necessity. Disjunct populations of several species that occur in Oregon should not be confused with peripheral species.

Table 33. ODFW sensitive species with potential habitat in the Imnaha subbasin (species with potential habitat from IBIS 2003; sensitive species ODFW 2003b).

Category	Common Name	Species Name	USFS 1995[1]	ONHP (2003) element occurrence records (year last detected)
Critical	Pallid bat	*Antrozous pallidus*		
	Northern goshawk	*Accipiter gentilis*	P	1992
	Burrowing owl	*Athene cunicularia*	P	1974
	Upland sandpiper	*Bartramia longicauda*	P	
	Ferruginous hawk	*Buteo regalis*	P	1980
	Northern pygmy-owl	*Glaucidium gnoma*	S	
	Flammulated owl	*Otus flammeolus*	P	
	White-headed woodpecker	*Picoides albolarvatus*	P	
	Black-backed woodpecker	*Picoides arcticus*	P	
	Three-toed woodpecker	*Picoides tridactylus*	P	1992
	Red-necked grebe	*Podiceps grisegena*	S	
	Northern leopard frog	*Rana pipiens*		
	Bull trout	*Salvelinus confluentus*	P	
	Pygmy nuthatch	*Sitta pygmaea*	P	
Vulnerable	Inland tailed frog	*Ascaphus montanus*	P	1993

Category	Common Name	Species Name	USFS 1995[1]	ONHP (2003) element occurrence records (year last detected)
	Pygmy rabbit	*Brachylagus idahohensis*		
	Western toad	*Bufo boreas*	S	
	Swainson's hawk	*Buteo swainsoni*	P	1985
	Greater sage-grouse	*Centrocercus urophasianus*		
	Olive-sided flycatcher	*Contopus cooperi*	P	
	Townsend's big-eared bat	*Corynorhinus towsendii townsendi*	P	
	Western rattlesnake	*Crotalus viridis*	P	
	Bobolink	*Dolichonyx oryzivorous*	S	
	Pileated woodpecker	*Dryocopus pileatus*	P	
	Greater sandhill crane	*Grus canadensis tabia*		
	Pacific lamprey	*Lampetra tridentata*		
	American marten	*Martes americana*	P	1992
	Fringed myotis	*Myotis thysanodes*		1990
	Steelhead/redband trout	*Oncorhynchus mykiss*	P	
	Desert horned lizard	*Phrynosoma platyrhinos*		
	Horned grebe	*Podiceps auritus*	S	1983
	Great gray owl	*Strix nebulosa*	P	
Undetermined	Boreal owl	*Aegolius funereus*		
	Bufflehead	*Bucephala albeola*	P	
	Barrow's goldeneye	*Bucephala clangula*	P	
	Willow flycatcher	*Empidonax traillii*	P	
	Spruce grouse	*Falcipennis canadensis*	P	
	Harlequin duck	*Histrionicus histrionicus*	S	1929
	Silver-haired bat	*Lasionycteris noctivagans*	P	
	White-tailed jackrabbit	*Lepus townsendii*	S	
	Western small-footed myotis	*Myotis ciiolabrum*	P	
	Long-eared myotis	*Myotis volans*	P	
	Mountain quail	*Oreortyx pictus*	P	
	Columbia spotted frog	*Rana luteiventris*	P	1992
	Bank swallow	*Riparia riparia*	S	
	Williamson's sapsucker	*Sphyrapicus thyroideus*	P	
Naturally	Black swift	*Cypseloides niger*		
Rare	Franklin's gull	*Larus pipixcan*		

[1] P = present, S-suspected

USDA Forest Service, Region 6, Regional Forester's Sensitive Species List

The Region's Sensitive Species Program provides goals and objectives to manage sensitive species and their habitats. This program includes the Regional Forester's sensitive species list (Table 34) to prevent the need for federal listing at a future date. It is the policy of the Region that 1) all actions and programs authorized, funded, or carried out by the USFS are reviewed to determine their potential effect on threatened and endangered species, sensitive species, and species proposed for listing and 2) sensitive species on the current Regional Forester's sensitive species list are given the same management consideration as federally listed species (USFS 1995).

Table 34. USFS Region 6 sensitive species (USFS 1995).

Common Name	Scientific Name
American peregrine falcon	*Falco peregrinus anatum*
Bald eagle	*Haliaeetus leucocephalus*
Ferruginous hawk	*Buteo regalis*
Long-billed curlew	*Numenius americanus*
Yellow-billed cuckoo	*Coccyzus americanus occidentalis*
Harlequin duck	*Histrionicus histrionicus*
Greater sandhill crane	*Grus canadensis tabia*
Upland sandpiper	*Bartramia longicauda*
Black rosy-finch	*Leucosticte atrata*
Townsend's big-eared bat	*Corynorhinus towsendii townsendii*
California wolverine	*Gulo gulo luteus*
Lynx	*Lynx canadensis*
Blue Mountain cryptochian caddisfly	*Cryptochia neosa*

Partners in Flight Focal Species

Partners in Flight (PIF) was established in 1990 as a conservation effort to focus on land birds and their habitats. Concern over continental and local declines in numerous bird populations due in part to habitat loss, degradation, and fragmentation on breeding and wintering grounds and along migratory routes as well as reproductive problems associated with nest predation, brood parasitism, and competition with exotic species initiated the PIF collaborative effort. Partnerships among many agencies including federal, state and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals have contributed to the great success of PIF. Partners in Flight works to enhance cooperation between private and public sector efforts in North America and the Neotropics in order to improve monitoring and inventory, research, management, and education programs involving birds and their habitats.

The development of bird conservation plans (BCPs) for the entire continental U.S. is one of the primary activities of Partners in Flight. The goal of the Bird Conservation Plans is to ensure long-term maintenance of healthy populations of native landbirds. The planning process for the BCPs has four steps: 1) identify species and habitats most in need of conservation (i.e., prioritization); 2) describe desired conditions for these habitats based on knowledge of species life history and habitat requirements; 3) develop biological objectives that can be used as management targets or goals to achieve desired conditions; and 4) recommend conservation actions that can be implemented by various entities at multiple scales to achieve biological objectives.

Bird conservation plans are organized by physiographic areas and state. The Imnaha subbasin is within the Central Rocky Mountains physiographic area and is included in the Bird Conservation Plan for Oregon/Washington. This conservation plan emphasizes an ecosystem management approach to landbird preservation but includes components of single-species and indicator species management. The most important habitat features and conditions for landbirds within the planning area were identified and then focal species considered representative those habitats were selected to help guide conservation planning (Table 35).

Table 35. Priority habitat features and associated landbird species for conservation in habitats of the Northern Rocky Mountains Landbird Conservation region of Oregon and Washington.

Habitat Type	Focal Species Blue Mountain Province	Habitat Feature/Conservation Focus
Dry Forest (ponderosa pine and ponderosa pine/Douglas-fir/grand fir	white-headed woodpecker (*Picoides albolarvatus*)	large patches of old forest with large trees and snags
	flammulated owl (*Otus flammeolus*)	old forest with interspersion grassy openings and dense thickets
	chipping sparrow (*Spizella passerina*)	open understory with regenerating pines
	Lewis's woodpecker (*Melanerpes lewis*)	patches of burned old forest
Mesic Mixed Conifer (late-successional)	Vaux's swift (*Chaetura vauxi*)	large snags
	Townsend's warbler (*Dendroica townsendi*)	overstory canopy closure
	varied thrush (*Ixoreus naevius*)	structurally diverse; multilayered
	MacGillivray's warbler (*Oporornis tolmiei*)	dense shrub layer in forest openings or understory
	olive-sided flycatcher (*Contopus cooperi*)	edges and openings created by wildfire
Riparian Woodland	Lewis's woodpecker (*Melanerpes lewis*)	large snags
Riparian Shrub	willow flycatcher (*Empidonax trallii*)	willow/alder shrub patches
Unique Habitats	hermit thrush (*Catharus guttatus*)	subalpine forest
	upland sandpiper (*Bartramia longicauda*)	montane medows (wet/dry)
	vesper sparrow (*Pooecetes gramineus*)	steppe shrublands
	red-naped sapsucker (*Sphyrapicus nuchalis*)	aspen
	gray-crowned rosy-finch (*Leucosticte tephrocotis*)	alpine

1.2.1.3 Managed Terrestrial Species

The Imnaha subbasin is home to many valuable game species. The subbasin contains potential habitat for 1 amphibian, 42 birds, and 7 mammals that are classified as game species by the state of Oregon (IBIS 2003) (Table 36) Four game species were selected as focal species for this assessment: the Rocky Mountain elk, mountain goat, bighorn sheep, and mule deer (see section 1.2.2 for more information).

Table 36. Oregon game species with potential habitat in the Imnaha subbasin (IBIS 2003).

Common Name	Scientific Name
Amphibians	
Bullfrog	*Rana catesbeiana*
Birds	
Greater white-fronted goose	*Anser albifrons*
Snow goose	*Chen caerulescens*
Ross's goose	*Chen rossii*
Canada goose	*Branta canadensis*
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*
Ruddy duck	*Oxyura jamaicensis*
Chukar	*Alectoris chukar*
Gray partridge	*Perdix perdix*
Ring-necked pheasant	*Phasianus colchicus*

Common Name	Scientific Name
Ruffed grouse	*Bonasa umbellus*
Greater sage-grouse	*Centrocercus urophasianus*
Spruce grouse	*Falcipennis canadensis*
Blue grouse	*Dendragapus obscurus*
Wild turkey	*Meleagris gallopavo*
Mountain quail	*Oreortyx pictus*
California quail	*Callipepla californica*
Northern bobwhite	*Colinus virginianus*
American coot	*Fulica americana*
Common snipe	*Gallinago gallinago*
Band-tailed pigeon	*Patagioenas fasciata*
Mourning dove	*Zenaida macroura*
Mammals	
Muskrat	*Ondatra zibethicus*
Black bear	*Ursus americanus*
Mountain lion	*Felis concolor*
Rocky mountain elk	*Cervus elaphus nelsoni*
White-tailed deer	*Odocoileus virginianus ochrourus*
Rocky Mountain goat	*Oreamnos americanus*
Bighorn sheep	*Ovis canadensis*

1.2.1.4 Species Recognized by Tribes (Cultural/Spiritual Significance)

The Imnaha subbasin was the homeland of the Joseph (Wellamotkin) Band of the Nez Perce Tribe (Chalfant 1974). Although the Nez Perce Tribe believes in the inherent value of all plant and animal species, certain species have particular significance to tribal members due to their historical and current importance for sustenance and/or ceremonial purposes.

Archaeological excavations conducted in the Downey Lake Area of the Big Sheep watershed indicate that the subbasins early inhabitants made extensive use of bighorn sheep (USFS 1995). Deer and elk also were and continue to be important game species for tribal members. Salmon and steelhead were and are very important to the Nez Perce Tribe, and tribal members timed seasonal migrations around the runs (NPT 2003).

The basic roots gathered for winter storage included camas bulb (kehmmes), bitterroot (thlee-tahn), khouse (qawas), wild carrot (tsa-weetkh), wild potato (keh-keet), and other root crops. Fruits collected in the area include service berries, gooseberries, hawthorn berries, thorn berries, huckleberries, currants, elderberries, chokecherries, blackberries, raspberries, and wild strawberries. Other food gathered includes pine nuts, sunflower seeds, and black moss (NPT 2003). Lomatiums, like biscuitroot and khouse, are known to occur in the watershed on the rocky soils characteristic of ridgetop environments. Camas is usually found associated with wet meadow environments and may occur in the Zumwalt prairie (USFS 1995).

1.2.1.5 Locally Extirpated and Introduced Species

Human activities have altered the species composition of the Imnaha subbasin. Some species such as the grizzly bear, and gray wolf are known to have occurred in the subbasin historically but don't occur in the subbasin now. Others like the sharp-tailed grouse and bighorn sheep occurred in the subbasin historically, were extirpated as a result of human activities and have since been reintroduced. The historic status of the pronghorn, bison, and Rocky Mountain goat in the subbasin is not entirely clear, but archaeological evidence indicates, that they were used as prey species by the Native American groups that inhabited the subbasin. It is possible that these animals were not harvested within the subbasin but rather were killed in neighboring areas and transported into the subbasin (Table 37). Rocky Mountain goats and bighorn sheep have been selected as focal species for this assessment, more information on their populations in the subbasin can be found in section 1.2.9.4.

Ten non-native terrestrial vertebrate species are thought to occur within the subbasin. The majority of these species are native to Asia or Europe and were not introduced directly to the Imanha subbasin but colonized from surrounding areas (Table 38). Four species of introduced game birds inhabit the subbasin these species are economically important as they provide hunting opportunities but may compete with native birds for food and nest sites (Table 38; Johnson and O'Neil 2000). The remainder of the introduced species are generally considered undesirable and make have negative impacts on native wildlife, for instance starlings have been documented to usurp nest sites from many species of native birds and bullfrogs have been shown to outcompete and prey on native amphibian species. Introduced wildlife species are not considered to be a significant factor limiting native wildlife populations in the subbasin.

Table 37. Species extirpated from the Imnaha subbasin (from Johnson and O'Neil 2001, with exceptions noted).

Common Name	Scientific Name	Comments
Bighorn sheep	*Ovis canadensis*	Successfully reintroduced (see section 1.2.9.4)
Bison?	*Bos bison*	Imnaha just outside historical range in Johnson and O'Neil, remains have been found in subbasin (USFS 1998d)
Yellow-billed cuckoo	*Coccycuz americanus*	Extirpated? Rare observations occasionally occur. Breeding pair in LaGrande in 1992
Gray wolf	*Canis lupus*	May be recolonizing from ID
Grizzly bear	*Ursus arctos*	Last grizzly in Oregon shot in Wallowa County in 1931
Sharp-tailed grouse	*Tympanuchus phasianellus*	reestablished in Zumwalt Prairie
Pronghorn?	*Antilocarpa americana*	Archaeological evidence indicates historical presence in subbasin (USFS 1998d)
Rocky Mountain goat	*Oreamos americanus*	Many sources (Verts and Carraway 1998, Johnson and O'Neil 2001) consider the mountain goat to be an introduced species in Oregon but local information suggests it was extirpated at or prior to European settlement and reintroduced (see section 1.2.9.3) (ODFW 2003c)

Table 38. Introduced wildlife species of the Imnaha subbasin (Johnson and O'Neil 2001).

Common Name	Scientific Name	Origin	Reason for Original Introduction
Chukar	*Alectoris chukar*	Eurasia	game
Gray partridge	*Perdix perdix*	Eurasia	game
Ring-necked pheasant	*Phasianus colchicus*	Eurasia	game
California quail	*Callipepla californica*	southwestern United States	game
Rock pigeon	*Columba livia*	Eurasia	aesthetics, racing, messengers,
European starling	*Sturnus vulgaris*	Eurasia	aesthetics
House sparrow	*Passer domesticus*	Eurasia	aesthetics, insect control
Bullfrog	*Rana catesbeiana*	eastern and central United States	insect control, aesthetics, hunting, food
Norway rat	*Rattus norvegicus*	Asia	stowaway
House mouse	*Mus musculus*	Europe	stowaway

1.2.2 Focal Species Selection

1.2.2.1 List of Species Selected

A total of 19 focal species were selected for assessment in the Imnaha subbasin. The list of aquatic species includes spring/summer chinook (*Oncorhynchus tshawytscha*), fall chinook (*O. tshawytscha*), summer steelhead (*O. mykiss*), bull trout (*Salvelinus confluentus*), and Pacific lamprey (*Lampetra tridentata*). The list of terrestrial species is shown in Table 39.

Table 39. Terrestrial focal species to be assessed in the Imnaha subbasin.

Common Name	Scientific Name	Habitat to Represent	Specific Structure, Habitat Elements, or Issues to Represent
Flammulated owl	*Otus flammeolus*	Ponderosa Pine Forest	mature structural stage
White-headed woodpecker	*Picoides albolarvatus*	Ponderosa Pine Forest	mature structural stage
American marten	*Martes Americana*	Montane Mixed Conifer Forest and Eastside Mixed Conifer Forest	mature structural stage, snags
Boreal owl	*Aegolius funereus*	Montane Mixed Conifer Forest	
Olive-sided flycatcher	*Contopus cooperi*	Montane Mixed Conifer Forest and Eastside Mixed Conifer Forest	

Common Name	Scientific Name	Habitat to Represent	Specific Structure, Habitat Elements, or Issues to Represent
Rocky mountain elk	*Cervus elaphus*	Montane Mixed Conifer Forest	summer and fall ranges
Rocky Mountain goat	*Oreamnos americanus*	Alpine Grasslands and Shrublands	
Bighorn sheep	*Ovis Canadensis*	Eastside Grasslands	canyon lands
Grasshopper sparrow	*Ammodramus savannarum*	Eastside Grasslands	bunchgrass communities
Mule deer	*Odocoileus hemionus*	Agriculture, Pastures	landowner conflicts
Mountain quail	*Oreortyx pictus*	Wetland and Riparian Areas	shrub and brush cover
Yellow warbler	*Dendroica petechia*	Wetland and Riparian Areas	riparian
Long-toed salamander	*Ambystoma macrodactylum*	Wetland and Riparian Areas	water quality
Bald eagle	*Haliaeetus leucocephalus*	Open Water	salmon

1.2.2.2 Methodology for Selection

Aquatic

Focal species were chosen according to guidelines provided in NPPC (2001). These guidelines suggested inclusion of species that met the following criteria in order of importance: 1) designation as a Federal endangered or threatened species; 2) ecological significance; 3) cultural significance; and, 4) local significance.

Considering their federal status listing, the Imnaha Aquatics Technical Team (IATT) agreed that the selection of the four threatened salmonids and Pacific lamprey was appropriate. Ecological considerations in the selection of the focal species were based on the unique genetic characteristics, roles and habitat types occupied by the respective fishes. The various focal species selected by the IATT were considered to be locally important to the Imnaha subbasin based on their economic value (*e.g.,* spring/summer chinook and steelhead fisheries), ecologic value (*e.g.,* genetic uniqueness, contribution to respective Environmentally Significant Units/Recovery Units), and cultural significance.

The Interior Columbia Basin Technical Recovery Team (TRT; 2003) identifies two independent populations of spring/summer chinook in the subbasin; the Imnaha mainstem (IRMAI) and Big Sheep Creek (IRBSH; *refer to* Section 1.2.3.1 for additional information), the Snake River fall chinook population (SNMAI; *refer to* Section 1.2.4.1 for additional information), which represents a distinct unit when compared to populations occurring elsewhere throughout the Columbia Basin, and a unique spawning aggregate of summer steelhead (IRMMT-s; *refer to* Section 1.2.5.1 for additional information).

The input and dispersal of marine-derived nutrients represents a unique ecological function facilitated by the anadromous species. The importance of adult salmon/steelhead and lamprey carcasses upon terrestrial (*e.g.,* common merganser, bald eagle, and northern river otter) and aquatic (*e.g.,* bull trout, juvenile salmon) food webs is well documented (*e.g.,* Cederholm et al. 2000). Also important, is the role (or lack thereof) anadromous species play as a prey base for piscivorous species (*e.g.,* bull trout).

Distribution is unique for the various aquatic focal species, which supported the IATTs selection. Fall chinook and lamprey represent a mainstem-oriented species occupying low gradient stream reaches. Key spring/summer chinook spawning and rearing areas are also on mainstem reaches, yet occur farther upstream in the subbasin. Summer steelhead represent the most widely distributed salmonid, and spawn and rear throughout most accessible reaches in the subbasin. Bull trout represent a headwater-oriented species, with a fluvial component that occupies various distinct habitat types throughout the year.

All focal species selected have important cultural significance to the Nez Perce Tribe. As a fishing-oriented tribe, the Nez Perce have relied upon the Imnaha subbasin to harvest salmon and steelhead for consumptive and religious purposes. Although currently depressed, Pacific lamprey were also sought after by the Nez Perce. Bull trout, although currently not harvested, also represent a species historically harvested by Nez Perce peoples.

Terrestrial

Terrestrial species for the subbasin were selected during a meeting of the Imnaha subbasin terrestrial subcommittee. Due to the wide variety of wildlife species that use the Imnaha subbasin it is generally not appropriate to manage using a species based approach. Wildlife management in the subbasin focuses on creating high quality habitat that can support the full contingent of native wildlife species in the subbasin. In the case of species with very specific requirements that can not be adequately addressed through a habitat based approach to management a more fine filter species based approach may be employed. In keeping with this habitat based approach, focal species were selected to represent the current WHTs that have been identified to occur in the Imnaha subbasin by the Northwest Habitat Institute. Preference was given to species designated as threatened, endangered, sensitive, Partners in Flight priority or focal, functional link, functional specialist, culturally important or managed, when these species were considered good representatives of habitat quality. More focal species were selected to represent widely distributed or disproportionately important habitat types, compared with habitats that are only a minor component of the landscape. Species were selected to represent structural conditions or habitat elements that are particularly important to a variety of wildlife species in the subbasin and that are thought to be less common than they were historically. Susceptibility to current and historical management, data availability, monitoring potential were also factors considered during the selection process.

1.2.3 Spring/Summer Chinook Population Delineation and Characterization

1.2.3.1 Population Data and Status—Spring/Summer Chinook

Abundance and Trends

Imnaha subbasin spring/summer chinook salmon population abundance and trends should be characterized using the following key performance measures (see also RME section); adult escapement, index of spawner abundance (index area redds), spawner abundance, index of juvenile abundance (parr density), juvenile emigrant abundance, and hatchery production abundance. Additional performance measures of; fish per redd, hatchery fraction, in-tributary harvest, and smolt equivalents support calculation of derived performance measures further characterizing population abundance and productivity. Given the existence of a spring/summer chinook salmon hatchery program in the Imnaha subbasin, performance measures should characterize both natural and hatchery-origin aspects.

Adult Escapement

Historically, the Imnaha subbasin supported one of the largest runs of spring/summer chinook salmon in Wallowa County (Wallowa County and NPT 1993). Prior to the construction of the four lower Snake River dams, the estimated maximum escapement of adult chinook salmon to the subbasin was 6,700[3] fish (USACE 1975). Annual adult escapement of adult chinook salmon has been indirectly quantified since 1982 (Figure 36; Table 40). Returns of natural origin chinook salmon (not including jacks) have declined to levels below 150 individuals during some years (Ashe et al. 2000), which is notable because it is estimated that up to 10% of the annual escapement of wild/natural Snake River spring/summer chinook salmon are of Imnaha origin (NMFS 2001). In the past four years (2000-2003), returns have increased to 2,364 – 6,543 individuals (ODFW unpublished data provided by P. Kinery). This escapement total represents both natural and hatchery origin adults.

[3] LSRCP used 55% of the chinook escapement over McNary Dam to estimate the number of fish returning to the Snake River, then took 5.5% of that value to estimate spring/summer chinook returns into the Imnaha

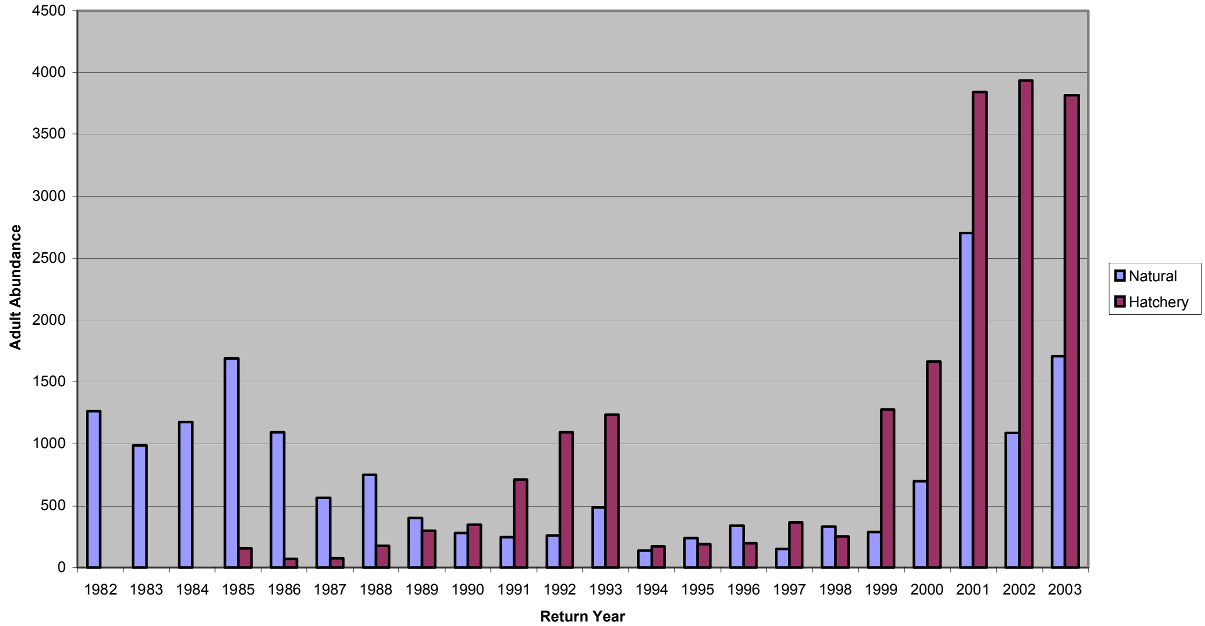

Figure 36. Estimated abundance of natural and hatchery-origin adult chinook salmon to the Imnaha River subbasin 1982 – 2003 (ODFW unpublished data provided by P. Kinery)

Table 40. Total escapement, number of broodstock collected, and number and origin of natural spawners in the Imnaha River (1979–2003)

Year	Total Escapement[1]	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1979[2]	192	0	0	192	0	0
1980[2]	125	0	0	125	0	0
1981[2]	307	0	0	307	0	0
1982	1,262	28	0	1,234	0	0
1983	990	64	0	926	0	0
1984	1,178	36	0	1,142	0	0
1985	1,844	115	14	1,573	142	8
1986	1,165	315	21	788	51	6
1987	644	83	22	484	55	10
1988	928	140	68	609	111	15
1989	697	105	187	297	108	27
1990	627	81	159	199	188	49
1991	959	51	262	198	448	70
1992	1,353	54	331	205	763	79
1993	1,724	58	394	430	842	66
1994	311	20	31	118	142	55
1995	432	38	30	204	160	44
1996	535	72	61	266	136	34
1997	517	23	149	129	216	63
1998	586	77	57	255	197	44

Year	Total Escapement[1]	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1999	1,676	22	254	287	1,113	80
2000	2,364	49	282	647	1,364	68
2001	6,356	86	169	2,465	3,134	56
2002	5,269	38	276	1,042	3,311	76
2003	5,387	75	304	1,623	3,020	65

1/ Jacks are included in the estimates. Total escapement is the sum of total natural spawners estimated from redd counts and fish retained for hatchery broodstock

2/ Estimates prior to 1982 are based on redd counts above the location of the weir and not expanded for those fish spawning below the weir location.

Estimation of adult escapement for the mainstem Imnaha River is determined via mark-recapture techniques for the area upstream of the weir and expanded to the entire subbasin by fish/redd estimates. Operation of the weir across the entire run with capture efficiencies at or near 100% would improve the accuracy and precision of the fish per redd estimates. Currently escapement estimates for Big Sheep Creek rely on fish/redd expansion using Imnaha mainstem data. Direct enumeration would be desirable if increased escapement into Big Sheep Creek is realized.

Index of Spawner Abundance (Redd Counts)

Trends in chinook salmon relative abundance have been monitored since 1957 via redd counts. Spring/summer chinook redd count surveys have been conducted in various portions of the Imnaha subbasin for several decades. Surveys have typically occurred in index areas, such as Big Sheep Creek, Lick Creek, and the upper Imnaha; however, additional "supplemental" surveys have recently occurred in an effort to identify previously undefined spawning locations.

The trend in redd counts has been variable over the period for which data collection has occurred. In the Big Sheep Creek index area, the number of redds observed declined significantly in the mid-1970s, and has remained at low (<20) levels ever since (Figure 37). Supplemental surveys conducted in the Big Sheep drainage in 2000–2001 identified only one additional redd (in 2001) over the course of 9 additional stream miles surveyed. Escapement in the Lick Creek index area was highest in the mid-1960s to early 1970s, then peaked again in 1978 and in 1997, a result of outplanting hatchery adults (Figure 38). No additional redds were found following supplemental surveys in 2000–2001. The number of spring chinook redds identified in index areas on the mainstem Imnaha were substantially higher prior to the 1980s and 1990s (Figure 39); however, a total of 261 redds were identified following supplemental redd surveys in 2000, while 612, 1105, and 727 redds were observed in 2001- 2003, respectively.

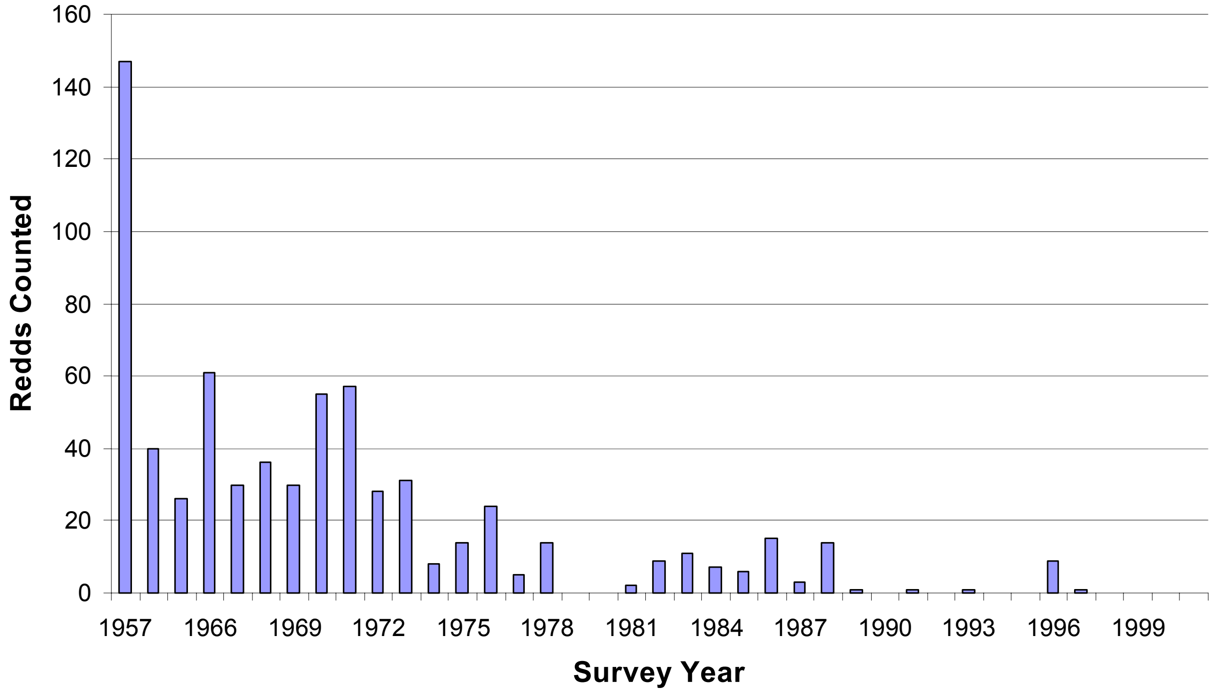

Figure 37. Big Sheep Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).

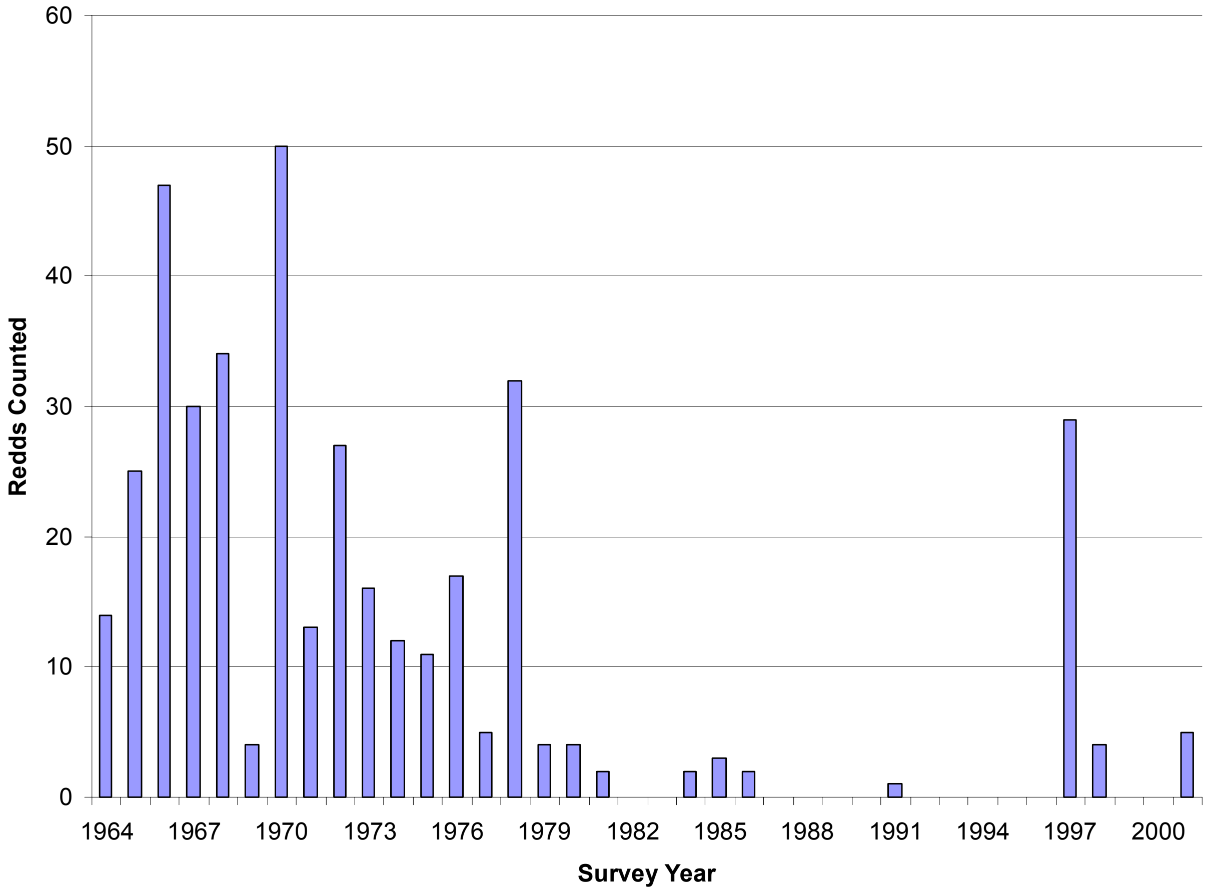

Figure 38. Lick Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).

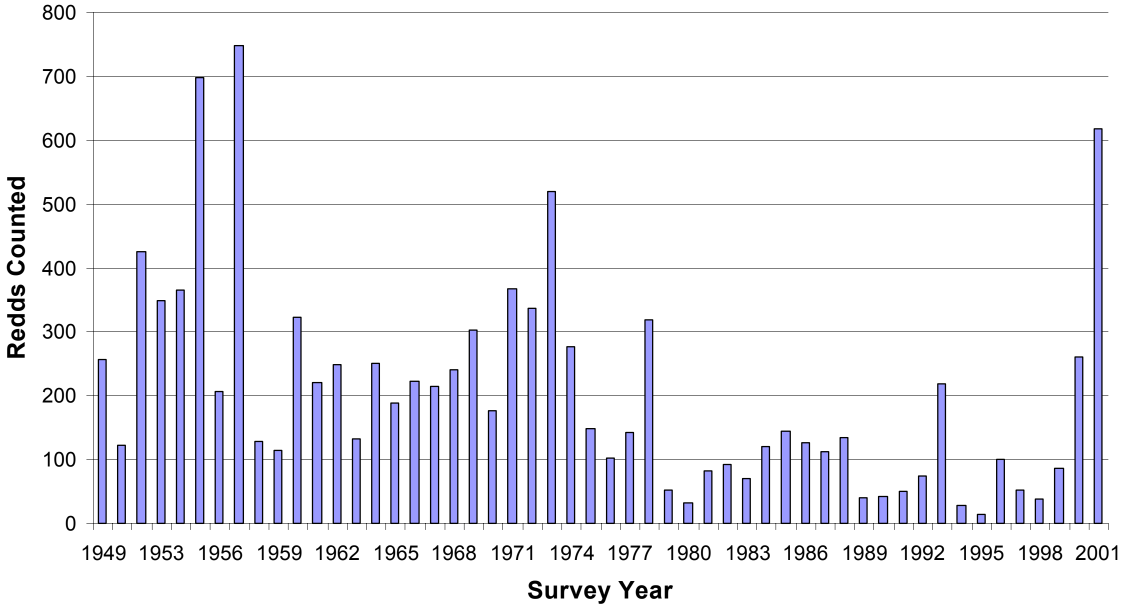

Figure 39. Spring/summer chinook redd counts on the mainstem Imnaha River (StreamNet data, downloaded August 2003).

Spawner Abundance

Estimates of spawner abundance have not been directly assessed in the Imnaha subbasin. Derived estimates can be generated by adjusting escapement estimates by prespawning mortality rate estimates for the area upstream of the weir. Redd counts provide an index of spawner abundance with unknown/quantified sources of bias and precision.

Index of Juvenile Abundance (Density)

Juvenile density estimates provided here have been summarized from Blenden and Kucera (2002). In their report they provide a baseline relative index of juvenile abundance and fish species composition information. Big Sheep Creek was snorkeled approximately 4.5 stream kilometers (skm) above Carrol Creek from 1992-1995 and also just above Lick Creek in 1994. Lower Lick Creek was snorkeled at approximately skm 0.6 in 1994 and upper Lick Creek was snorkeled from between skm 2.4 and 5.9 from 1994-2000 excluding 1995. The Imnaha River was snorkeled at approximate river kilometer (rkm) 84 and 90 from 1991 to 1996.

Average density of age 0+ natural chinook salmon in Big Sheep Creek pool habitat varied from 17.2 to 22.2 fish/100m^2 from 1992 to 1994 (Blenden and Kucera 2002). No natural chinook salmon were observed in lower Big Sheep Creek in 1995 in either pool or run habitat. Age 0+ chinook salmon mean density in run habitat ranged from 5.6 to 24.7 fish/100m^2 (Figure 40). Annual variation in subyearling chinook salmon density in run habitat varied as much as three fold. Age 1+ natural chinook salmon mean density (5.3 fish/100m^2) was highest in 1993 run habitat and followed the relative higher densities of chinook salmon parr observed in 1992.

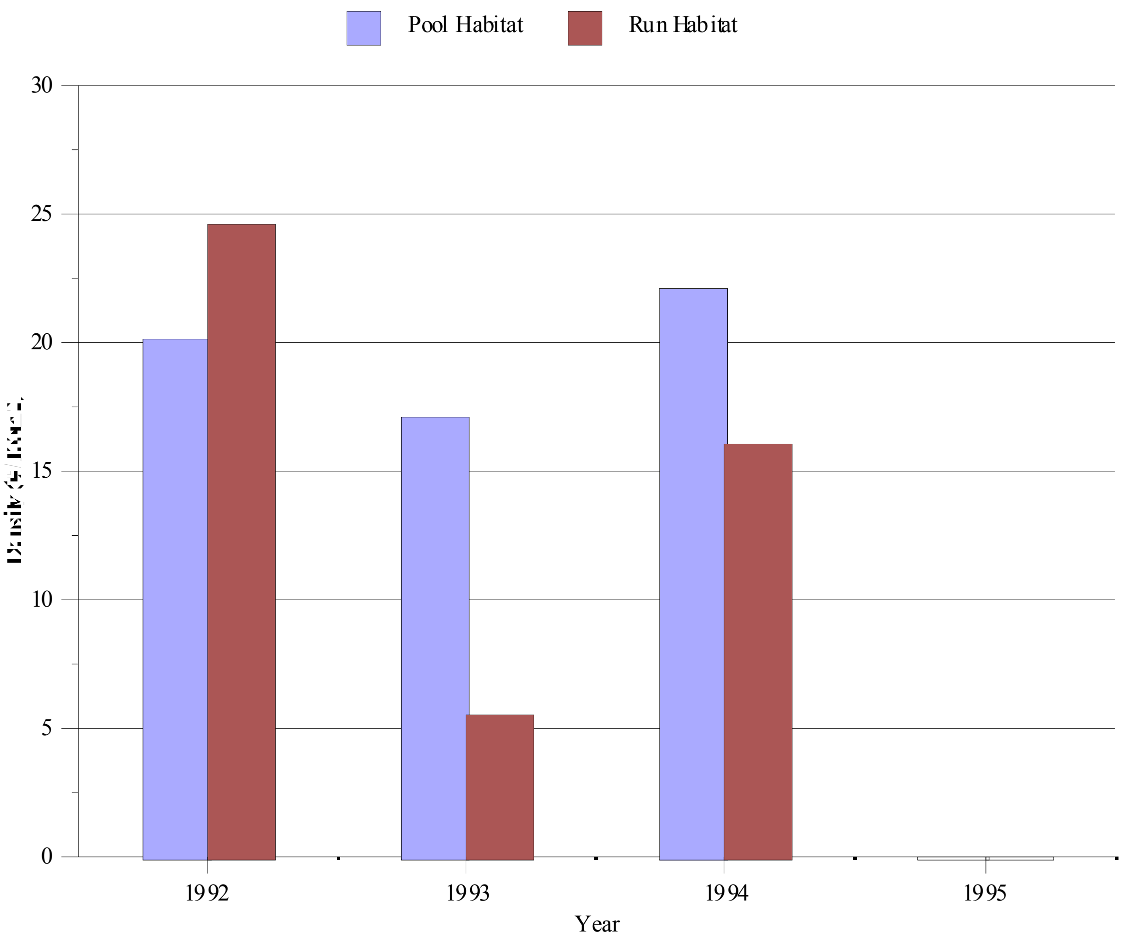

Figure 40. Average density (fish/100m^2) of age 0+ chinook salmon in pool and run habitat in lower Big Sheep Creek from 1992 to 1995 (Blenden and Kucera 2002).

Juvenile chinook salmon density information was collected in Lick Creek, in the Imnaha River subbasin, to document the reproductive success of adult hatchery chinook salmon releases. The natural salmon spawning aggregate in Lick Creek is essentially locally extirpated. Chinook salmon parr densities in Lick Creek ranged from 32.5 to 224 fish/100m^2 the year after adult hatchery salmon releases during three different years. During three years when no adult hatchery chinook salmon were released, age 0+ chinook salmon densities the following year were zero. Outplanted adult hatchery chinook salmon were able to successfully spawn and produce progeny in Lick Creek.

The Imnaha River snorkeling sites were located within the chinook salmon redd count index area from Indian Crossing to Mac's Mine. Juvenile natural chinook salmon was the most abundant fish species observed, followed by mountain whitefish, steelhead and bull trout. Mean densities of age 0+ chinook salmon (72.4/100m^2) were highest in 1994 pool habitat and were lowest in 1996 run habitat (9.8/100m^2). Average density of age 0+ chinook salmon was highest in pool habitat, and ranged from 30.4 to 72.4 fish/100m^2 from 1992 to 1995 (Figure 41). Mean densities of subyearling chinook salmon within pool habitat differed substantially between years, varying as much as 100%. Confidence intervals (95% C.I.'s) around pool habitat mean densities were substantial, ranging from 56% to 101.6%. Between year statistical comparison of pool habitat mean density was not performed due to low sample sizes of snorkeled habitat (n=5 to 6). In each year, observed densities of age 0+ chinook salmon in pool habitat was two to 3.4 times higher than run habitat average densities. Pool habitat appeared to be preferred over run habitat by age 0+ chinook in the Imnaha River. The mean density of age 0+ chinook salmon in run habitat ranged from 9.8 to 38 fish/100m^2 over the study period (Figure 41). Average densities of subyearling chinook salmon in run habitat types did not vary substantially between years. The exception occurred in 1994 when density (38 fish/100m^2) was twice that of any other years' observed average density. Ninety five percent confidence intervals surrounding age 0+ chinook salmon average densities (run habitat) ranged from 29.8% to 86.7%. Age 1+ chinook salmon mean densities were highest in 1996 pool habitat (5.3/100m^2) and lowest in 1994 run habitat (0.1/100m^2). Juvenile emigrant trapping investigations in the upper Imnaha River (rkm 74) in 1992 and 1993 indicated that thousands of age 0+ chinook salmon had emigrated from natural production areas prior to initiation of snorkeling activities in mid August (Blenden - unpublished data).

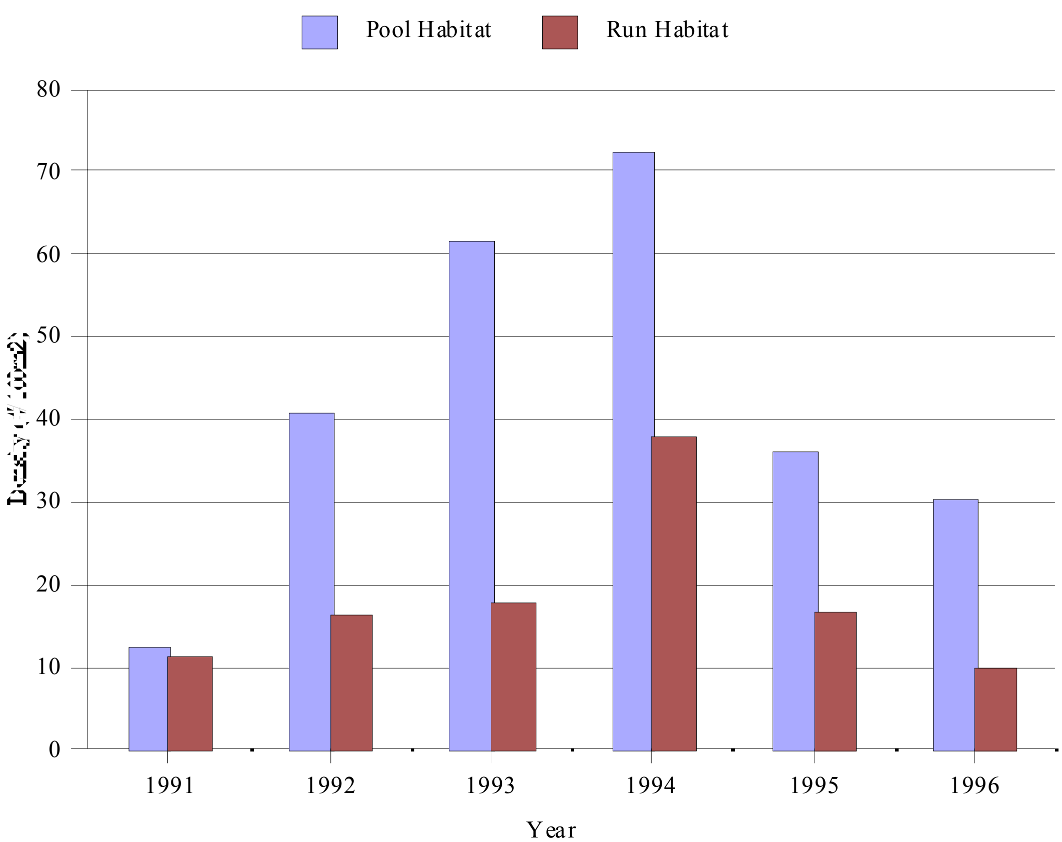

Figure 41. Average density of age 0+ chinook salmon in pool and run habitat in the Imnaha River from 1991 to 1996 (Blenden and Kucera 2002).

Juvenile Emigrant Abundance

Juvenile emigrant abundance data is not available for the Imnaha River subbasin. The performance measure represents a critical data gap. Seasonal estimates for portions of the emigration period are available (Gaumer 1968, Cleary et al 2003, Ashe et al 1995); however, in only one migration year (1992 - 1993) was trapping conducted across over the entire emigration period.

Population Risk Assessment

Snake River spring/summer chinook salmon (including the Imnaha River) have suffered from a severe decline in population size. Fish return sizes, particularly from 1980-2000, were less than 1% of those from about 1955-1970 (Hyun and Talbot 2004). The National Marine Fisheries Service (NMFS) listed evolutionarily significant units (ESU) of these fish as 'threatened' on April 22, 1992 and August 18, 1997 respectively under the Endangered Species Act. However return sizes from 2001-2003 showed a significant increase.

Hyun and Talbot (2004) conducted a viability analysis for Snake River spring/summer chinook salmon using time series data of abundance index (Figure 42). We provide here a much abbreviated summary of their paper to describe extinction risk of the Imnaha River chinook salmon populations. They developed an integrated risk metric that incorporates estimates of the Diffusion Approximation (DA) model parameters and the viability of the current population size relative to that from pre-1980. The status of ESUs and populations was assessed over two time series: (1) the entire time series of available data, and (2) time series after 1980. To address an issue concerning whether the current population viability is comparable to those from the healthy time, the entire time series was used. To assess whether the current population viability is at extinction risk, recent data series was used because salmonid longevity is typically five or six years and thus population sizes from 10 or more years ago is less correlated to the current population size.

An abundance index of naturally origin fish at return year *t* was calculated as follows:

$$I_t = [(\text{escapement index}) + (\text{harvest estimate})] \times (\text{fraction of natural origin fish})$$

The current viability of all Snake River spring/summer chinook salmon ESU and populations (including the Imnaha) was significantly poor, compared to that from the healthy time period. Table 41 shows probability of population growth rate (Pr $\hat{\mu} < 0$) of all spring/summer chinook salmon ESU and populations are larger than 0.5. Hyun and Talbot assigned 0.5 to be an *ad hoc* threshold for Pr($RVC < 1$). They assumed that, if the bad event '$RVC < 1$' (i.e., the current population size is less than those from the pre-1980 period) occurs with possibility of 50% or more, a population of interest is at risk. The resultant threshold of integrated risk metric becomes 0.25 because 0.5 for Pr($\hat{\mu} < 0$) x 0.5 for Pr($RVC < 1$) = 0.25. Based on the integrated risk metric, the Big Sheep Creek and Imnaha River mainstem spring/summer chinook salmon population are at risk (Table 42). These results may differ when data from 2002 and 2003 are included.

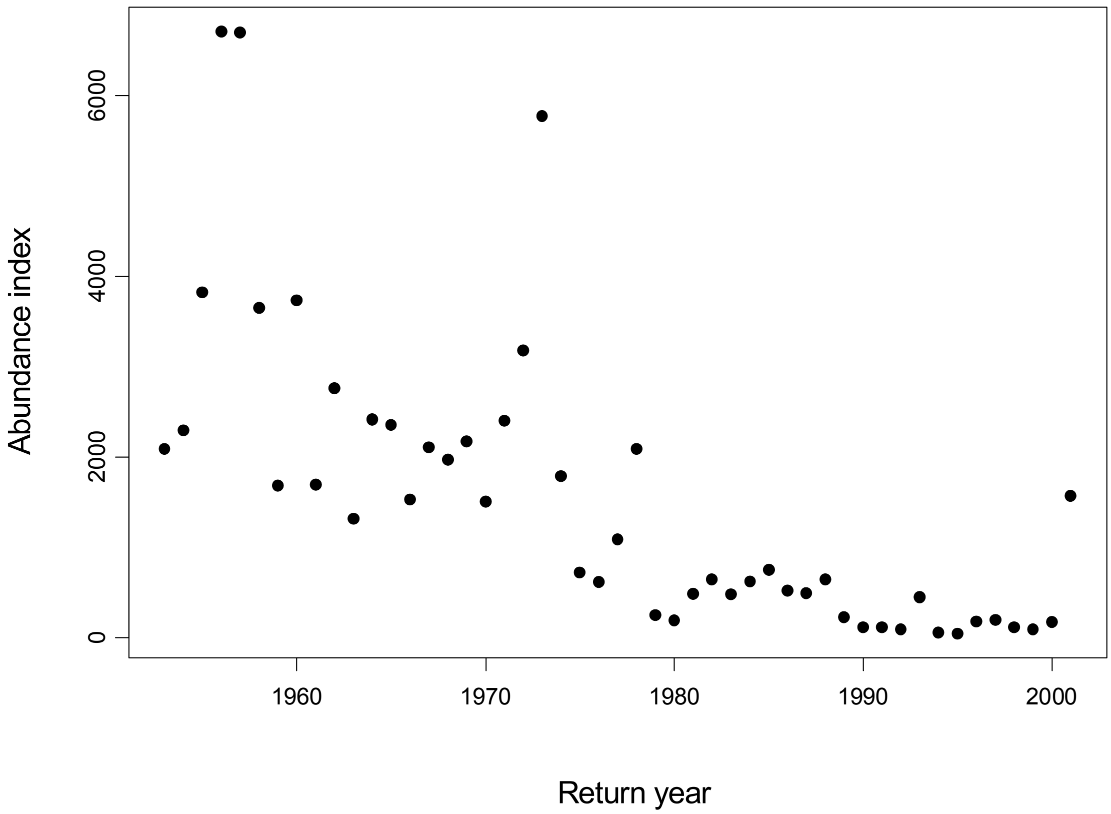

Figure 42. Abundance index (expanded redd counts adjusted for estimated Columbia River harvest) over time of Imnaha River mainstem spring/summer chinook salmon population.

Table 41. Summary of Pr($\hat{\mu}$ <0) estimated with available data series of spring/summer chinook salmon ESU and Imnaha populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6); n: the length of annual time series data; y1 and y2: the range of annual time series data; and DA risk: Pr($\hat{\mu}$ <0)).

Code	n	yr1	yr2	$E(\hat{\sigma}^2)$	$E(\hat{\mu})$	DA risk
ESU	20	1980	1999	0.020	-0.032	0.815
7	49	1953	2001	0.030	-0.054	0.982
6	39	1957	2001	0.045	-0.191	1.000

Table 42. Summary of integrated risk metric for spring/summer chinook salmon ESU and Imnaha subbasin populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6). The first row under the table header has results for the ESU, and the other rows have results for the populations; n: the length of data used for calculation of Pr($\hat{\mu}$ < 0); y1 and y2: the range

of annual time series data used for calculation of Pr($\hat{\mu}$ < 0); DA risk: Pr($\hat{\mu}$ < 0); m: the length of data used for calculation of Pr(*RVC*<1); α and β: shape and scale parameters in a Gamma density; p: p-value of K-S goodness of fit test for the Gamma density; RVC risk: Pr(*RVC*<1); and Integ. risk: Integrated risk metric.

Code	n	Yr1	yr2	$E(\hat{\sigma}^2)$	$E(\hat{\mu})$	DA risk	m	α	β	p	RVC risk	Integ. risk
ESU	20	1980	1999	0.020	-0.032	0.815	NA	NA	NA	NA	NA	NA
6	22	1980	2001	0.060	-0.209	1.000	NA	NA	NA	NA	NA	~ 1
7	22	1980	2001	0.050	0.005	0.466	24	1.701	0.641	0.21	0.559	0.261

The Big Sheep Creek population is currently considered to have too few individuals available to maintain its viability as a naturally reproducing population (USFS 2003d). Some managers consider populations approaching or less than 300 breeding adults to be in need of corrective strategies to bring the population into compliance with the *Wild Fish Management Policy* (Chilcote et al. 1992). NPT considers a minimum spawner abundance threshold of 500 required to support long-term population persistence in the Imnaha River subbasin (Jay Hesse, pers. Com). The interim recovery goal (NMFS 2002) is 2,500 natural-origin spawners. Assessment of goal achievement is based on an eight year geometric mean, which has not been met once during the last eight years.

Productivity and Survival

Imnaha River Subbasin spring/summer chinook salmon population productivity and survival should be characterized using the following key performance measures (see also RME section); progeny-per-parent ratio, juvenile recruit-per-spawner ratio, egg-to-emigrant survival rate, smolt-to-adult return rate, pre-spawn mortality, juvenile survival to Lower Granite Dam, in-hatchery life stage specific survival, and relative reproductive success between natural and hatchery-origin fish. Additional performance measures of; juvenile survival to all mainstem dams, ocean and Columbia River harvest rate, and post-release survival rate support calculation of derived performance measures characterizing population productivity and survival. Given the existence of a spring/summer chinook salmon hatchery program in the Imnaha River Subbasin, performance measures should characterize both natural and hatchery-origin aspects.

Progeny per parent ratio

Run reconstructions for Imnaha spring/summer chinook salmon have been derived from spawning ground surveys, age frequencies, mainstem and tributary harvest rates, and mainstem conversion rates for upstream passage of adults available from the 1940s to 1990 (Carmichael et al.1998). Each of the estimated performance measures used in run reconstruction have associated error (unknown and know). The progen-per-parent (P:P) ratios presented are based on point estimates only. Progeny-to-parent ratios for natural spawning spring/summer chinook salmon have been well below replacement for most brood years since 1983 and as low as 0.2 (Carmichael et al.1998; Figure 43).

Table 43. Mean ± coefficient of variation (and range) for spawners, recruits, and recruit per spawner numbers in aggregate and index populations of wild spring and summer chinook in the Imnaha subbasin (1949–1990). Values for recruits per spawner represent geometric means and standard deviations (coefficient of variation is standard deviation divided by the mean and expressed as a percentage) (reproduced from Beamesderfer et al. 1996).

Population	*N*[1]	Spawners	Recruits to Freshwater	Recruits per Spawner
Mainstem (1949–1990)	41	1,110 ± 69% (169–3,462)	2,845 ± 90% (125–10,720)[2]	2.0 ± 139% (0.3–16.3)
Big Sheep/Lick (1962–1990)	27	201 ± 93% (0–644)	349 ± 140% (0.0–1,895)[3]	0.9 ± 332% (0.0–13.7)

[1] Number of brood years for which data were collected

[2] Represents the maximum and minimum number of freshwater recruits over 41 years

[3] Represents the maximum and minimum number of freshwater recruits over 27 years

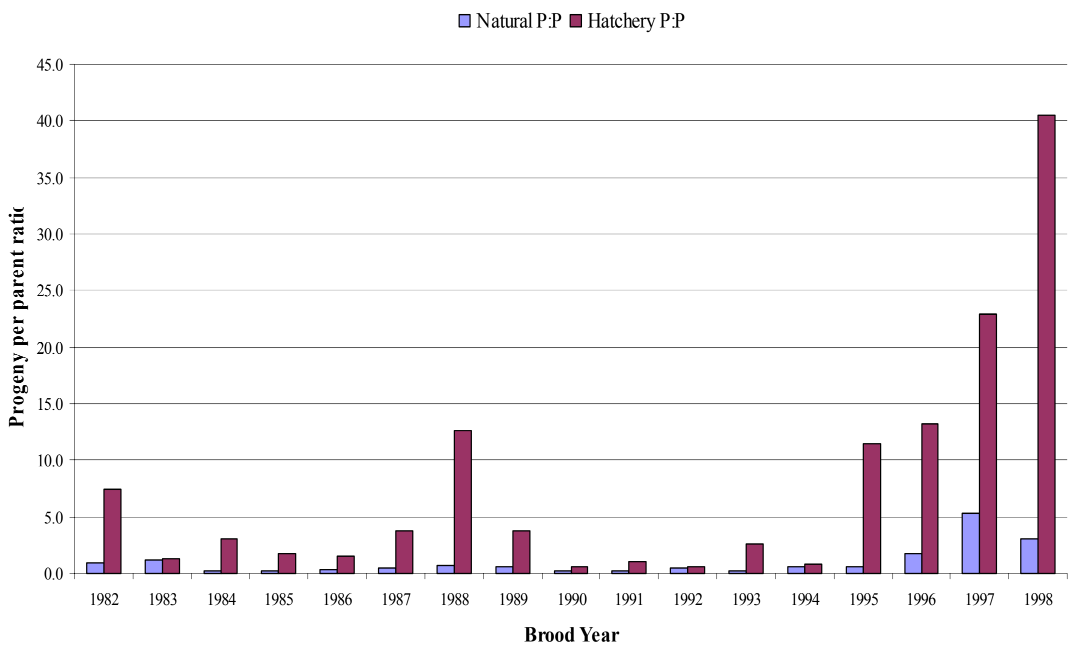

Figure 43. Annual progeny-parent ratio for natural and hatchery-origin chinook salmon in the Imnaha River Subbasin for brood years 1982 – 1998 (ODFW LaGrande data files P. Kinery)

Juvenile Recruit-per-Spawner

Direct assessment of juvenile recruit-per-spawner has not be accomplished in the Imnaha subbasin.

Egg-to-Emigrant Survival Rate

Egg-to-emigrant survival rate has not quantified for Imnaha River subbasin spring/summer chinook salmon. This represents a critical uncertainty (data gap).

Smolt-to-Adult Return Rate

Smolt-to-adult return rate (SAR) was calculated for two groups of PIT tagged juvenile natural-origin chinook salmon emigrants from the Imnaha River, for brood years 1996 to 1998 (Cleary et al. 2003). The two groups are represented by: 1) juvenile chinook salmon tagged during the fall of the year which emigrated past the lower Imnaha River trap (termed presmolts), and 2) chinook salmon smolts which emigrated past the lower Imnaha River trap during the spring (termed smolts). Estimated SAR's for these two groups represent in-river migrating fish (although a few smolts were inadvertently diverted to the transportation system) defined as those fish that were bypassed (C_1) or migrated by either spill or turbine routes (C_0). The estimated SAR provides a SAR index of inriver migrating Imnaha River chinook salmon. A season wide juvenile survival rate from the lower trap to Lower Granite Dam (LGR) for the life stage and migration year of interest was used to generate comparable estimated smolt equivalents at LGR, which was then used to estimate SAR's from LGR to LGR. The LGR to LGR SAR was calculated as it provides a more comparable SAR rate given life stage differences.

Natural-origin chinook salmon presmolts evidenced a higher LGR to LGR SAR index for all brood years examined when compared to smolts (Table 12). The LGR to LGR SAR index for fall tagged pre-smolts ranged from 2.41% to 3.08%. The LGR to LGR SAR index for spring tagged smolts ranged from 1.75% to 2.94% for the same brood years. The 1996 brood year pre-smolt SAR of 3.08% appeared substantially different from the smolt SAR of 1.75%. Observed differences between presmolt and smolt SAR indexes for brood years 1997 and 1998 were relatively small (0.17% - brood year 1997, and 0.04% - brood year 1998).

The observed SAR index for presmolt chinook salmon from the lower Imnaha River trap to LGR ranged from 1.00% to 1.86% for the three brood years examined (Figure 44, Table 44). The SAR index for smolts from the lower Imnaha River to LGR varied from 1.49% to 2.49%.

Ongoing attempts at defining hatchery-to-hatchery smolt-to-adult survival rates (SAR) adjusted for harvest have been made by DeHart et al. (2003). As part of the Comparative Survival Study (CSS) for upriver (above LGR) hatchery chinook, DeHart et al. (2003) is conducting a multi-year program to develop (among other objectives) a long-term index of survival rates from release of yearling chinook smolts at hatcheries to return of adults to hatcheries. Associated tasks include (1) partitioning survival rates from hatchery (smolts) to LGR (smolts); (2) partitioning survival rates from LGR (smolts) back to LGR (adults); and (3) partitioning survival rates from LGR (adults) back to the hatchery of origin (adults).

Estimated survival rates for hatchery smolts emigrating from the Imnaha to LGR are shown in Table 45. Survival rates from the Imnaha to Lower Granite have essentially remained similar for the period evaluated (1997-2000). Weighted SARs for LGR-to-LGR have improved during the evaluation period, and most notably during 1999-2000 (Table 45). Survival from LGR to the Imnaha hatchery was unavailable due to discrepancies between the SARs estimated from total production release and the PIT tag SARs (refer to DeHart et al. 2003 for a more complete discussion), but were estimated to be approximately 50% after accounting for harvest. Hatchery to hatchery SARs are shown in Figure 44.

Table 44. Detections of PIT tagged Imnaha River adult chinook salmon and estimated smolt to adult return rate indices (SAR) of in-river migrating fish from the lower Imnaha River trap to Lower Granite Dam (LGR) and from LGR to LGR for brood years 1996 to 1998. All pre-smolts were tagged in the fall and all smolts were tagged in the spring (Cleary et al. 2003).

Brood Year	Life Stage	Number PIT Tagged	Estimated Smolt Equivalents at LGR	Number of Adult Detections at LGR	Age at Return			SAR Trap to LGR (%)	SAR LGR to LGR (%)
					III	IV	V		
1996	Pre-Smolt	1,453	878	27	5	15	7	1.86	3.08
1997		2,000	830	20	3	16	1	1.00	2.41
1998		2,009	739	22	2	12	8	1.10	2.98
1996	Smolt	3,956	3,370	59	3	41	15	1.49	1.75
1997		5,306	4,696	105	8	69	28	1.98	2.24
1998		4,369	3,705	109	3	62	44	2.49	2.94

Table 45. Estimated number of chinook smolts at Lower Granite Dam and returning adults (age 4 and only) to Lower Granite Dam for Imnaha hatchery fish during migration years 1997-2000 (reproduced from DeHart et al. 2003).

Migr. Year	Hatchery Release	Survival: Hat-to-LGR (S_1)	Estimated # smolts at LGR (in 1000s)	Weighted LGR-to-LGR SAR[1]	Estimated # Adults at LGR
1997	50,911	0.581	30.8	0.0047	145
1998	93,108	0.685	63.8	0.0067	426
1999	184,725	0.664	122.7	0.0228	2,792
2000[2]	179,797	0.685	123.2	0.0230	2,834

1/ Weighted estimated LGR-to-LGR SARs are obtained by taking proportion of total population of smolts (tagged and untagged) at Lower Granite Dam in each study category (Study categories: T_0=transported hatchery chinook smolts; C_0= smolts that were never collected or bypassed at Snake River collector dams; C_1= smolts that were collected and bypassed at one or more Snake River collector) and multiplying by the respective study category's LGR-to-LGR SAR (refer to DeHart et al. 2003, Table 28, Chapter 2)

2/ Only 2-ocean returning adults were used in 2000 to match the hatchery rack PIT tag data available at the time of the study

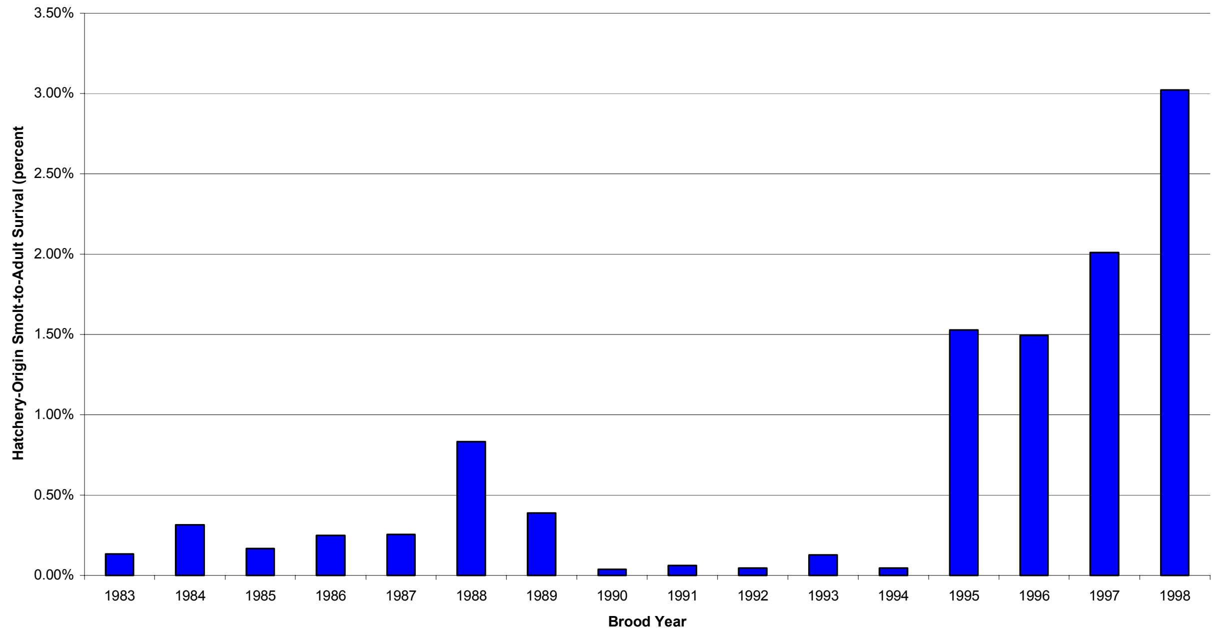

Figure 44. Imnaha River hatchery-origin spring/summer chinook salmon smolt-to-adult survival rate (release to tributary) by brood year. Estimates based on total number of smolts released and estimated number of returning adults at ages 3 to 5 (ODFW data files from P. Kinery).

Representative annual estimates of Imnaha Subbasin natural-origin chinook salmon smolt-to-adult survival estimates are lacking. These estimates require either emigrant abundance or representative PIT tagging along with tributary specific adult abundance.

Prespawning Mortality

Prespawning mortality has been monitored since 1987 (Figure 45); ranging from 0% to 32% (ODFW data files from P. Kinery). These estimates characterize only females during the spawning period. As such, comprehensive assessment of in-basin prespawn mortality is lacking.

Juvenile survival to Lower Granite Dam

Seasonwide estimates of juvenile chinook salmon (presmolt and smolt) survival from the mouth of the Imnaha River to Lower Granite Dam have been made since 1993 (Table 45; Cleary et al 2003 and Cleary et al in press). Survival estimates from emigrating presmolt to smolt at Lower Granite Dam have ranged from 25% to 61% (Figure 46). Survival estimates of spring emigrating natural chinook salmon have ranged from 76% in 1994 to 91% in 1995 (Figure 47). Survival estimates of hatchery chinook salmon smolts have ranged from 67% in 1994 to 80% in 1997 (Figure 48). Post release survival (release to mouth of the Imnaha River) has ranged from 88 to 100% (Figure 49). Representative trapping and tagging across the entire emigration period has not been conducted to date and represents a data gap. Representative trapping tagging across the spring seasonal periods has been maintained with the exception of high debris load periods.

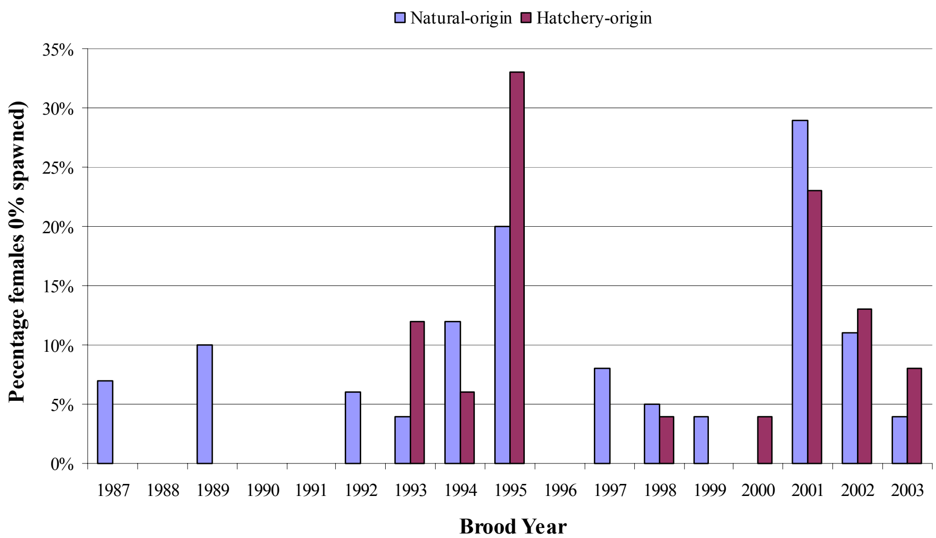

Figure 45. Annual prespawning mortality frequency for natural and hatchery-origin chinook salmon. Insufficient data for years 1990 and 1991 (ODFW LaGrande data files).

Table 46. Season-wide estimates of survival from the lower Imnaha River trap to Lower Granite Dam from 1993 to 2003. Ninety-five percent confidence intervals are shown in parentheses (Modified from Cleary et al. 2003; updated with NPT data files from P. Cleary).

Migration Year	Natural Chinook Salmon Survival (%)		Hatchery Chinook Salmon Survival (%)		Natural Steelhead Survival (%)		Hatchery Steelhead Survival (%)	
1993	80.9	(11.8)						
1994	76.2	(5.3)	67.1	(10.2)				
1995	90.9	(6.7)	72.1	(6.3)	83.7	(7.1)	77.5	(3.1)
1996	81.2	(5.3)	71.4	(9.4)	86.5	(3.9)	64.6	(4.7)
1997	89.5	(12.9)	80.4	(8.0)	90.1	(3.9)	81.4	(2.0)
1998	85.2	(2.0)	75.7	(3.1)	86.0	(2.2)	82.9	(2.3)
1999	88.5	(2.0)	71.6	(4.7)	87.7	(3.1)	85.4	(2.0)
2000	84.8	(2.3)	74.4	(4.3)	84.4	(2.7)	85.8	(2.4)
2001	83.7	(0.8)	80.3	(1.6)	82.7	(1.4)	82.0	(1.6)
2002	86.9	(4.4)	77.3	(4.4)	83.0	(5.4)	81.8	(3.5)
2003[1]	75.9	(2.3)	72.4	(6.8)	82.0	(2.5)	89.4	(3.3)

[1] Hatchery chinook salmon estimates based on the release of captured PIT tagged fish released from the chinook salmon acclimation facility.

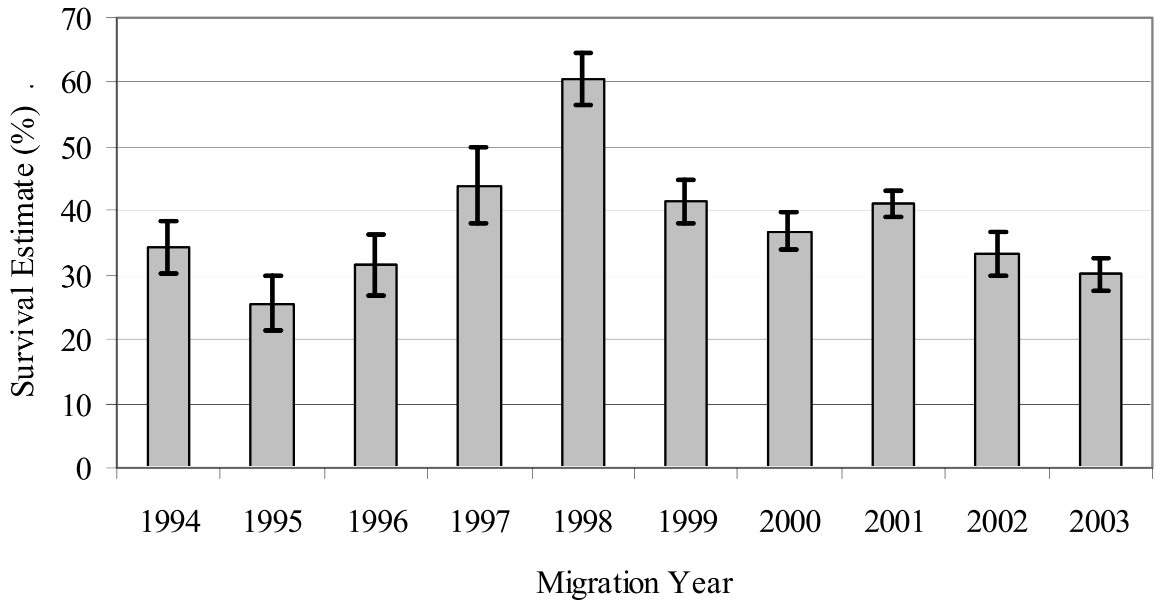

Figure 46. Estimated survival from the trap to Lower Granite Dam of natural chinook salmon pre-smolts, tagged in the fall, from for migration years 1994 to 2003 (Cleary et al 2003 and Cleary et al in press).

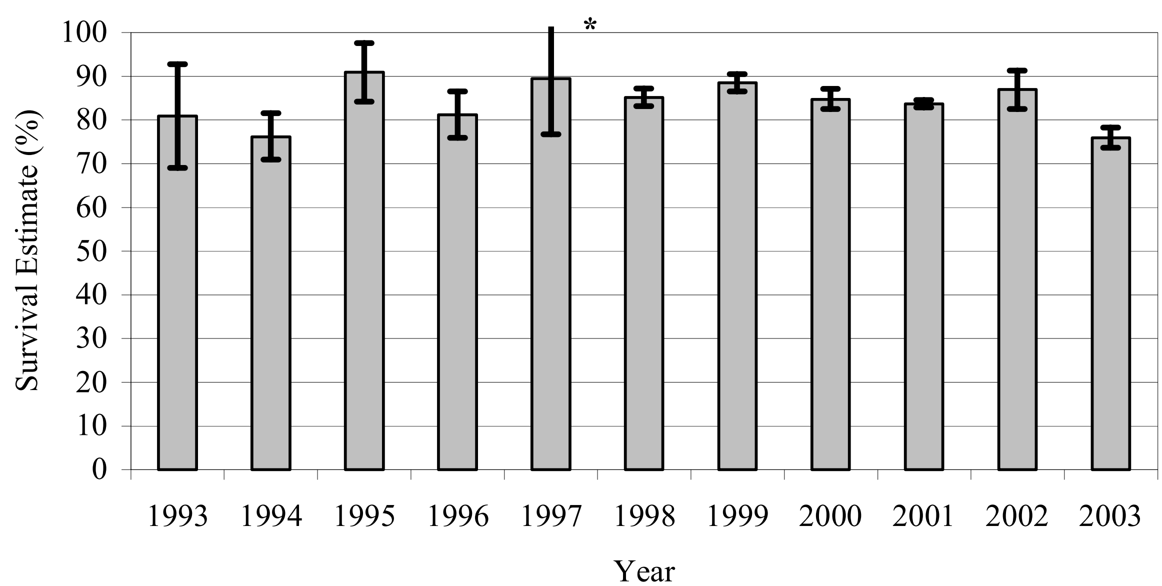

Figure 47. Seasonwide survival estimates for natural chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 2000. Error bars indicate 95% confidence limits. Asterisks indicate upper confidence levels greater than 100% (Cleary et al 2003 and Cleary et al in press)

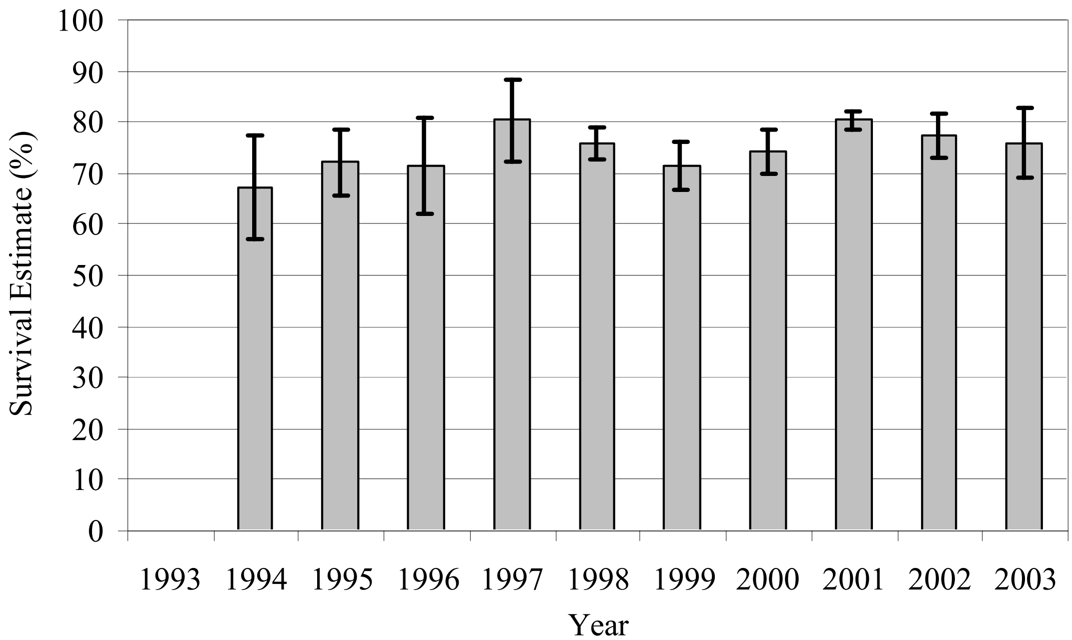

Figure 48. Seasonwide survival estimates for hatchery chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 1999. Error bars indicate 95% confidence limits (Cleary et al. 2003 and Cleary et al in prep)

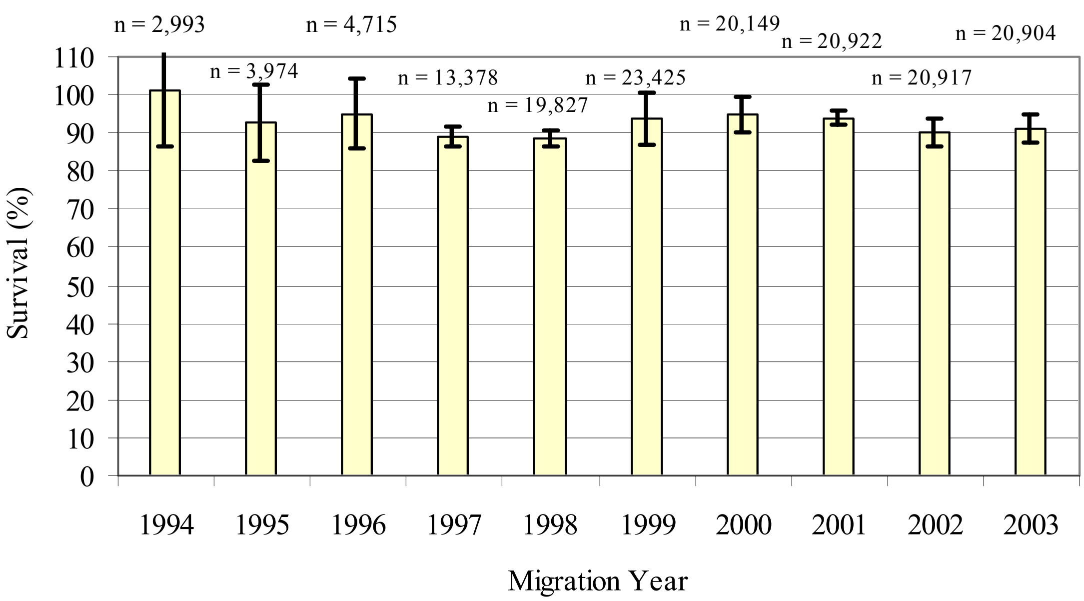

Figure 49. Annual survival of hatchery chinook salmon from the Imnaha River acclimation facility to the Imnaha River trap from 1994 to 2003. The size of annual PIT tag release groups are shown above for each year and error bars indicate the 95% C.I. (Cleary et al 2003 and Cleary et al in press).

In-hatchery Life Stage Specific Survival

In-hatchery life stage specific survival for Imnaha River spring/summer chinook salmon is monitored annually for green egg to eye-up, eye-up to smolt, and green egg to smolt survival rate. Green egg to eye-up survival has ranged from 61.7 to 97.6% and averaged 82.0% from 1983 through 2003. Eye-up to smolt survival has ranged from 66.6 to 99.7% and averaged 90.3% from 1983 through 2003. Green egg to smolt survival has ranged from 58.5 to 91.0% and averaged 73.2% from 1983 through 2003.

Table 47. Life stage specific abundance and survival for Imnaha River spring/summer chinook salmon hatchery production program 1982 – 2003 (ODFW LaGrande data files).

	Numbers			Survival		
Year	Egg take	Eyed Eggs	Smolts	% Egg to Eye	% Eye to Smolt	% Green to Smolt
1982			24,920	#DIV/0!	#DIV/0!	#DIV/0!
1983	163,862	125,000	115,830	0.763	0.927	0.707
1984	51,800	38,400	35,264	0.741	0.918	0.681
1985	156,721	126,728	123,530	0.809	0.975	0.788
1986	280,431	208,466	198,535	0.743	0.952	0.708
1987	187,395	142,683	142,320	0.761	0.997	0.759
1988	521,938	439,556	253,042	0.842	0.576	0.485
1989	412,008	402,000	267,670	0.976	0.666	0.650
1990	326,612	272,721	246,386	0.835	0.903	0.754
1991	193,206	165,384	157,659	0.856	0.953	0.816
1992	524,005	453,264	438,627	0.865	0.968	0.837
1993	1,047,064	1,011,464	873,115	0.966	0.863	0.834
1994	111,794	96,143	91,240	0.860	0.949	0.816
1995	68,121	52,658	50,911	0.773	0.967	0.747
1996	110,146	103,317	93,108	0.938	0.901	0.845
1997	282,823	206,744	184,725	0.731	0.893	0.653
1998	308,572	229,886	179,716	0.745	0.782	0.582
1999	168,930	128,725	123,014	0.762	0.956	0.728
2000	333,824	315,464	303,769	0.945	0.963	0.910
2001	459,276	283,373	268,510	0.617	0.948	0.585
2002		382,256	398,458		1.042	
2003	498,001	438,240	374,400	0.880	0.854	0.752
				0.820	**0.903**	**0.732**
					Averages	

*1988 - unusual smolt number based on eyed eggs
*1993 - smolts (590,069) plus parr (283,046)
*2003 - estimated smolt release in 2005

Relative Reproductive Success

Direct assessment of relative reproductive success of hatchery and natural-origin Imnaha River subbasin spring/summer chinook salmon has not been quantified to date.

Life History and Genetic Diversity

Imnaha subbasin spring/summer chinook salmon population diversity should be characterized using the following key performance measures (see also RME section); adult spawner distribution, juvenile rearing distribution, genetic diversity, age-at-return, age-at-emigration, adult run timing, and spawn-timing. Additional performance measures of; stray rate, disease frequency, age class structure, size-at-return, size-at-emigration, condition factor of juveniles, adult spawner sex ratio, fecundity by age, juvenile emigration timing, and mainstem arrival timing support calculation of derived performance measures further characterizing population diversity.

Adult Migration

After residing in the Pacific Ocean for two to four years, adult spring/summer chinook salmon enter the Columbia River from February through May. They proceed up the Columbia 522 kilometers (324 miles), enter the Snake River during the spring and proceed upriver an additional 308 kilometers (191 miles), then enter the Imnaha River between late May and early July (Table 48) where they generally will have another 74 kilometers (46 miles) to navigate prior to reaching the fish weir that diverts them to a temporary holding area. Total distance traveled is 904 kilometers (about 562 miles) from the ocean. Peak migration into the upper portion of the subbasin generally occurs during June through the first part of July (Table 49). Annual age-class structure for natural-origin chinook salmon has averaged 5% 1-ocean (jacks), 53% 2-ocean, and 42% 3-ocean from 1987 to 2000 (ODFW LaGrande data files). Less than one percent of the mature adults have been comprised of 4-ocean age fish during this period. Observations of precocial (yearling) males spawning have occurred, but have yet to be quantified. Hatchery-origin age class structure annually has averaged 11% 1-ocean (jacks), 62% 2-ocean, and 26% 3-ocean (ODFW LaGrande data files). Maintaining representative age-at-return from historic conditions has been identified as a challenge with the ongoing hatchery program.

Adult Holding

Spring/summer chinook typically use the upper-third of the mainstem and Big Sheep Creek below Lick Creek for holding (Ashe et al. 2000), but may use the lower portion of the river as well. Those that occupy the mainstem below Big Sheep Creek will hold based on temperature suitability (Table 48), while those that rely on habitat in the upper subbasin hold from June through the end of August (Table 49). Channelization has adversely affected some holding areas in Big Sheep Creek (i.e., from Carol Creek to Coyote Creek and from Muley Creek to the mouth of Big Sheep Creek), but habitat is generally good in the upper reaches (Ashe et al. 2000).

Table 48. Life history timing for anadromous focal species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Upstream Adult Migration																								
Summer steelhead			lesser	1 peak	1 peak	peak	peak	lesser	lesser								lesser	lesser	lesser	1 lesser	1 lesser	lesser		
Spring/summer chinook salmon								lesser	lesser	1 peak	1 peak	1 peak	1 peak	1 lesser	1 lesser	1 lesser	1 lesser							
Fall chinook salmon																		lesser	lesser	peak	1 peak	peak	lesser	presence
Adult Spawning																								
Summer steelhead						1 lesser	1 lesser	1 peak	1 peak	peak	peak													
Spring/summer chinook salmon																								
Fall chinook salmon																				lesser	peak	1 peak	lesser	lesser
Adult Holding																								
Summer steelhead	1 peak	1 peak	1 peak	1 peak	1 peak	lesser	lesser	lesser										lesser	lesser	1 peak	1 peak	1 peak	1 peak	1 peak
Spring/summer chinook salmon								lesser	1 peak	1 peak	1 peak	1 peak	1 peak	1 peak	1 peak	lesser	lesser							
Fall chinook salmon																								
Egg Incubation through Fry Emergence																								
Summer steelhead						lesser	lesser	1 peak	1 peak	1 peak	1 peak	1 peak	1 peak	lesser										
Spring/summer chinook salmon																								
Fall chinook salmon	peak	peak	peak	peak	peak	peak	lesser	lesser	lesser	lesser	lesser	lesser								lesser	peak	peak	peak	peak
Juvenile Rearing																								
Summer steelhead	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	presence	presence	presence	presence	presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence
Spring/summer chinook salmon	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence	1 presence
Fall chinook salmon				presence	presence	presence	presence	presence	presence	presence	presence	presence	presence											
Downstream Juvenile Migration																								
Summer steelhead	lesser	lesser	lesser	lesser	lesser	1 lesser	1 lesser	1 peak	1 peak	1 lesser	1 lesser	lesser						lesser	lesser	lesser	lesser	lesser	lesser	lesser
Spring/summer chinook salmon				peak	1 peak	1 peak	1 peak	1 peak	1 peak	1 lesser	1 lesser	lesser	lesser	lesser	lesser	lesser	lesser	lesser	lesser	lesser	lesser	lesser		
Fall chinook salmon										presence	presence	presence	presence											

(peak) Represents periods of peak[1] use based on professional opinion.
(lesser) Represents lesser[2] level of use based on professional opinion.
(presence) Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

[1] Based on professional opinion, peak use equates to 70% of life stage activity occurring in this time frame.
[2] Based on professional opinion, lesser use equates to 30% of life stage activity occurring in this time frame.

Table 49. Life history timing for anadromous focal species in the Imnaha subbasin, upriver from the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Upstream Adult Migration																								
Summer steelhead			1	1																				
Spring/summer chinook salmon											1	1	1	1		1	1							
Adult Spawning																								
Summer steelhead						1	1																	
Spring/summer chinook salmon														1	1	1	1	1						
Adult Holding																								
Summer steelhead			1	1	1																			
Spring/summer chinook salmon											1	1	1	1	1									
Egg Incubation through Fry Emergence																								
Summer steelhead								1	1	1	1	1	1											
Spring/summer chinook salmon	1	1	1	1	1											1	1	1	1	1	1	1	1	1
Juvenile Rearing																								
Summer steelhead	1	1	1	1	1	1						1	1	1	1	1	1	1	1	1	1	1	1	1
Spring/summer chinook salmon	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Downstream Juvenile Migration																								
Summer steelhead						1	1	1	1	1	1													
Spring/summer chinook salmon										1														

Represents periods of peak use based on professional opinion.

Represents lesser level of use based on professional opinion.

Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

[1] Peak use equates to 70% of life stage activity occurring in this time frame.

[2] Lesser use equates to 30% of life stage activity occurring in this time frame.

Spawning

Peak spawning for spring chinook is in the late summer, occurring usually in late August to early September (Ashe et al. 2000) (Table 49). Spawning ground surveys conducted by the Oregon Fish Commission established peak spawning in the Imnaha slightly prior to August 24, although peaks may occur earlier or later depending on the run year (Thompson and Haas 1960). More recent (1986–1989) surveys validate the spawn timing findings documented by the Oregon Fish Commission.

Adult Spawner Distribution

The Interior Columbia Technical Recovery Team(TRT; 2003) defines the core spawning area for mainstem Imnaha spring/summer chinook (IRMAI) to occur from the Blue Hole (RM 69) downstream to Grouse Creek (RM 34.7; Figure 50). Others contend that the primary spawning area is slightly smaller, occurring between Summit Creek (RM 37.5) and the Blue Hole (Mundy and Witty 1998). Mainstem chinook spawning has been documented as far downstream as Freezeout Creek (RM 29.4) and as far upstream as Imnaha Falls (RM 73). Fewer numbers of fish spawn in primary tributaries, including the South Fork Imnaha, Big Sheep Creek and Lick Creek. Although spawning has been observed in the South Fork Imnaha, it is not known if it occurs on an annual basis.

The core spawning area defined by the TRT for the Big Sheep Creek (IRBSH) population occurs from the Road 39-140 Bridge to Coyote Creek, and the lower 3 miles of Lick Creek (Figure 50). ODFW has defined spawning locations in the lower 4.5 miles of Lick Creek and has observed spawning activity lower in the mainstem Big Sheep during years with lower temperatures and higher flows (B. Knox, ODFW, personal communication, February, 2004). There are reports stating that spring/summer chinook may have historically spawned further downstream than currently (Freezeout Creek to Keeler Creek), 1.5 miles further upstream on Big Sheep Creek, and 0.6 mile further upstream on Middle Fork Big Sheep Creek (USFS 2003d).

Incubation

Based on research conducted by the USFWS at Ollokot Campground (RM 48.5) in 1987 and 1988, spring chinook eggs deposited in early August would result in emergence of free-feeding fry in early to mid-November (Mundy and Witty 1998). Eggs deposited by fish in mid-August would emerge in mid-April; eggs deposited in early September would emerge in late May; and eggs deposited in mid-September would emerge in mid-June. It is important to note, however, that the research was based exclusively on water temperature data and standard thermal units used in fish culture, and that one should assume natural conditions to be much more variable. According to ODFW, spring chinook incubation may last as long as 7 months after the fish spawn because much of the spawning habitat is iced over from November to March.

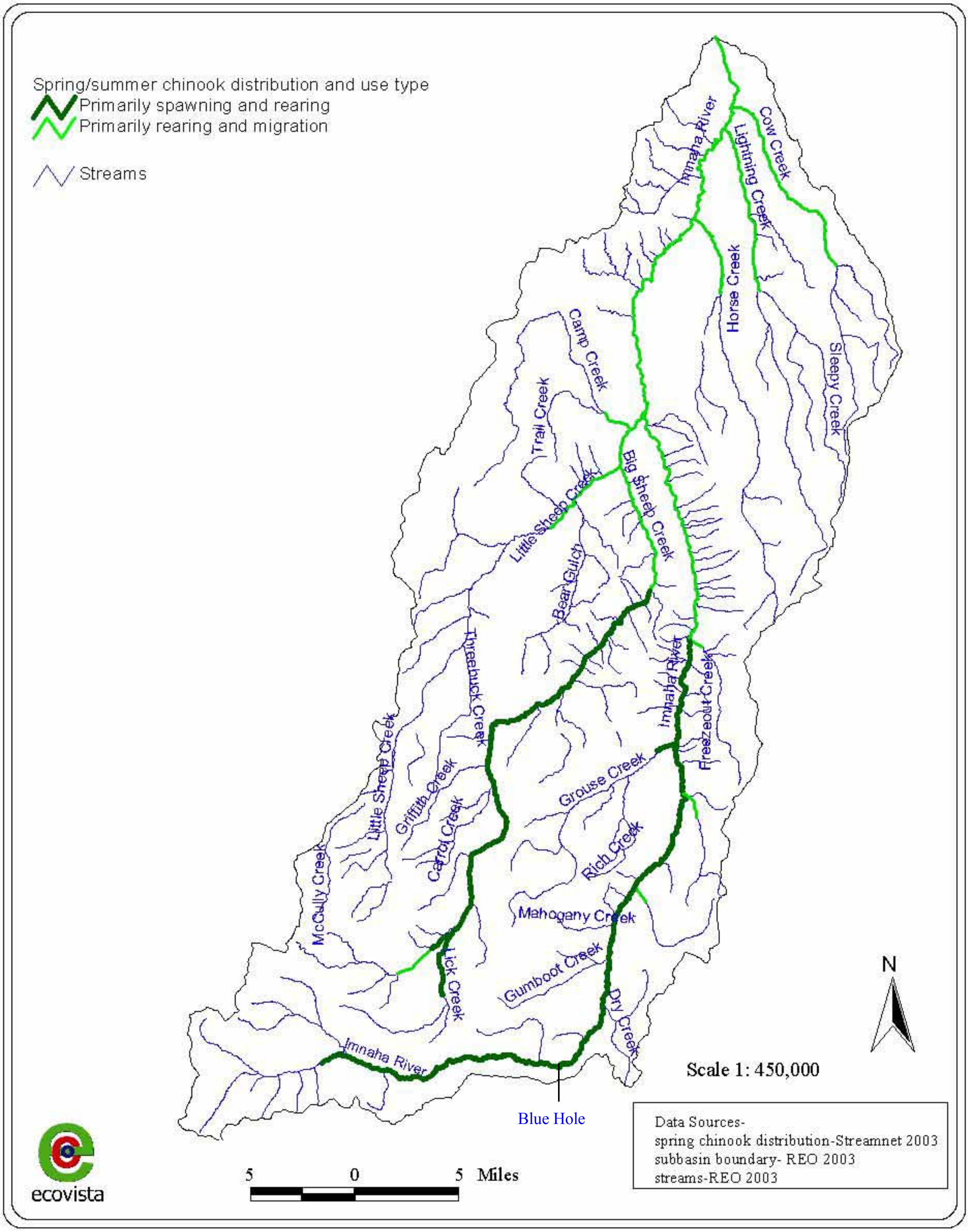

Figure 50. Spawning and rearing locations of Imnaha spring/summer chinook.

Juvenile Rearing Distribution

Prior to their emigration in April, parr and pre-smolts will distribute throughout Big Sheep Creek and the upper, middle and lower Imnaha, and Snake River from September through February (Schwartzberg et al. in prep; Ashe et al. 2000). Juvenile chinook use portions of the mainstem for rearing, but are also present in lower Cow, lower Lightning, lower Horse, Big Sheep, and Lick Creeks (Gaumer 1968; Huntington 1994), and are suspected to use the lower reaches of Skookum (RM 53.7), Gumboot (RM 46.8), Mahogany (RM 45.0), Crazyman (RM 42.8), Summit (RM 37.5), Grouse (RM 34.7), and Freezeout creeks (RM 29.4) (Mundy and Witty 1998). Gaumer (1968) documented some movement of fry and small parr into the lower Imnaha and lower Big Sheep Creek during spring months; however, Gaumer also determined that the peak movement of parr into lower Big Sheep Creek occurred in November, while peak movement into the lower Imnaha occurred during October and November. The fact that little or no movement of juvenile fish occurred during summer months could be due to elevated water temperatures from July into September (Ashe et al. 2000), which also coincides with peak water withdrawals by irrigation diversions in upper portions of Big and Little Sheep Creek. Similar to adults, spring chinook juveniles may have reared further downstream in the mainstem Imnaha and used more tributary habitat than they currently do, yet evidence documenting their historical distribution is unavailable (USFS 2003d).

Smolt Migration

As shown in Table 48, peak emigration of spring chinook residing in the mainstem Imnaha below Big Sheep Creek initiates in late February and extends through early May, whereas fish residing in the upper portion of the subbasin don't exhibit peak downstream migration until April (Table 49). The movement of fish to the lower subbasin in the fall is considered to represent more of a redistribution of fish rather than a true downstream migration, which helps explain why there's juvenile migration without spawning in this area and why downstream migration initiates sooner than it does in the upper subbasin (B. Knox, ODFW, personal communication, May 2003).

Length-at-smolt data are provided in Ashe (et al. 1995), Blenden (et al. 1996, 1997, 1998) and Cleary et al. (2000 and 2003). Natural chinook salmon captured during the spring of 2000 averaged 110 mm in fork length, 14.1 grams, with a condition factor of 1.05 (Table 50). Median fork lengths for natural chinook salmon have been significantly smaller ($p < 0.05$) than median fork lengths for hatchery chinook salmon. In 2000, hatchery chinook salmon averaged 132 mm in fork length and weighed an average of 26.7 grams, with a condition factor of 1.15 (Cleary et al. 2000).

Table 50. Mean lengths, weights, and condition factors of natural and hatchery chinook salmon captured from the Imnaha River trap (RM 4) from February 26 to June 15, 2000 (Cleary et al. 2000).

Statistic	Natural	Hatchery
Mean Fork Length (mm)	110	132
Sample Size	4,330	2,399
Range	69–150	101–219
Standard Deviation	9.5	9.6

Statistic	Natural	Hatchery
Mean Weight (g)	14.1	26.7
Sample Size	4,065	1,989
Range	4.1–35.3	10.8–94.1
Standard Deviation	3.83	6.8
Mean Condition Factor (*K*)	1.05	1.15
Sample Size	4,042	1,976
Range	0.71–1.69	0.63–1.69
Standard Deviation	0.08	0.07

Out-of-Basin Distribution

Arrival timing of Imnaha subbasin natural and hatchery-origin chinook smolts at Snake River dams has been documented since 1992. Overall, downstream movement of Imnaha chinook to the lower four Snake River dams, appears to be earlier than for other Snake River Basin populations (Mundy and Witty 1998; Ashe et al. 2000).

The NPT has collected five to ten years of arrival timing data for natural and hatchery chinook salmon and steelhead from the Imnaha River (Table 51; Cleary et al. 2003 and in prep.). The annual first, median, 90%, and last arrival times were averaged for future modeling. Ninety five percent confidence intervals for arrival times are presented in parenthesis in the remainder of this section. The mean arrival timing range for natural chinook salmon pre-smolts from 1998 to 2003 at Lower Granite Dam (LGR) is from March 31 (± 8 days) to May 16 (± 19 days), with mean median and 90% arrival timing of April 17 (± 9 days) and May 2 (± 27 days), respectively. Mean median arrival times at Lower Granite Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN) for natural chinook salmon pre-smolts are April 24 (± 11 days), April 27 (± 17 days), and May 1 (± 17 days), respectively. Mean 90% arrival timing for natural chinook salmon pre-smolts was May 1 (± 12 days) at LGO, May 5 (± 17 days) at LMO, and May 8 (± 15 days) at MCN.

Natural chinook salmon smolts mean arrival times at LGR from 1993 to 2003 are as follows: mean arrival time range of April 5 (± 15 days) to July 1 (± 56 days), mean median arrival time of April 28 (± 9 days), and mean 90% arrival of May 14 (± 11 days). Mean median arrival times at LGO, LMO, and MCN for natural chinook salmon smolts are May 1 (± 8 days), May 5 (± 13 days), and May 9 (± 11 days). Mean 90% arrival timing is May 14 (± 18 days) at LGO, May 22 (± 15 days) at LMO, and May 22 (± 12 days) at MCN.

Mean arrival timing of hatchery chinook salmon smolts from 1992 to 2003 represents the PIT tagged hatchery chinook salmon used to estimate the survival from the trap to LGR, LMO, and MCN. Mean arrival ranges are April 12 (± 13 days) to May 26 (± 12 days) at LGR, April 20 (± 10 days) to May 31 (± 12 days) at LGO, April 25 (± 6 days) to June 2 (± 13 days) at LMO, and April 29 (± 11 days) to June 1 (± 13 days) at MCN. Mean median arrival timing is as follows: May 3 (± 10 days) at LGR, May 8 (± 9 days) at LGO, May 12 (± 7 days) at LMO, and May 14 (± 8 days) at MCN. Mean 90% arrival timing from 1992 to 2003 is as follows: May 13 (± 7 days), May 17 (± 10 days), May 21 (± 6 days), and May 22 (± 6 days), at LGR, LGO, LMO, and MCN, respectively.

Table 51. Mean first, median, 90%, and last arrival timing for natural chinook salmon presmolts and smolts, and hatchery chinook salmon smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (± days) (Cleary et al. in prep).

Rearing, Species, Life Stage, Dam	First Arrival		Median Arrival		90% Arrival		Last Arrival	
	Mean	(± days)	Mean	(± days)	Mean	(± days)	Mean	(± days)
Natural Chinook Salmon Pre-Smolts (1998 to 2003)[1]								
LGR	31-Mar	(8)	17-Apr	(9)	2-May	(27)	16-May	(19)
LGO	11-Apr	(14)	24-Apr	(11)	1-May	(12)	18-May	(28)
LMO	19-Apr	(16)	27-Apr	(17)	5-May	(17)	19-May	(18)
MCN	20-Apr	(16)	1-May	(17)	8-May	(15)	17-May	(15)
Natural Chinook Salmon Smolts (1993 to 2003)								
LGR	5-Apr	(15)	28-Apr	(9)	14-May	(11)	1-Jul	(56)
LGO	15-Apr	(10)	1-May	(8)	14-May	(18)	1-Jul	(48)
LMO	21-Apr	(13)	5-May	(13)	22-May	(15)	2-Jul	(49)
MCN	20-Apr	(14)	9-May	(11)	22-May	(12)	18-Jun	(35)
Hatchery Chinook Salmon Smolts (1992 to 2003)								
LGR	12-Apr	(13)	3-May	(10)	13-May	(7)	26-May	(12)
LGO	20-Apr	(10)	8-May	(9)	17-May	(10)	31-May	(12)
LMO	25-Apr	(6)	12-May	(7)	21-May	(6)	2-Jun	(13)
MCN	29-Apr	(11)	14-May	(8)	22-May	(6)	1-Jun	(13)

[1] Median and 90% arrival timing does not include data from migration year 2001 due to the sample size.
[2] Median and 90% arrival timing does not include data from migration year 2002 due to the sample size.

The data in Table 51 is the cumulation of 10 years of emigration studies in the Imnaha River. It provides a baseline for evaluating the performance of hatchery produced fish and the effects of hatchery production on natural populations. There is a lot of variation in the data but it does show that the hatchery produced fish for the Imnaha River arrive at LGR, LGO, LMO, and MCN at times similar to naturally produced fish but that hatchery fish consistently tend to arrive later. However, these differences are within days and are probably not statistically or biologically different given the 95% confidence intervals.

Carrying Capacity

No information currently exists on spring/summer chinook carrying capacity in the Imnaha subbasin. By all accounts the subbasin remains underseeded. Technical Advisory Committee has described that the resource managers agree the natural environment has been significantly under-seeded for the past thirty years (LeFleur, 2000).

Spring chinook carrying capacity in the Imnaha subbasin has been estimated by the Northwest Power and Conservation Council (NPPC 1990) via the Smolt Density Model (SDM). Although estimates are considered subjective (B. Knox, ODFW, personal communication, February, 2004), the total estimated smolt capacity in the Imnaha is 1,154,499 fish. Carmichael and Boyce (1986) estimated spawning ground capacity for adult chinook salmon to be 3,821.

Genetic Integrity—Unique Population Units

Imnaha River spring chinook appear to be a genetically distinct population from other Snake River fish. In 1989 and 1990, samples of subyearling chinook were taken from the Salmon, Grande Ronde, and Imnaha subbasins and electroporetically analyzed for genetic differences in enzymatic frequencies associated with 35 loci (Waples et al. 1993). Results from the analysis indicate that Imnaha fish initially grouped with natural populations from the Grande Ronde subbasin before grouping with fish from the Salmon subbasin, and upon further definition, differed significantly from both Grande Ronde and Salmon populations (Waples et al. 1993). Waples (et al. 1993) further established that Imnaha River hatchery-produced chinook were genetically similar to naturally produced fish, a fact due in large part to the substantial degree of integration of the hatchery and natural components of the Imnaha population. Similar findings are presented in the Interior Columbia Basin Technical Recovery Team (TRT; 2003) stating that hatchery and wild collections from the mainstem Imnaha River were genetically indistinguishable.

The TRT identifies two independent populations of spring chinook in the subbasin; the Imnaha mainstem (IRMAI) and Big Sheep Creek (IRBSH). Genetic samples from the IRMAI mainstem Imnaha population fell within the cluster containing most of the Grande Ronde collections, and were distinct from all other populations (TRT 2003). Geographical distance between primary spawning areas (48 km) distinguishes Imnaha mainstem fish from Big Sheep Creek fish, as does the historically poor demographic correlation between the groups. The Big Sheep Creek population is considered to be functionally extirpated based on (1) limited natural escapement since 1982 (see index area redd count figures 40 and 41; 0 to 6 redds annually from 1992 to 1996); and (2) outplanting of surplus hatchery origin adults into Big Sheep and Lick creeks (1993, 1997, 2000-2003). Hatchery management actions are implemented as if a single population.

1.2.3.2 Spring/summer Chinook Harvest

Current In-Basin Harvest

Spring chinook harvest in the Imnaha has fluctuated over the years, as shown in Table 52. Sport harvest restrictions were first imposed by the State of Oregon on spring chinook anglers in 1916, where the daily bag limit was set at 50 pounds of chinook per day (Mundy and Witty 1998). This limit was reduced to 20 pounds per day in 1925 and eventually reduced to two fish or ten jacks per day at the close of the fishing season in 1978 (Ashe et al. 2000).

Accompanying bag limits were restrictions on season of harvest and location of harvest. Fishing was prohibited above Grouse Creek circa 1944–1954 in an effort to protect spawning chinook. The upper boundary gradually moved downstream to Freezeout Creek, restricting anglers to waters below Freezeout Creek Bridge. Between 1974 and 1979, the sport-fishing season was closed three times due to declines in adult returns (Table 52). Sport harvest for Imnaha River spring chinook was closed for the better part of the past ten years, but was opened in 2001 - 2003. Estimated sport and tribal harvest was 335 chinook in 2001 and 395 in 2002, and 332 in 2003.

Table 52. Historical sport and tribal harvest of Imnaha River chinook salmon between 1953 and 2003 (Beamesderfer et al. 1996; B. Knox, ODFW, personal communication, April 2003; J. Oatman , NPT, personal communication, April 2004).

Year	Sport	Tribal	Total	Year	Sport	Tribal	Total
1953	149	149	298	1972	17	17	34
1954	15	15	30	1973	107	107	214
1955	20	20	39	1974	Closed	0	0
1956	21	21	41	1975	Closed	0	0
1957	187	187	374	1976	Closed	0	0
1958	117	117	234	1977	44	44	88
1959	168	168	336	1978	Closed	0	0
1960	201	201	402	1979	Closed	0	0
1961	42	42	84	1980	Closed	0	0
1962	9	9	18	1981	Closed	0	0
1963	14	14	28	1982	Closed	0	0
1964	0	0	0	1983	Closed	0	0
1965	3	3	6	1984	Closed	0	0
1966	24	24	49	1985	Closed	0	0
1967	10	10	21	1986	Closed	0	0
1968	61	61	121	1987	Closed	0	0
1969	9	9	19	1988–2000	Closed	0	0
1970	4	4	7	2001	302	33	335
1971	19	19	37	2002	152	243	395
				2003	125	207	332

1.2.3.3 Spring/summer Chinook Hatchery Program

(The following discussion is taken from USFWS 2001 where not otherwise specified).

Historical artificial production of spring/summer chinook in the Imnaha subbasin dates back to 1949 when the Oregon Game Commission initiated a spring/summer chinook egg-take program in an effort to supplement Imnaha chinook into the Umpqua subbasin in southwest Oregon (Ashe et al. 2000). Between July and August 1951, 152 male and 6 female chinook were collected from spawning beds in the mainstem Imnaha and from a weir constructed at Coverdale (Mundy and Witty 1998). Fifteen years later, 119 adult spring/summer chinook collected from Hells Canyon Dam were outplanted into the Imnaha (Neeley et al. 1993). In 1976, Congress authorized the production of hatchery spring/summer chinook under the auspices of the *Lower Snake River Compensation Plan* (LSRCP; Ashe et al. 2000). The LSRCP was initiated in the Imnaha subbasin in 1982. The first releases of hatchery-produced juvenile spring/summer chinook occurred in 1984.

The authorized purpose of the LSRCP program is to provide adult return compensation for Snake River dams. And while the Northeast Oregon Hatchery program is still being operated as a mitigation program with production goals designed to provide for tribal, sport, and commercial harvest, its current management emphasis is for spring/summer chinook population recovery and genetic conservation. The Federal salmon recovery strategy (Conservation of Columbia Basin Fish, Final Basinwide Salmon Recovery Strategy, Dec 2000) specifically states "the overarching goal……is to reduce or eliminate adverse genetic, ecological, and management effects of artificial production on natural production while retaining and enhancing the potential of hatcheries to contribute to basin wide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also incorporate an increased emphasis on conservation and recovery…..".

Current production goals are the same as when it was a mitigation program and all returning adults are released to spawn in the basin – some in the Imnaha and some in Big Sheep and Lick Creeks. The current program is operated under section 10 ESA permit authorization and Nez Perce Tribe/ODFW co-management agreement.

The LSRCP supplementation program was initiated using only adult salmon returning to the Imnaha River and each year naturally produced fish are incorporated into the hatchery broodstock (NPT et al. 1990). Until recently, two facilities were used for the chinook production program; the Imnaha River satellite facility (located near Gumboot Creek) for adult collection, adult holding, and smolt acclimation, and Lookingglass Fish Hatchery (LFH) for incubation and rearing of juveniles. The LFH, operated by the ODFW, was originally designed to produce 1.4 million spring/summer chinook salmon smolts weighing 69,000 pounds; however, based on recent agreements between co-managing entities, the facility has reduced its fish rearing densities.

Adults collected at the Imnaha weir are held or transported to LFH, where they are held and spawned. The weir and associated acclimation pond is an adult trapping facility and juvenile acclimation facility (respectively) operated by ODFW on the mainstem Imnaha (RM 46). The weir is normally placed in the Imnaha River after flows recede to the point that anchors and weir sections can be installed without them washing out (DeHart et al. 2003). The timing of the weir installation may contribute to some uncertainty regarding adult escapement assessment, as up to 40% of the chinook run could pass upstream prior to its installation (DeHart et al. 2003).

LFH was designed to serve as the incubation and rearing facility; however, because of substantial changes to the original program which resulted in the need to incubate listed fish on treated (or disease free) water, facility limitations (i.e. lack of chilled well water), equipment failure, and malfunction at Lookingglass Hatchery all eggs are currently shipped to Oxbow Fish Hatchery (near Bonneville Dam) or Irrigon Fish Hatchery for incubation and early rearing of juveniles. Following rearing for about five months, juveniles are transported back to LFH for another 9 months before smolts are transported back to the acclimation facility, where they are held for one month prior to release in April. Exceptions to releases of fish from the acclimation facility or directly into the mainstem Imnaha occurred in 1987 when Imnaha smolts were released at LFH because of disease concerns, in 1990 when smolts were also released in Big Sheep Creek, and in 1994 when pre-smolts were released in Big Sheep Creek, Little Sheep Creek, and the Imnaha River (Beamesderfer et al. 1996).

Wild chinook adults were initially collected for broodstock beginning in 1982. Wild fish comprised the majority of the broodstock until 1989 when significant numbers of hatchery fish began to return. Currently, hatchery and natural fish are used for broodstock each year. Broodstock management is guided by a sliding scale management plan that places emphasis on minimizing demographic risk at escapement levels below a minimum adult spawner escapement threshold and minimizing genetic risk of the hatchery program at escapement levels above threshold. The TRT (2003) states that the IRMAI chinook population has a 'genetic affinity to locally-derived broodstock', whereas there is no genetic evidence of hatchery introgression in the IRBSH population. To date, the co-managers have used the sliding scale guidelines for broodstock collection and have implemented constraints on hatchery fish spawning in the wild through harvest and adult outplanting into Big Sheep and Lick creeks.

Life history and genetic characteristics are similar for hatchery and natural fish, with the exception of age composition at return. Hatchery fish return a greater proportion of age 3 males and fewer age 5 fish. Progeny-to-parent ratios for natural fish have been below replacement (1.0) throughout most of the eighties and nineties, but recent (last 3-4 years) have been above 1.0. The ratio for hatchery fish has been above 1.0 in most years and has averaged 4.0. Model results indicated that presently a greater number of total fish and natural spawners return to the basin, which is attributable to the hatchery program. . Comanagers have made a substantial number of adaptive management changes to improve the program including reduced emphasis on smolt production goals and increased emphasis on genetic conservation, gene banking, implementation of sliding scale management plan, aggressive fish health protection, low density rearing, and more natural smolt size-at-release (25/lb.).

Smolt production levels have been highly variable and typically well below the goal of 490,000 because of the abundance of natural fish, broodstock management criteria, and hatchery facility constraints (Table 53). Currently smolt production has been reduced by 25% due to the facility limitations at Lookingglass FH. Smolt-to-adult survival rates have been below the goal of 0.65% with a maximum value of 0.58% for the 1988 brood year. Substantial smolt mortality occurs from release through the mainstem river corridor, which is a major constraint on smolt-to-adult survival.

Table 53. Hatchery releases of spring/summer chinook in the Imnaha subbasin (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002**	% natural origin spawners 1980-1997	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-2002
Big Sheep Cr	IRBSH	unknown	unknown	- -	- -	- -	- -	- -	- -	- -
Imnaha R	IRMAI	unknown	unknown	Imnaha	22,498	325,882	203,355	179,987	2,607,054	1,626,843

** Average among those yeas in the indicated period for which data was available

The release of hatchery chinook smolts into streams geographically removed from the acclimation facility, or outplanting, is currently considered to be moderate (TRT 2003). Over the last ten years an average of 50,000 to 500,000 fish have been outplanted annually in the Imnaha, all of which have been from in-population broodstock (TRT 2003).

In 2001, a total of 3,503 adult spring/summer chinook salmon were trapped at the Imnaha River trap, compared with 1,106 adults trapped in 2000. Of the fish trapped in 2001, 1,503 were unmarked and 2,003 were of hatchery origin. A total of 2,643 adult spring/summer chinook salmon were passed above the weir for natural spawning and 253 and 201 were stocked into Lick Creek and Big Sheep Creek (respectively). Fish designated for broodstock were transported to the LFH and held until spawned. Ninety-eight Imnaha River females were spawned resulting in 441,000 green eggs. Approximately 123,112 BY1999 spring/summer chinook smolts were released in the in the spring of 2001 into the Imnaha River.

The run of spring/summer chinook salmon in 2001 was more than sufficient to meet broodstock and escapement goals so consequently a sport fishery was opened. The 2001 opening of the spring/summer chinook fishery in the Imnaha marked the first that has occurred in over 25 years.

Future Plans

Co-managers plan to continue managing the chinook salmon hatchery program as a compensation program emphasizing the conservation/restoration tool to prevent extinction, enhance natural production, and assess supplementation as a tool for recovery. The program will be operated under ESA authorization and future decisions resulting from Columbia River Fisheries Management Plan negotiations will, in part, determine changes in future direction. Co-managers also plan to place increased emphasis on conservation hatchery management, genetic analysis (DNA), continued gene banking, improved rearing, and rearing natural size smolts.. The Northeast Oregon Hatchery project is designing new facilities and identifying modifications to LFH and new facilities necessary to get production back up to 490,000 fish – the original LSRCP goal. The LSRCP Program is also addressing disease-free water issues at Lookingglass Hatchery and methods to meet chinook compensation goals.

Northeast Oregon Hatchery will incorporate some components of Natural Rearing System (NATURES) techniques. NATURES techniques provide juvenile hatchery fish with conditions more similar to those experienced in a natural stream. Juveniles will be raised to smolts from incubation to release in variable water temperature conditions mimicking the natural regime. Rearing conditions will also include low density (0.1 to 0.13 lb/cf/in), cryptic substrate coloration, instream/water surface structure, and natural photo-period (indoors). Smolts will be acclimated and volitionally released into known natural production areas in their natal stream with the intent that the returning adults will spawn in their natural habitat rather than solely supporting hatchery production and harvest.

Artificial propagation of chinook salmon from the Imnaha River will be supported by adult collection, holding and spawning at the Imnaha Satellite Facility. Eggs will be incubated at this site until eye-up then transferred to Lookingglass Fish Hatchery and Lostine Hatchery location(s) for final incubation and early rearing. Transportation of smolts from Lookingglass Fish Hatchery and the Lostine Hatchery to the Imnaha Satellite Facility (Gumboot) will occur in mid-March for acclimation and release.

1.2.4 Fall Chinook Population Delineation and Characterization

1.2.4.1 Population Data and Status—Fall Chinook

Abundance and Trends

Fall chinook salmon are present in the Imnaha subbasin; however, their abundance has likely been reduced from historical levels. Prehistoric and early historic run sizes are unknown. Some estimate that as many as 300 fall chinook salmon may have entered the Imnaha subbasin annually prior to construction of the four lower Snake River dams (NPT 1990) but this is uncertain.

Fall chinook redd surveys, which have occurred periodically since 1964, document the occurrence of spawners along the lower 21 miles of the Imnaha (Figure 51 and Figure 52). Current (1993 to present) redd survey efforts involve the use of helicopters and are conducted on an annual basis through cooperation between the USFWS, Washington Department of Fisheries, USFS, ODFW, Idaho Power, Idaho Department of Fish and Game (IDFG), and Nez Perce Fisheries. Fall chinook redd counts have recently increased , during 2001 –2003 a total of 38, 72, and 41 redds, respectively, were observed.

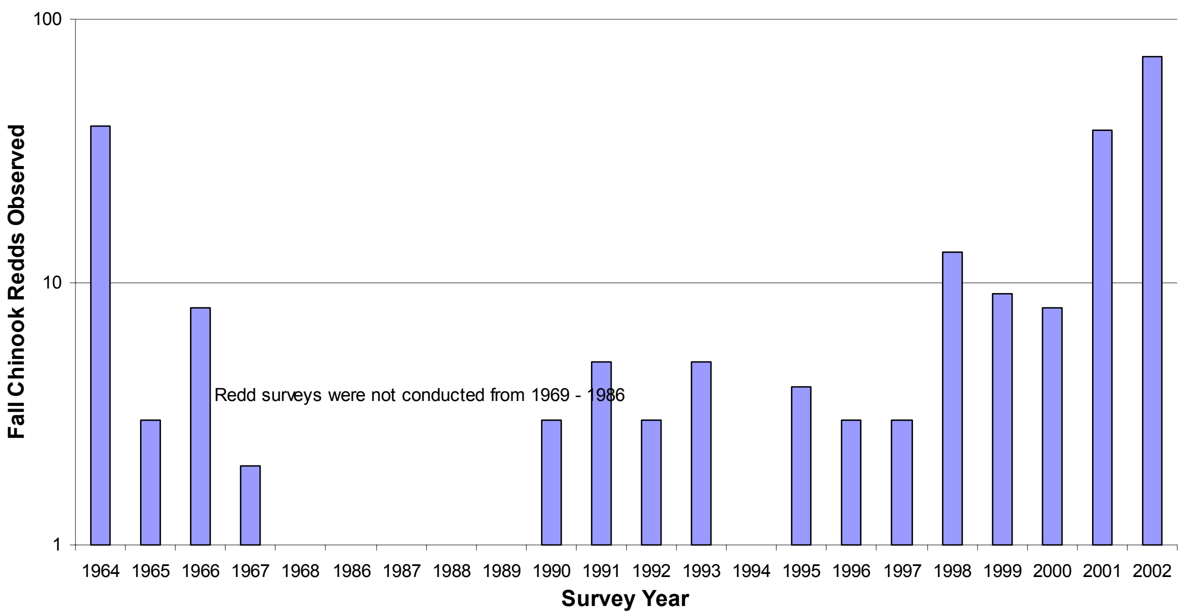

Figure 51. Number of fall chinook salmon redds counted in the Imnaha River between the years 1964 and 2002 (from Mundy and Witty 1998, Garcia 2000, H. Burge, USFWS, personal communication, 2003).

Due to the low escapement, the contribution of spawning to brood-year recruitment has not been demonstrated (Chapman and Witty 1993), and it is likely that some of the spawners represent hatchery strays (Neeley et al. 1993, USFS 1998b), or Snake River fish using the Imnaha for temporary refugia.

Productivity

Information used to define fall chinook productivity in the Imnaha subbasin is not available. Some have suggested that excessively low temperatures may limit embryonic development of Imnaha fall chinook and consequently reduce production (Mundy and Witty 1998), although supporting data are limited. Others (e.g., Mundy and Witty 1998) suggest that juvenile fish may be swept out of the system during spring runoff; however, this theory is also speculative and currently unfounded.

Life History Diversity

Adult Migration

Little is known about adult migration patterns of fall chinook that spawn in the Imnaha River (Mundy and Witty 1998). Provided that Imnaha fall chinook are the same stock that use the Snake River for spawning, adults spend three to five years in the Pacific Ocean (USFS 2003d) prior to the initiation of their upstream spawning migration. Adults enter the Columbia River from August through November (USFS 2003d) and proceed upstream through the Snake River until reaching the Imnaha River from October through November.

Spawning

Spawning takes place almost immediately after the salmon enter the river (Oct. 15–Nov. 30). For Snake River fish occurring above the Salmon River confluence, spawning was determined to initiate when water temperatures dropped below 16.0° C, and terminated when temperatures approached 5.0 °C. Groves (2001) found the relationship between spawn timing and temperature to be less predictable, however, as fish were observed initiating spawning activities when temperatures were as high as 17.0 °C or delaying activities at temperatures around 12 °C. Based on survey data from 1991–2000, Groves (2001) proposes that fall chinook spawn timing between Asotin and Hells Canyon Dam is equally influenced by the total number of fish within the population and how clumped their distribution is upon arrival upstream of Lower Granite Dam. Groves (2001) concludes that, as the escapement past Lower Granite Dam increases, spawning tends to begin earlier, peak within a short time, and end earlier than when escapement is depressed.

Groves and Chandler (1999) determined that redd depths for Snake River fall chinook salmon ranged from 0.2 to 6.5 meters, mean water column velocity ranged from 1.3 to 6.8 feet per second, and substrate-level water velocity ranged from 0.3 to 6.6 feet per second. Substrate sizes used for spawning ranged between 1.0 and 5.9 inches (Groves and Chandler 1999). Groves and Chandler (2001) determined that the average redd encompassed an area equal to 45.8 square meters (n = 8; standard error = 3.87).

Incubation

Because of their ESA listing, little applied research has been conducted regarding the incubation life history stage of fall chinook in the Imnaha subbasin. Methods used to define habitat and water quality criteria relative to incubation life history stages generally require unnecessary and unacceptable levels of direct “take” (in the form of mortality) and are prohibited under the ESA.

The rate of egg development and emergence timing of fall chinook is positively correlated with water temperature (Connor et al. 2002). In the Imnaha, water temperatures during the winter–spring incubation period are typically warmer than other downriver Snake tributaries supporting fall chinook (i.e., Salmon and Clearwater rivers), allowing for an earlier emergence of fry in mid- to late-April (Connor et al. 2002).

Juvenile Rearing

Development of fall chinook parr in the Imnaha is considered to be rapid, with fish initiating their seaward migration in July and August as zero-aged (subyearling) smolts (Mundy and Witty 1998). Timing of growth to parr size (> 45 mm) is largely based on emergence timing (Connor et al. 2002), and unlike spring/summer chinook, is independent of photoperiod, suggesting it may be a heritable trait (Myers et al. 1998). Mundy and Witty (1998) suspect that, if fry do swim up in May and June, most would be swept downriver and into the Snake River because of spring flushing flows common in the Imnaha.

As described above, Imnaha fall chinook emerge in the spring, rear for two to three months and then emigrate seaward. It is likely that Imnaha fall chinook emigrate from the subbasin upon attaining a suitable size and use the warmer and more productive mainstem Snake River for additional rearing prior to their downstream migration. While in the Snake River, fall chinook juveniles inhabit the sandy littoral areas (Tiffan et al. 1999, BLM 2000) for up to two months or until water temperatures are no longer suitable (i.e., Curet [1994] found that juvenile fall chinook remained along the shoreline of Lower Granite Reservoir until water temperatures exceeded 18 °C). The movement away from the littoral zone signifies the progression from parr to smolt stages, which for fall chinook occurs earlier in life than for other anadromous salmonids. Connor (et al. 1993, as cited in Mundy and Witty 1998) established the upper and lower size limits for differentiating juvenile fall and spring/summer chinook (Table 54).

Table 54. Maximum and minimum fork lengths for in-season race identification of fall chinook salmon seined on the Snake River (Connor et al. 1993, as cited in Mundy and Witty 1998).

Limit	Estimated Fall Chinook Salmon Size (mm) by Date								
	5/21	5/28	6/4	6/11	6/18	6/25	7/2	7/9	7/16
Maximum	70	73	76	78	81	84	87	89	92
Minimum	55	55	55	55	55	58	61	64	66

Smolt Migration

Unlike spring/summer chinook, juvenile fall chinook outmigrate the summer following spawning, rather than rearing in freshwater for 13-14 months before outmigrating. Similar to spring/summer chinook, the downstream migration of subyearling fall chinook from the Imnaha is protracted, occurring from late spring (June) through midsummer (August; Rondorf and Miller 1993; Connor et al. 2002), or soon after yolk resorption at 30 to 45 mm in length (Healey 1991, as cited in Connor 2002). Connor et al. (2002) found late emigration timing to be detrimental to production as smolt survival to Lower Granite Dam decreased with reduced summer flows, higher water temperatures, and decreases in turbidity.

Studies have shown that outmigrating fall chinook juveniles are capable of moving substantial distances during the day as well as at night, but average 2.3 kilometers per day through the Hells Canyon reach of the Snake River. At this rate subyearlings from the Imnaha typically reach Lower Granite Dam in late July (Connor et al. 1993, as cited in Mundy and Witty 1998). During their outmigration, fall chinook will swim actively only at low water velocities, rarely drifting passively (Rondorf and Miller 1993, 1994, 1995). The subyearlings have a biological requirement for food and may consume terrestrial insects and zooplankton in reservoir reaches and aquatic insects in the free-flowing reaches.

Carrying Capacity

The suitability and availability of fall chinook spawning substrate does not appear to be a factor limiting production of the species. Surveys conducted by Thompson and Hass in 1959 identified 2,566 square yards of good, and 12,967 square yards of marginal fall chinook spawning gravel in the Imnaha River between Imnaha and the mouth (Mundy and Witty 1998). Thompson and Haas (1960) reported enough gravel was available for the construction of 600 fall chinook redds in the mainstem between Horse Creek and the mouth. In 1998 NPT mapped fall chinook spawning habitat on the lower 15 miles of the Imnaha River. Potential spawning sites were based on suitable spawning criteria for fall chinook as reported in Arnsberg et al. (1992). Spawning criteria for depths were 0.5 ft to infinity, mean column water velocities between 0.5 ft/s to 4.0 ft/s, and dominant substrate sizes of 2-6". A total of 68 potential spawning areas were identified, which included some prior and current documented fall chinook spawning sites. Spawning sites ranged from 5-2,268 square meters with a total measured area of 18,527 square meters. Using an estimated 20.4 square meters per redd (Burner 1951), the Imnaha River could support about 900 fall chinook redds in the lower 15 miles of the Imnaha.

Unique Population Units

As discussed above, the Imnaha fall chinook population is considered to be part of the Snake River population (SNMAI) and occurs in the Snake River Evolutionarily Significant Unit (TRT 2003).

Genetic Integrity

Based on geographic separation, habitat differences, and apparent demographic independence, the Snake River fall chinook population represents a distinct unit (SNMAI) when compared to populations occurring elsewhere throughout the Columbia Basin (TRT 2003). Fall chinook occurring in the mainstem Imnaha were not separated from those occurring in the Snake, due in part to a lack of data, and also because Imnaha fish represent one of many aggregates that are currently considered to make up the larger Snake River population (TRT 2003).

Currently, the mainstem run of fall chinook up to Hells Canyon Dam consists of hatchery-reared stock, natural fish (fish born to hatchery-reared parents that spawned in the wild), and wild fish. Genetic analysis of samples collected from 1995 to 1997 determined that the majority of all wild fry and parr inhabiting these mainstem areas were the progeny of fall chinook salmon (Connor et al. 2002).

1.2.4.2 Distribution–Fall Chinook

Current In-Basin Distribution

It is estimated that after adjusting for spawning/rearing suitability, only 20% or less of historical Snake River habitat is currently available to fall chinook (TRT 2003). Fall chinook currently rear and spawn in the lower 5 miles of the Imnaha River. Designated Critical Habitat includes the 23 miles of the Imnaha River from its mouth to the town of Imnaha.

Historical Distribution

Accounts from Nez Perce tribal elders suggest that fall chinook historically used the lower 19.5 miles of the Imnaha mainstem (from the confluence to the town of Imnaha) for spawning, and generally did not occur above the town of Imnaha (Chapman 1940). Others contend that fall chinook spawning occurred as far upstream as the confluence of Freezeout Creek (Fernan Warnock, personal communication, as cited in Mundy and Witty 1998). Fall chinook have never been reported to occur in the Big Sheep watershed.

It is possible that fall chinook were once exclusively reliant on the mainstem Snake River for spawning and rearing and historically never occurred in tributary habitat. As reported in Mundy and Witty (1998), the blockage of Snake River habitat by the construction of Brownlee, Oxbow, and Hells Canyon dams during the late 1950s and early 1960s may have caused upper Snake River fall chinook to seek alternative spawning habitats, the majority of which occurred in primary tributaries to the Snake River. Connor et al. (2002) support this theory and point out that historical evidence documenting tributary spawning is not conclusive (Connor et al. 2002).

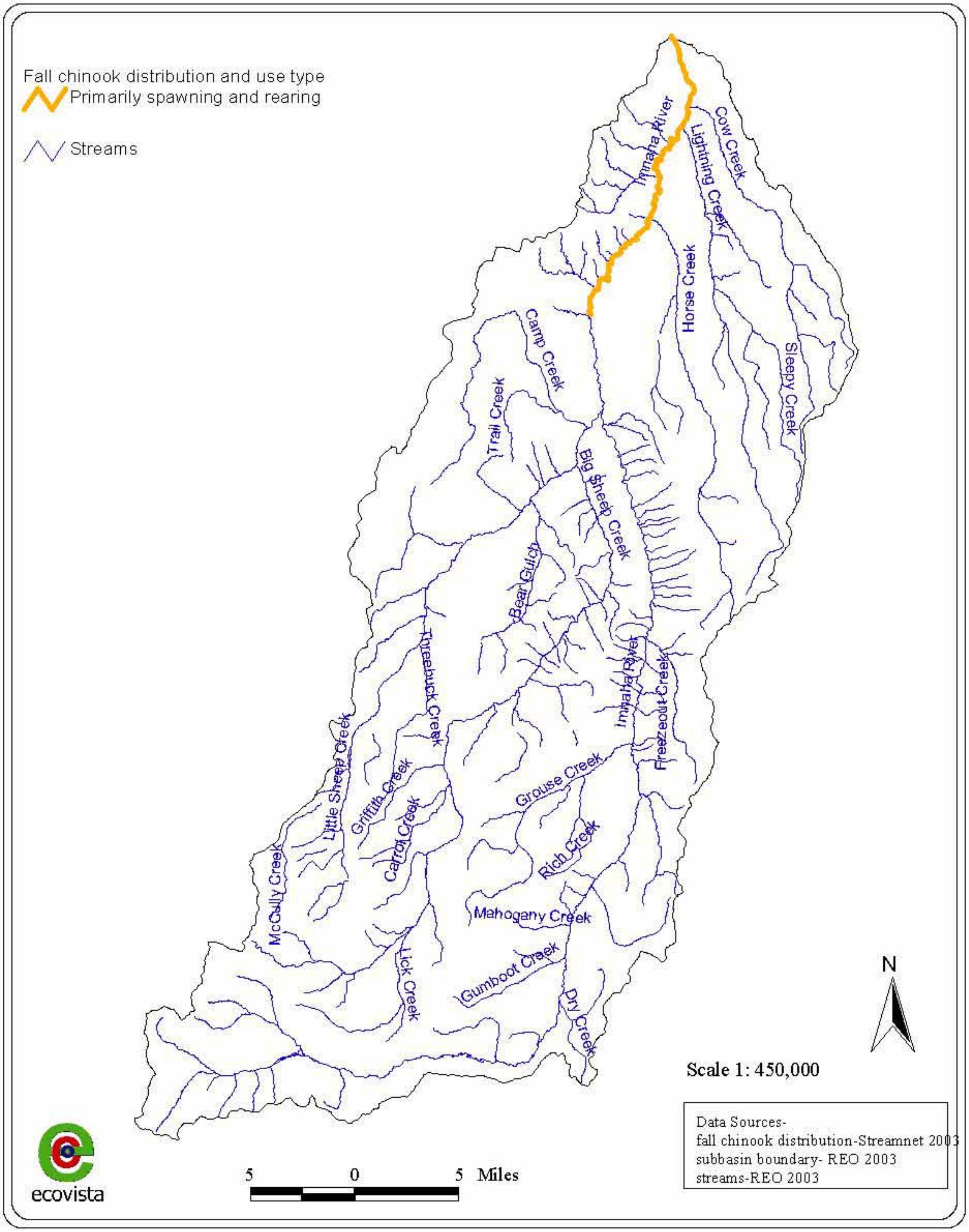

Figure 52. Fall chinook distribution and use type, Imnaha subbasin.

The TRT (2003) contend that since fish within the Snake River ESU currently tend to form aggregates in areas of suitable habitat quality, it is reasonable to assume that a similar structure existed historically, with the discontinuous aggregates functioning as elements of a metapopulation. Areas of unsuitable habitat quality likely served an isolation function to various spawning groups.

Identification of Differences in Distribution Due to Human Disturbance

Based on current and historical distribution, there is little reason to believe that human disturbance has had any significant influence on fall chinook distribution in the Imnaha subbasin. Changes in streamflow and water temperatures from the Wallowa Valley Improvement Canal may influence current distribution to some degree; however, the magnitude of effect is unknown.

1.2.4.3 Fall Chinook Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

No harvest is currently allowed.

Historical In-Basin Harvest Levels

Historic fall chinook harvest levels are unknown.

1.2.4.4 Fall Chinook Hatchery Influence

Currently, the mainstem run of fall chinook up to Hells Canyon Dam consists of hatchery-reared stock, natural fish (fish born to hatchery-reared parents that spawned in the wild), and wild fish (Blankenship and Mendel 1997). Averaged over the last five years, an estimated 25% of natural spawning fish are of hatchery-origin, which represents a recent increase (TRT 2003). There is some genetic evidence of hatchery introgression, as Snake River fall chinook tend to have a high affinity to locally derived broodstock. All releases of hatchery fish are from in-population broodstock (Table 55).

Table 55. Hatchery releases of Snake River fall chinook (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002*	% natural origin spawners 1980-1997*	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-20
Snake River	SNMAI	36	66	Lyons Ferry	432,652	1,694,568	344,489	3,461,212	13,556,546	2,755,9
				Snake River	79,303	75,458	1,444,303	634,420	603,661	11,554,4
				All Stocks	**511,954**	**1,770,026**	**1,788,792**	**4,095,632**	**14,160,207**	**14,310,3**

*Average among those yeas in the indicated period for which data was available

1.2.5 Summer Steelhead Population Delineation and Characterization

1.2.5.1 Population Data and Status—Summer Steelhead

The Imnaha subbasin contains wild and natural populations of A-run Snake River summer steelhead (*O. mykiss*). Unlike the larger B-run fish, which average 5-8 kg (11-18 lbs.) and enter the Snake River later in the fall, A-run fish average 2-4 kg (4.4-8.8 lbs.) and begin to enter the river in August (Berryman et al. unknown date). Natural fish are hatchery-derived fish which spawn in the natural environment. Only the native Imnaha stock is used for the hatchery program and wild/natural fish are still being added to the hatchery broodstock (USFS 2003d).

The summer steelhead occurring in the mainstem Imnaha and all its tributaries represent a single, independent population (IRMMT-s) within the Snake River ESU (TRT 2003). Given a lack of clear genetic or geographic delineation, the TRT defined a single population in the subbasin rather than differentiating between the geographically proximal spawning aggregates that occur throughout the Imnaha.

Abundance and Trends

According to the U.S. Army Corps of Engineers (USACE 1975), historical peak escapement of A-run summer steelhead to the Imnaha subbasin was estimated to be 4,000 fish, based on the maximum count over McNary Dam of 172,600 in 1962–1963. Seven years of data are available from McNary prior to completion of Ice Harbor Dam in 1961. Steelhead counts for those seven years ranged from 40,660 to 111,288 (all lower than the 1962–1963 count). If LSRCP methods are applied to apportion these runs, the range of escapement into the Imnaha would have been 946 to 2,590 per year for the seven-year period.

Current trends in escapement are based on redd counts in Camp Creek, a tributary to Big Sheep Creek. Camp Creek, a spring-fed stream, is used for annual redd surveys due to its accessibility, flows, and water clarity during survey periods and its early spawning group of fish (B. Knox, ODFW, personal communication, April 12, 2001). Summer steelhead redd counts in the lower 6 miles of Camp Creek are shown in Figure 53. Redd counts have also been conducted in other portions of the subbasin since 1962 (Table 56).

As shown in Table 56, peak counts in Camp Creek occurred in 1966 and 1967 when 18.0 redds per mile were observed. Over the next decade (1968–1978), average counts declined significantly to 2.9 redds per mile, reaching a low point in 1975 and 1976 of 0.7 and 0.6 redds per mile, respectively. From 1979 to 1989, the counts averaged 6.2 redds per mile. The increase in the number of redds observed from 1985 to 1987 was consistent with trends observed during the same period throughout the Columbia Basin (B. Knox, ODFW, personal communication, April 19, 2001) but may also be related to the Lower Snake River Compensation Program (LSRCP) facility constructed on Little Sheep Creek in 1982 (D. Bryson, Nez Perce Tribe, personal communication, April 27, 2001). From 1990 to 2003, the average count was 6.5 redds per mile, an increase due in large part to the returns recorded from 2000-2003.

Steelhead redd counts can not be conducted in a representative manner throughout the subbasin due to physical conditions (high turbidity and limited access). In addition, the accuracy and precision of existing counts is unknown.

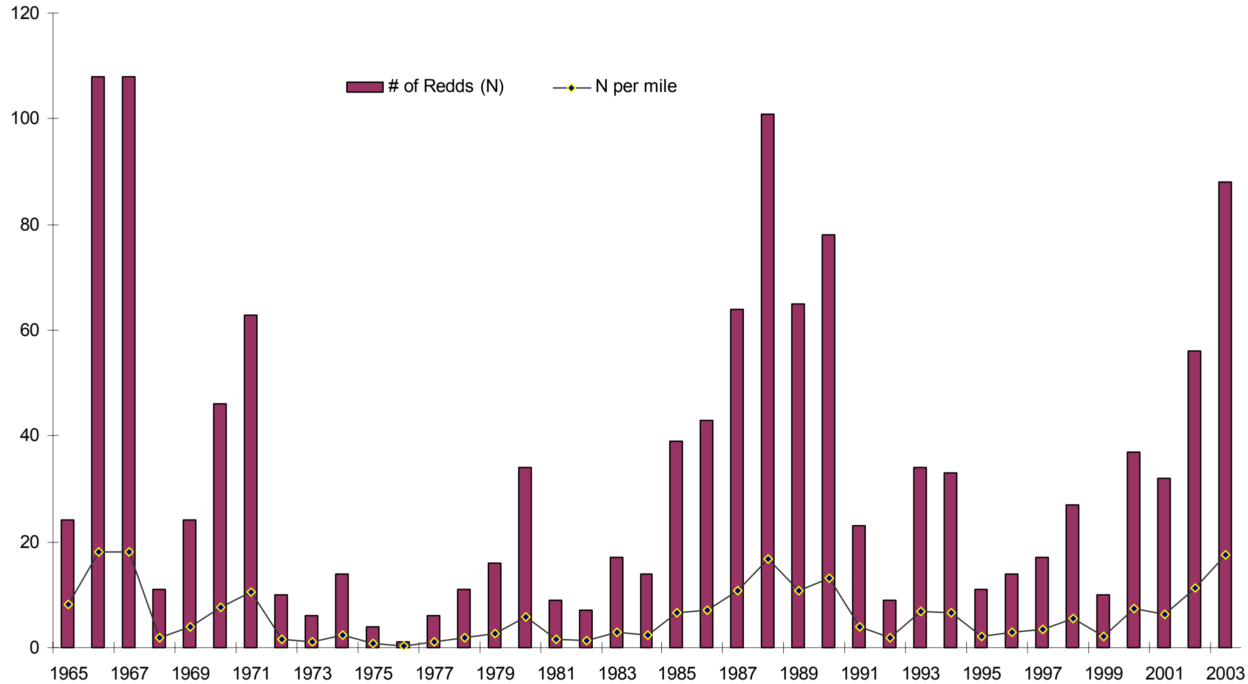

Figure 53. Summer steelhead redd counts in the lower 6 miles of Camp Creek for the run years 1965–2001 (USFS 2003d; ODFW unpublished data, 2004).

Adult escapement monitoring via upstream and downstream portable picket weirs was initiated in Lightning Creek in 2000 and Cow Creek in 2001(Hesse et al. *in press*). Tributary specific estimated abundance in Lightning Creek has been 36 (35 – 41 95% CI), 141 (103 –186 95% CI), 231 (136 – 264 95% CI), from 2000 to 2002. Estimated abundance in Cow Creek has been 86 (70 –105 95% CI), 63 (54 – 71 95% CI), and 102 (88-116 95%CI) adults annually through 2003. Adult run-timing into spawning areas spans from early-March through early-June. Sex ratios have been highly skewed, ranging from 62 to 87 percent female. Stray hatchery origin adults have comprised two to 32 percent of the total escapement. Vital statistics for steelhead in Little Sheep Creek are presented in Table 57.

Adult steelhead abundance information for the Imnaha subbasin represents a critical data gap. It is unknown if the redd count trend data or escapement information from Cow, Lightning, and/or Little Sheep is representative/suitable as an index for the subbasin.

Juvenile rearing density monitoring has also occurred throughout various portions of the subbasin. Snorkeling observations of steelhead density and habitat have been conducted in Big Sheep Creek, Lick Creek, and the mainstem Imnaha River from 1992 to 1999 (Table 58; Blenden and Kucera 2002). Densities of juvenile *O. mykiss* (multiple year classes) were highest in lower Lick Creek, yet never exceeded 0.5 fish per square meter. Multiple pass electrofishing surveys were conducted in Lightning, Big Sheep, Little Sheep creek, and Gumboot creeks in 1999 and 2000. Densities of wild *O. mykiss* age 0+ were highest in Reach 1 of Gumboot Creek in 2000 (1.86 fish/m^2), age 1+ were highest in Reach 6 of Gumboot Creek in 1999 (0.35 fish/m^2) and age 2+ densities were also highest in 1999 in Reach 6 of Gumboot Creek (0.25 fish/m^2) Table 59). Densities of age 0+ hatchery steelhead were highest in Reach 4 of Big Sheep Creek in 1999 (2.10 fish/m^2), age 1 densities were highest in Reach 4 of Little Sheep Creek (0.15 fish/m^2), while age 2+ densities were highest in Reach 1 of Little Sheep Creek in 1999 (0.14 fish/m^2) (Table 59).

Table 56. Summer steelhead redd counts (#/mile) for various years and tributaries in the Imnaha subbasin (ODFW data, recd. 02/04)

Stream	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1986	1992	1999
Bear Gulch																0.0			
Carrol																		4.0	
Cow				1.0															
Devils Gulch						1.0		1.5											
Freezeout	1.5			0.0			1.0												
Gumboot					2.0	0.0	0.0		0.0						0.0	1.8		14.1	2.7
Gumboot (NF)									0.0										
Horse				1.0											0.3				
Lick					2.0				0.0							0.5		9.6	
Lightning (Imnaha)				2.0															
Lightning (L.Sheep)	5.0	0.3	1.0	2.7	0.3	2.0	3.0	4.0	2.3	0.0	0.0	0.0	0.7	2.3					
L.Sheep				2.2		3.4	2.0	1.4	4.2				4.2				8.8		
Summit	1.0			0.5			0.0												

Table 57. Vital statistics for adult steelhead collected at the Little Sheep Creek trapping facility (ODFW unpublished data). M = males, F = females, W = wild fish, H = hatchery fish.

Return Year	Trapped			Prespawn Mortality		Passed Above Trap			Killed not Spawned		Spawned		
	Total	M	F	M	F	M	F	%W	M	F	M	F	%W
1982	53	9	44									25	100.0
1983	45	15	30									24	100.0
1984	72	27	45									34	100.0
1985 W	163	40	123	a98	40	6	21		3	2		75	
1985 H	52	26	26	a42	14	1	0	96.4	1	0		19	79.8
1986 W	49	14	35	a17	3	1	1		1	0	8	32	
1986 H	23	7	16	a13	9	0	0	100.0	1	0	3	10	75.5
1987 W	110	60	50	14	9	34	38		0	0	9	11	
1987 H	620	255	365	66	47	149	186	17.7	5	14	107	151	7.2

Return Year	Trapped			Prespawn Mortality		Passed Above Trap			Killed not Spawned		Spawned		
	Total	M	F	M	F	M	F	%W	M	F	M	F	%W
1988 W	47	26	21	0	0	14	16		1	2	6	6	
1988 H	b808	366	442	74	68	159	195	7.8	51	35	109	165	4.2
1989 W	56	19	37	25	0	10	16		1	1	4	20	
1989 H	306	71	235	115	44	31	121	14.6	1	3	24	109	15.3
1990 W	57	20	37	4	0	7	11		1	3	11	23	
1990 H	924	456	468	74	30	293	305	2.9	4	2	146	156	10.1
1991 W	29	11	18	0	0	6	8		1	1	4	9	
1991 H	366	221	145	19	3	23	18	25.5	59	5	129	121	4.9
1992 W	128	52	76	0	17	c37	38		0	0	b27	33	
1992 H	661	348	313	85	13	52	57	40.8	70	107	188	144	15.3
1993 W	99	21	78	0	0	17	60		0	0	4	18	
1993 H	1773	756	1017	18	5	60	17	50.0	535	881	154	116	7.5
1994 W	53	25	28	1	0	d21	20		0	0	12	8	
1994 H	141	30	111	1	0	e19	17	53.2	0	0	10	94	16.4
1995 W	17	3	14	0	0	2	10		0	0	1	4	
1995 H	278	175	103	7	0	28	6	26.1	39	2	101	95	2.5
1996 W	48	22	26	0	0	f22	19		0	0	6	6	
1996 H	g443	169	274	2	0	36	32	34.0	2	41	108	153	4.4
1997 W	29	11	18	0	0	9	15		0	1	2	2	
1997 H	937	516	421	2	12	32	21	31.2	300	206	182	182	1.1
1998 W	33	9	24	0	0	7	18		0	0	2	6	
1998 H	686	261	425	0	0	44	72	17.7	25	13	h192	340	1.5
1999 W	11	5	6	0	0	2	3		0	0	3	3	
1999 H	i332	157	175	2	0	42	33	6.3	0	1	88	124	2.8
2000 W	77	39	38	0	1	j36	23		0	0	16	14	
2000 H	k445	159	286	1	2	m49	92	29.5	2	3	82	106	13.8
2001 W	128	38	90	0	0	n38	74		0	0	12	16	
2001 H	o1,224	601	623	1	0	328	344	14.3	2	2	100	93	12.7
2002 W	204	63	141	0	1	p63	130		0	1	7	8	
2002 H	q3,260	1,256	2,004	9	2	359	646	19.2	9	5	60	97	9.6

Return Year	Trapped			Prespawn Mortality		Passed Above Trap			Killed not Spawned		Spawned		
	Total	M	F	M	F	M	F	%W	M	F	M	F	%W
2003 W	99	47	52	0	0	r47	46		0	0	3	6	
2003 H	s1,905	825	1,080	0	0	163	157	22.5	6	10	88	78	5.2

a. Includes mortality of spawned males held for additional spawning
b. (30) males and (30) females outplanted to Gumboot Cr
c. Includes (12) wild males spawned and released
d. (12) live spawned then released
e. (10) live spawned then released
f. (6) live spawned then released
g. (22) males and (46) females outplanted to ponds
h. produced 1,598,340 green eggs
i. (25) males and (17) females outplanted to Big Sheep Cr.
j. (13) live spawned then released
k. (55) males and (83) females outplanted to Big Sheep Cr.
m. (11) live spawned then released
n. (12) live spawned then released
o. (170) males and (184) females outplanted to Big Sheep Cr.
p. (7) live spawned then released
q. (775) males and (1,254) females outplanted to Big Sheep Cr.
r. (3) live spawned then released
s. (568) males and (835) females outplanted to Big Sheep Cr.

Table 58. Snorkeling observations of steelhead density (fish/100m^2) by habitat conducted in Big Sheep Creek, Lick Creek, and the Imnaha River (1992–1999) (Blenden and Kucera 2002).

Stream	Year	Habitat Type (Number of Transects)	Mean Density of Steelhead (fish/100m^2)
Big Sheep Creek	1992	Pool (3) Run (4)	12.6 24.1
Big Sheep Creek	1993	Pool (2) Run (3)	25.4 15.5
Upper Big Sheep Creek (7/7)	1994	Pool (2) Run (2)	36.2 26.2
Upper Big Sheep Creek (8/16)	1994	Pool (2) Run (2)	24.9 16.0
Lower Big Sheep Creek (7/8)	1994	Pool (2) Run (4)	28.0 20.8
Lower Big Sheep Creek (8/17)	1994	Pool (2) Run (4)	19.5 25.5
Big Sheep Creek	1995	Pool (3) Run (3)	18.9 22.0
Imnaha River	1992	Pool (5) Run (8)	2.0 2.8
Imnaha River	1993	Pool (5) Run (8)	2.9 1.5
Imnaha River	1994	Pool (5) Run (8)	0.4 0.5
Imnaha River	1995	Pool (5) Run (7)	1.8 1.6
Imnaha River	1996	Pool (5) Run (7)	2.5 2.4
Upper Lick Creek (7/7)	1994	Pool (3) Run (3)	13.4 19.5
Upper Lick Creek (8/16)	1994	Pool (3) Run (3)	23.9 30.2
Lower Lick Creek (7/7)	1994	Pool (3) Run (3)	41.4 29.4
Lower Lick Creek (8/16)	1994	Pool (3) Run (3)	38.0 37.7
Lick Creek	1996	Pool (7) Run (7)	19.0 9.8
Lick Creek	1997	Pool (6) Run (5)	21.3 15.9
Lick Creek	1998	Pool (6) Run (4)	24.0 13.9
Lick Creek	1999	Pool (6) Run (4)	11.7 13.7

Table 59. Juvenile *O. mykiss* rearing density (number/m^2) estimates for Lightning, Big Sheep, Little Sheep, and Gumboot creeks in the Imnaha River subbasin, 1999 and 2000 (ODFW and NPT unpublished data collected under LSRCP evaluation studies).

Year	Stream	Reach	Wild Age 0	Wild Age 1	Wild Age 2+	Hatchery Age 0	Hatchery Age 1	Hatchery Age 2+
1999	Little Sheep Creek	1	0.094	0.010	0.00	0.754		0.136
		2	0.198	0.005	0.005	0.166		0.005
		3	0.209	0.023	0.004	0.039		0.009
		4	0.020	0.020	0.031	1.552		0.060
		5	Not sampled in 1999					
		6	0.093	0.061	0.008	1.089		0.030
	Gumboot Creek	1	0.229	0.172	0.111			
		2	0.217	0.084	0.059			
		3	0.033	0.202	0.118			
		4	0.381	0.184	0.110			
		5	0.019	0.164	0.104			
		6	0.253	0.349	0.245			
	Big Sheep Creek	1	0.129	0.074	0.050	0.350		0.000
		2	0.039	0.177	0.078	0.624		0.008
		3	0.004	0.018	0.012	1.129		0.000
		4	0.004	0.042	0.011	2.101		0.004
	Lightning Creek	1	0.122	0.191	0.028			
		2	0.172	0.168	0.035			
		3	0.081	0.078	0.036			
		4	0.106	0.066	0.062			
2000	Little Sheep Creek	1	0.238	0.037	0.000		0.044	0.030
		2	0.355	0.022	0.000		0.000	0.008
		3	0.474	0.029	0.004		0.033	0.000
		4	0.358	0.005	0.019		0.150	0.005
		5	0.608	0.037	0.005		0.042	0.000
		6	0.111	0.011	0.011		0.071	0.000
	Gumboot Creek	1	1.859	0.125	0.066			
		2	0.956	0.081	0.000			
		3	0.259	0.219	0.084			
		4	0.259	0.104	0.025			
		5	0.202	0.061	0.074			
		6	0.000	0.085	0.000			
	Big Sheep Creek	1	0.326	0.040	0.004	0.000	0.036	0.009
		2	0.211	0.088	0.046	0.000	0.077	0.023
		3	0.111	0.019	0.003	0.000	0.123	0.000
		4	0.104	0.011	0.004	0.008	0.118	0.000
		5	0.167	0.035	0.006	0.000	0.004	0.061
		6	0.213	0.077	0.009	0.000	0.018	0.131
	Lightning Creek	1	0.000	0.162	0.017			
		2	0.191	0.123	0.037			
		3	0.140	0.080	0.060			
		4	0.253	0.103	0.053			

Seasonwide survival estimates of natural and hatchery juvenile steelhead smolts from the Imnaha River to the Snake River and Columbia River dams have been produced by the Nez Perce Tribe since 1995 (Table 46; Cleary et al. 2003). Steelhead smolts are captured using rotary screw traps at river kilometer (rkm)7 during the spring period from February through June   A portion of the fish are tagged weekly with passive integrated transponder (PIT) tags so that they could be detected at interrogation sites at Snake and Columbia river dams. Survival of PIT-tagged fish was estimated with the Survival Using Proportional model (SURPH model). Survival estimates of spring emigrating natural-origin smolts to Lower Granite Dam have ranged from 82 to 90% (Figure 55). While survival estimates of hatchery-origin smolts to Lower Granite Dam have ranged from 64 to 89% (Figure 56).

The biological characteristics of natural and hatchery steelhead have been evaluated from fish captured at the screw traps. Hatchery-origin fish are consistently larger than their natural-origin counterparts. For example, the median fork length for natural steelhead in 2000 was 182 mm, which was significantly ($p < 0.05$) smaller than hatchery fish (223 mm; Cleary et al. 2003). Mean weight for natural steelhead was 62 grams, compared with hatchery steelhead which weighed, on average, 106.8 grams. Although statistically smaller, natural steelhead had a mean condition factor (0.95) similar to their hatchery counterparts (0.93).

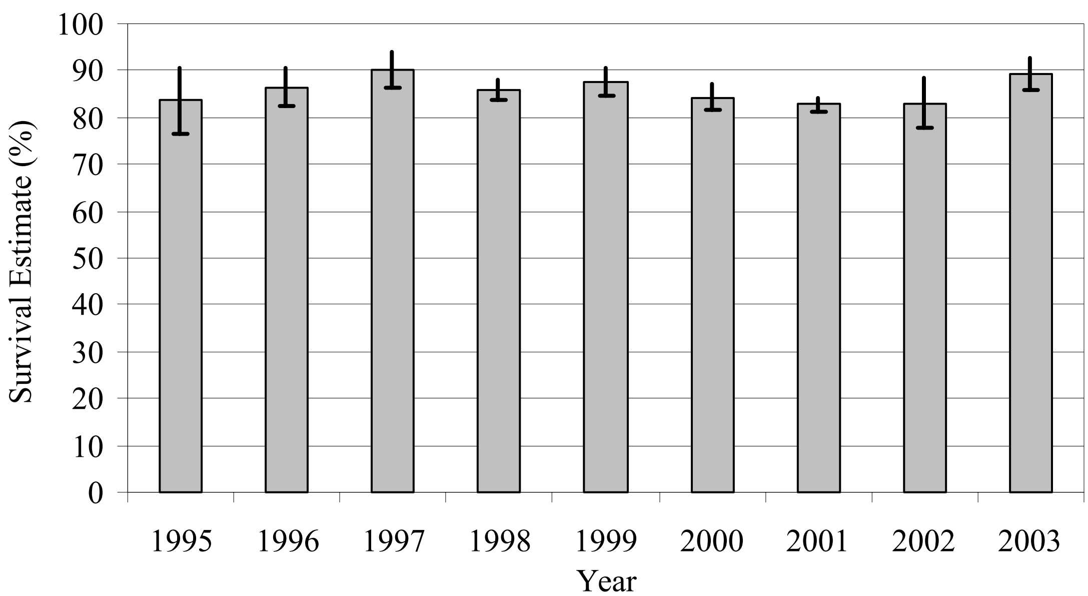

Figure 54.	Seasonwide survival estimates for natural steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al. 2003, and Cleary et al. in prep.).

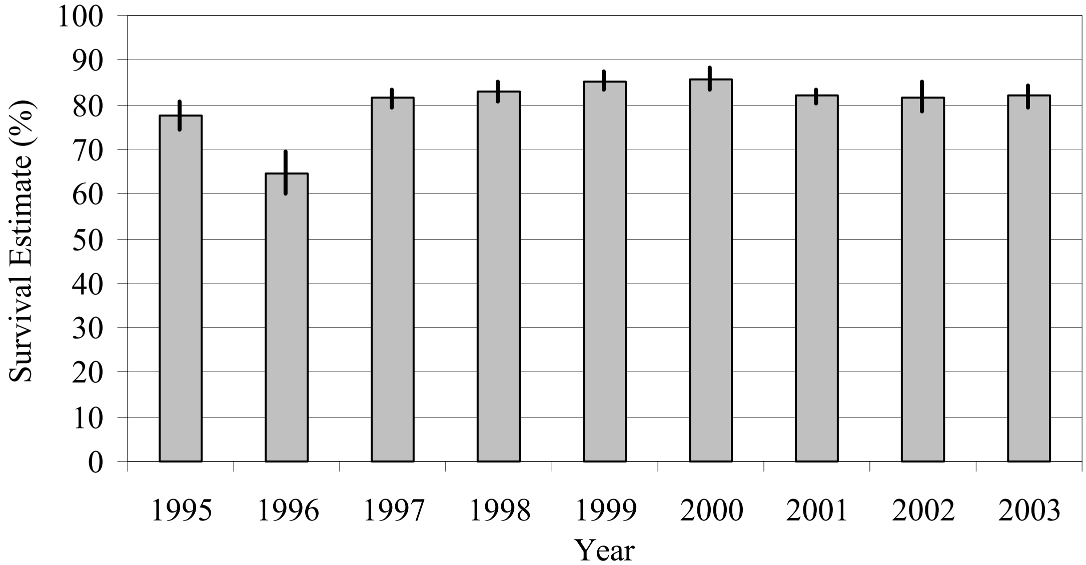

Figure 55. Seasonwide survival estimates for hatchery steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al 2003, and Cleary et al. in prep).

Natural and Hatchery Steelhead Arrival Timing

Median arrival timing of natural and hatchery Imnaha smolts to the four lower Snake River dams has been tracked since 1993 and is shown in Table 60. Historically, Imnaha natural steelhead have a ten year mean arrival date range of April 15 (± 26 days) to July 9 (± 63 days) at LGR (Table 13). The mean arrival date range for LGO, LMO, and MCN is as follows: April 19 (± 22days) to July 7 (± 52 days) at LGO, April 24 (± 22 days) to July 9 (± 78 days) at LMO, and April 27 (± 26 days) to June 15 (± 36 days) at MCN. The ten year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 11 (± 14 days) at LGR, May 14 (± 11 days) at LGO, May 16 (± 14 days) at LMO, and May 18 (± 13 days) at MCN. The mean 90% arrival timing for natural steelhead is as follows: May 27 (± 17 days) at LGR, May 27 (± 12 days) at LGO, June 7 (± 41 days) at LMO, and May 28 (± 15 days) at MCN.

The ten year mean range of arrival for Imnaha hatchery steelhead at LGR is April 23 (± 18 days) to July 26 (± 53 days). Downstream mean arrival ranges for hatchery steelhead are as follows: April 26 (± 17 days) to July 28 (± 73 days) at LGO, April 30 (± 16 days) to August 4 (± 85 days) at LMO, and May 7 (± 19 days) to July 5 (± 41 days) at MCN. The ten year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 21 (± 12 days), May 25 (± 8 days), May 30 (± 14 days), and June 2 (± 25 days), respectively. Mean 90% arrival occurred on June 6 (± 21 days) at LGR, June 14 (± 26 days) at LGO, June 19 (± 34 days) at LMO, and June 18 (± 35 days) at MCN.

Table 60. Mean first, median, 90%, and last arrival timing for natural and hatchery steelhead smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (± days) (Cleary et al 2003 and Cleary et al in prep).

Rearing, Species, Life Stage, Dam	First Arrival Mean	(± days)	Median Arrival Mean	(± days)	90% Arrival Mean	(± days)	Last Arrival Mean	(± days)
Natural Steelhead Smolts (1993 to 2003)[1]								
LGR	15-Apr	(26)	11-May	(14)	27-May	(17)	9-Jul	(63)
LGO	19-Apr	(22)	14-May	(11)	27-May	(12)	7-Jul	(52)
LMO	24-Apr	(22)	16-May	(14)	7-Jun	(41)	9-Jul	(78)
MCN	27-Apr	(26)	18-May	(13)	28-May	(15)	15-Jun	(36)
Hatchery Steelhead Smolts (1993 to 2003)[1]								
LGR	23-Apr	(18)	21-May	(12)	6-Jun	(21)	26-Jul	(53)
LGO	26-Apr	(17)	25-May	(8)	14-Jun	(26)	28-Jul	(73)
LMO	30-Apr	(16)	30-May	(14)	19-Jun	(34)	4-Aug	(85)
MCN	7-May	(19)	2-Jun	(25)	18-Jun	(35)	5-Jul	(41)

1 Median and 90% arrival timing does not include data from migration year 2002 due to the sample size.

Index of Juvenile Abundance

Juvenile density estimates provided here have been summarized from Blenden and Kucera (2002). In their report they provide a baseline relative index of juvenile abundance and fish species composition information. Big Sheep Creek was snorkeled approximately 4.5 stream kilometers (skm) above Carrol Creek from 1992-1995 and also just above Lick Creek in 1994. Lower Lick Creek was snorkeled at approximately skm 0.6 in 1994 and upper Lick Creek was snorkeled from between skm 2.4 and 5.9 from 1994-2000 excluding 1995.

Lower Big Sheep Creek average densities of multiple age groups of steelhead, in pool habitat, ranged from 12.6 to 25.4 fish/100m^2 from 1992 to 1995 (Figure 6). Steelhead density increased by 100% between 1992 and 1993, from 12.6 to 25.4 fish/100m^2, and remained at approximately 19 fish/100m^2 in 1994 and 1995. Juvenile steelhead density was higher in run habitat, compared to pool habitat, in three out of the four years snorkeling was conducted in lower Big Sheep Creek. Subyearling steelhead were not abundant in pool and run habitat types during any year, and did not contribute significantly to the density estimates.

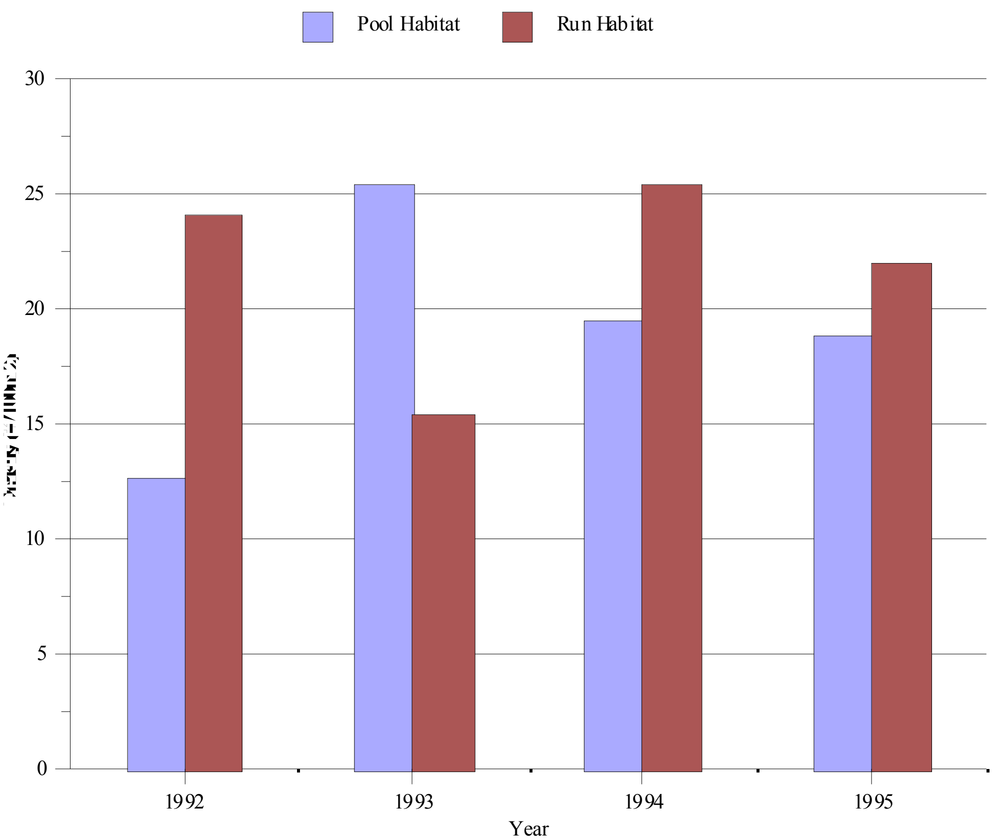

Figure 6. Average density of juvenile steelhead in pool and run habitat in lower Big Sheep Creek from 1992 to 1995.

Lick Creek natural steelhead mean densities in pool habitat ranged from 11.7 to 23.9 fish/100m^2 from 1994 to 2000 (Figure 7). Densities in pool habitat generally ranged between 17.9 to 23.9 fish/100m^2 over the study period. The exception occurred when average density varied by 100% (declined) from 1998 to 1999 (Figure 7). Average steelhead density in run habitat ranged from 9.8 to 30.2 fish/100m^2 (Figure 10). Steelhead densities generally ranged between 9.8 and 15.9 fish/100m^2 from 1996 to 2000. Young-of-the-year steelhead made up 52.8% and 64.6% of all steelhead observed in 1997 and 2000, and contributed significantly to estimated densities in those years. Three hatchery steelhead were observed in 2000 pool habitat for a mean density of 1.0 fish/100m^2. They most likely represent residual hatchery steelhead that dispersed upstream from the Little Sheep Creek acclimation facility.

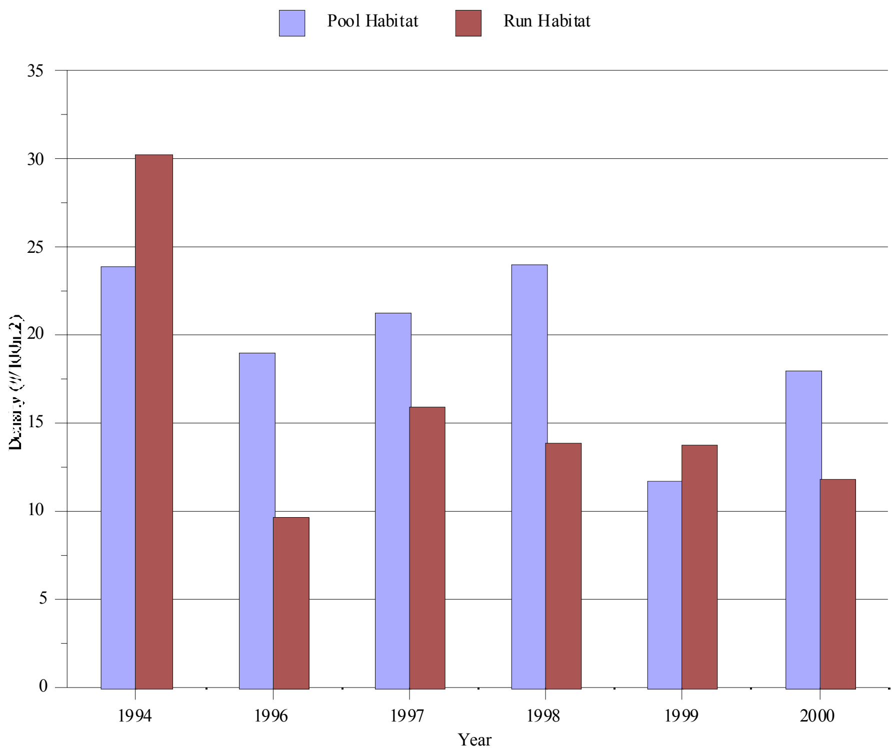

Figure 10. Average density of juvenile steelhead in pool and run habitat in upper Lick Creek from 1994 to 2000.

Productivity

Quantitative estimates of summer steelhead productivity at the subbasin scale are not available.

Life History Diversity

Adult Migration

Two strains of steelhead ascend the Snake Rivers each fall: A-run fish averaging 2-4 kg begin to enter the river in August while the larger B-run fish (averaging 5-8 kg) enter a month or so later (Berryman et al. unknown date). Adult A-run fish leave the Pacific Ocean after one to three years of residence (typically adults return to the Imnaha after only one year of ocean residence) and enter the Columbia River from June through September. They proceed up the Columbia and Snake rivers until reaching the Imnaha. Migration of adult steelhead to the Imnaha subbasin may initiate as early as the first part of September and extend through the end of November (Table 48). Peak upstream migration into the lower portion of the subbasin typically occurs in mid-February and extends through early April (Table 48), while peak movement into the upper portion of the subbasin occurs from late February until early April (Table 49).

Adult Holding

Seasonal positioning of adult Imnaha steelhead occurs in the lower Snake River, upstream to Pittsburgh Landing (RM 215) (Mundy and Witty 1998). Fish that move into the lower Imnaha (below the Big Sheep Creek confluence), will use deep pool habitats for holding through the winter (late October through early March) (Table 48) prior to initiation of spawning in the spring. Adults that spawn in the upper Imnaha will typically hold [stage] only temporarily (February through early March) (Table 49). Although some holding areas in Big Sheep Creek (i.e., from Carol Creek to Coyote Creek and from Muley Creek to the mouth of Big Sheep Creek) occur in channelized reaches, the effect is currently unknown.

Spawning

Peak spawning for summer steelhead is in the spring, occurring usually from mid-April to early June (Table 48 and Table 49). Spawn timing is strongly correlated to water temperatures. Steelhead will use the warmer tributaries, such as Camp Creek, earlier in the year and will spawn in the cooler, high-elevation tributaries (i.e., Gumboot Creek) later in the year. Most steelhead will spawn just after spring runoff, especially in smaller tributaries.

Imnaha steelhead are highly fecund. The fecundity of natural steelhead at the Little Sheep Creek weir, 1990–1993, averaged 3,927 eggs for 1-salt fish and 5,412 eggs for the 2-salt females (Carmichael et al. 1995).

Incubation

Depending upon spawn timing, peak incubation for summer steelhead begins in late April and extends through early July (Table 48 and Table 49). Fry in tributaries with warmer water may emerge from the gravel before spawning in higher tributaries is completed.

Juvenile Rearing

Juvenile steelhead may spend one to three years in fresh water before smolting (see Table 48, Table 49, and Table 59). Juveniles of three age classes were observed year-round throughout the subbasin (ODFW and NPT unpublished data).

Smolt Migration

Peak downstream juvenile migration of Imnaha steelhead initiates in late April and extends through early May (Table 48 and Table 49). Some steelhead may outmigrate from the Imnaha as pre-smolts, initiating downstream movement in September and extending through late April (*refer also to previous discussion of emigration research being conducted by the NPT*).

Carrying Capacity

Recent estimates of steelhead carrying capacity in the Imnaha subbasin are not available. In a 1987 report, Carmichael and Boyce (as cited in Mundy and Witty 1998) estimated that 165,199 summer steelhead smolts could be produced in the Imnaha subbasin.

Genetic Integrity

Recent genetic information for Imnaha summer steelhead is presented in TRT (2003). Based on genetic samples taken seven spawning areas, two distinct clusters of spawners occur in the Imnaha; fish from Big Sheep, Little Sheep, and Horse Creek clustered together and were distinct from spawners occurring in Cow and Lightning Creeks (Moran 2003 cited in TRT 2003). However, because the two clusters do not neatly correspond to geographic segments of the drainage, the two separate clusters were lumped as a single spawning aggregate (the TRT-defined IRMMT-s population).

A sample collection strategy was developed and implemented by co-managers in 1999 - 2002 to allow for DNA genetic analysis of stock structure of Imnaha steelhead, Nez Perce Tribe monitoring and evaluation personnel responsible for sample collection in eight streams, and the staff share sample collection responsibility with ODFW in two other streams. Sample analysis is being conducted by NMFS with LSRCP funding.

1.2.5.2 Distribution—Summer Steelhead

Current Distribution

Currently, Imnaha steelhead maintain widespread distribution throughout most of the subbasin, and generally occur in *all* tributaries that do not have vertical falls near their mouths (Mundy and Witty 1998). Approximately 397.6 river miles of summer steelhead spawning and rearing habitat have been identified in the Imnaha subbasin (Figure 56).

Although his samples were restricted to various portions of the subbasin, Gaumer (1968) found that juvenile steelhead of the 1965 brood year occurred in highest densities in the upper reaches of Horse, Lightning, and Cow creeks during fall sampling. Electrofishing catches remained high in the upper areas and increased at the middle and lower sampling stations during the winter and spring (Gaumer 1968).

Historical Distribution

Snake River summer steelhead population distribution in the Imnaha subbasin was historically more widespread than current conditions, a difference that is likely a result of land management activities.

Historical (pre-1900) distributions of steelhead in Little Sheep and Big Sheep creeks were likely similar to current distributions, with the exception of fish occurring above the Wallowa Valley Irrigation District Canal, which eliminated access to approximately 12.5 miles of habitat upon its construction (USFS 2003). Habitat that was eliminated includes that (above the canal) in McCully, Ferguson, Redmont, Salt, Big Sheep, South Fork Big Sheep, and North Fork Big Sheep Creeks, much of which is characterized by unfavorable steelhead habitat (i.e. high gradients, high elevation, large substrate with little gravel and low stream temperatures).

Landuse activities in the mainstem Imnaha (upper and lower) are considered to have modified flow regimes in perennial tributaries from historical conditions. Current steelhead distributions in tributary habitats may have included additional streams than presently identified, but more likely distributions extended further upstream in streams currently containing habitat (USFS 2003). The extent of habitat may have been greater due to the more perennial nature of streams prior to intensive management such as logging, road building, and grazing (USFS 2003). It could also be due to the competition for food and space that would have occurred when greater fish numbers were present (USFS 2003). This competition may have forced steelhead further upstream to escape competition (USFS 2003).

In the absence of historical distribution data, it is difficult to determine specifically which streams were inhabited by summer steelhead; however, based on the lack of residual rainbow trout above Imnaha Falls (RM 73), it is likely that steelhead have always been restricted to accessible areas downstream from this probable migration barrier (Mundy and Witty 1998).

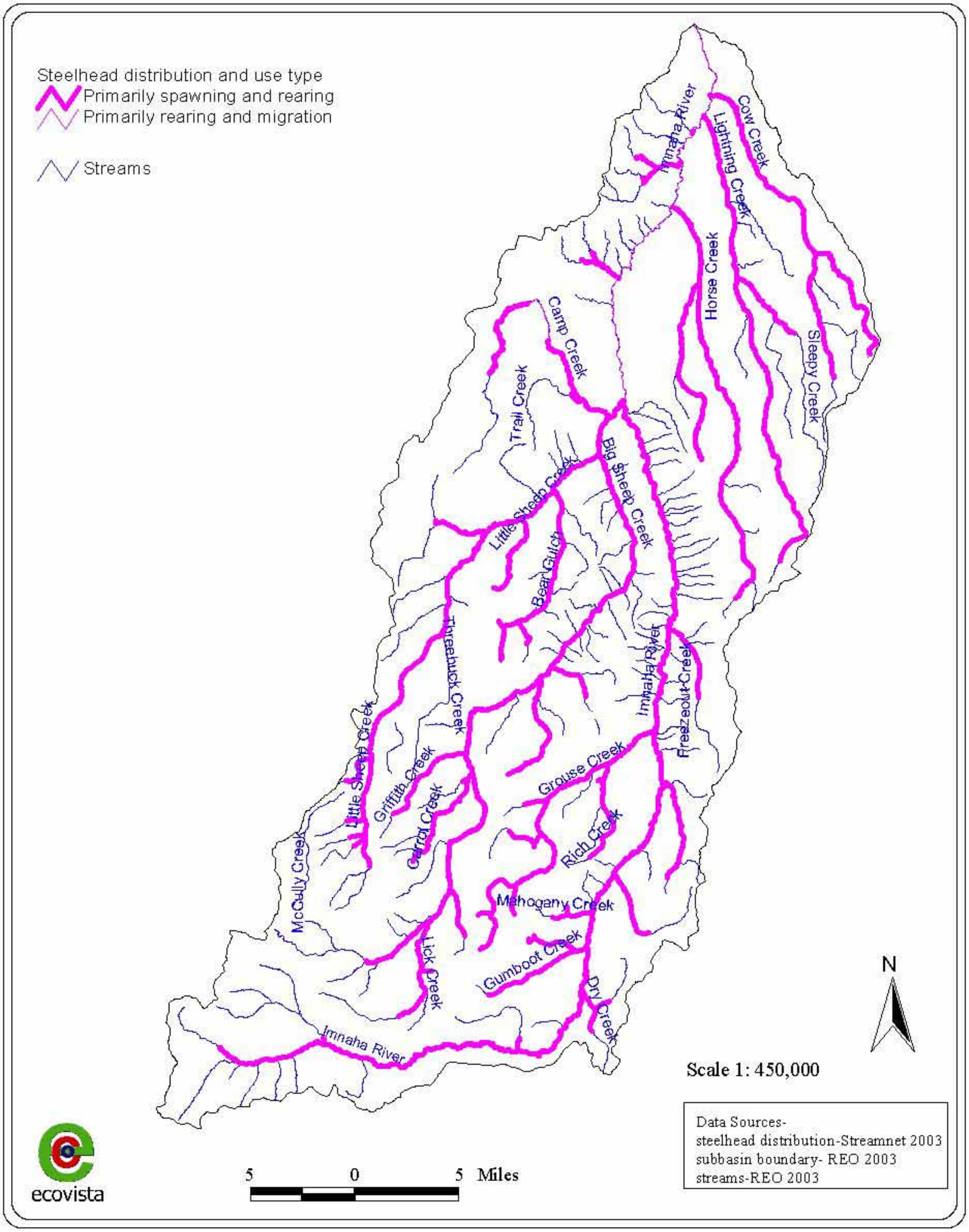

Figure 56. Steelhead distribution and use type, Imnaha subbasin.

1.2.5.3 Summer Steelhead Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

The summer steelhead fishery on the Imnaha was closed in 1974 due to declining adult returns, as indicated by adult counts at Ice Harbor Dam on the Snake River (USACE 1990) and low redds counts at index sites. Under the auspices of the Lower Snake River Compensation Program (LSRCP), a steelhead supplementation program was initiated in 1982 to help restore a tribal and recreational fishery (Carmichael 1989). A consumptive-based recreational summer steelhead fishery on adipose-clipped hatchery origin fish was subsequently re-opened in 1986 due to increased returns from the hatchery program (Flesher et al. 1993) (Figure 57).

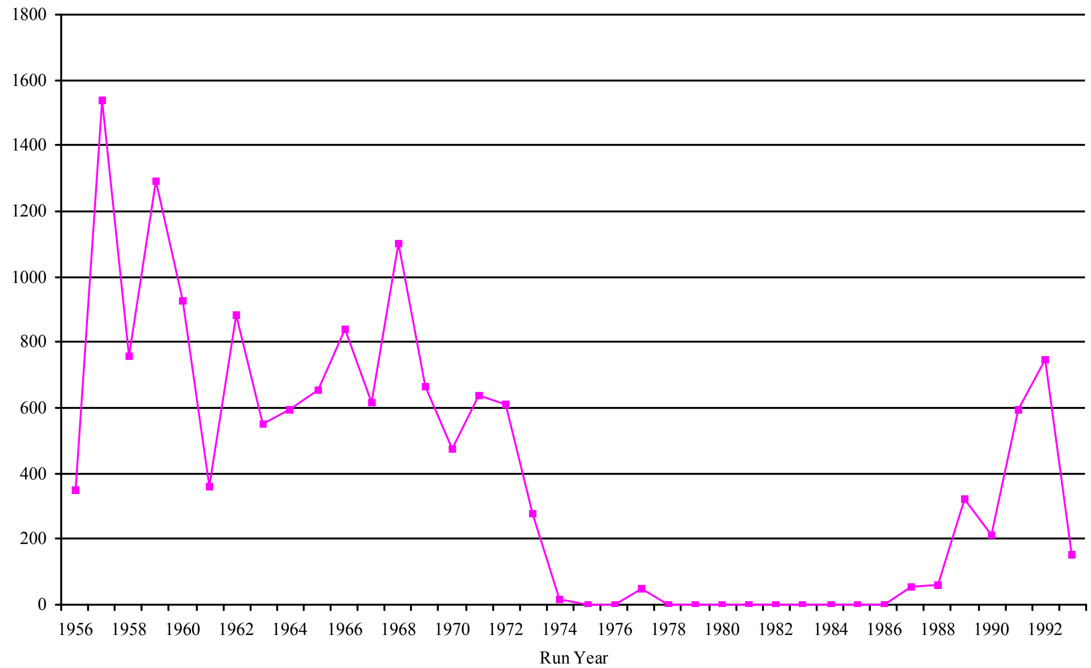

Figure 57. Estimated annual steelhead harvest in the Imnaha subbasin for the run years 1956–1993 (StreamNet database 2001).

Annual creel surveys for Imnaha steelhead have been conducted by the ODFW since the fishery reopened in 1986. The surveys, which are conducted only in the spring, provide managers with annual harvest information needed to assess LSRCP objectives and compensation goals. Results from creel surveys for the run years 1986–1998 are shown in Table 61. Contemporary tribal harvest activities within the drainage directed toward removing harvestable surpluses of hatchery origin fish has not occurred.

Table 61. Creel survey results for summer steelhead caught in the Imnaha River for the run years 1987–1998 (ODFW data presented in Carmichael et al. 1989a,b; Carmichael et al. 1991; Flesher et al. 1993; Flesher et al. 1994a,b; Flesher et al. 1995, 1996, 1997, 1999).

Run Year	Number of Anglers[1]	Effort (hours)	Catch		Catch Rate Index (hours/fish)
			Number Wild	Number Hatchery Kept	
1986–1992	Punchcard Data Only				
1992–1993	789	2,910	130	171	8.0
1993–1994	298	1,336	72	29	13.0
1994–1995	219	1,048	39	24	17.0
1995–1996	588	2,599	210	112	7.0
1996–1997	209	N/A	N/A	97[1]	6.0
1997–1998	111	N/A	N/A	27[1]	10.0

[1] Value represents a subsample of total.

Historical In-Basin Harvest Levels

Historical steelhead harvest data specific to the Imnaha subbasin extend back only to 1953. Native Americans harvested salmon and steelhead in the Imnaha river drainage before the time of colonization by peoples of European descent in the eighteenth century (Mundy and Witty 1998). Within the cultures active in the Imnaha subbasin, traditional fishing practices served to provide for conservation of salmon by limiting the times and areas of harvest (Mundy and Witty 1998).

1.2.5.4 Summer Steelhead Hatchery Influence

Summer steelhead production efforts in the Imnaha subbasin have occurred through the *Lower Snake River Compensation Plan* (LSRCP) since 1982. The preferred stock for hatchery use is Little Sheep stock and no outside introductions are planned (NPT et al. 1990).

Three facilities are used for the steelhead production program. The adult collection/smolt acclimation facility is located in the Imnaha River subbasin on the Little Sheep Creek. Adults are collected and spawned at Little Sheep Creek. Embryos are initially incubated at Wallowa Hatchery and then transported to Irrigon Hatchery. Final incubation and rearing to the smolt stage occurs at Irrigon FH. Following 10 to 13 months of rearing, smolts are transferred back to the acclimation facility for 30 days of acclimation prior to release in April and May. The Little Sheep Creek facility is designed to accommodate up to approximately 250,000 smolts.

Beginning in 1982, wild summer steelhead were collected from Little Sheep Creek for broodstock. Little Sheep Creek was chosen because it contained a healthy run of wild steelhead. The goal of the program was to incorporate naturally produced fish into the broodstock on an annual basis, to ensure adequate escapement of natural fish to Little Sheep Creek. Since 1987, returns of naturally produced adult steelhead to Little Sheep Creek have amounted to less than 20% of the total return in spite of substantial supplementation with hatchery-produced adults. Further, since the program began, the numbers of natural adult returns have exceeded prehatchery supplementation numbers only in 2002. Smolt production goals have, however, generally been achieved in all years except 1997.

Prior to 1998, releases had only occurred at the Little Sheep Creek facility and in the mainstem Imnaha River. In 1998, fry were planted in other tributaries, and since 1999, adults have been outplanted in Big Sheep Creek. The TRT (2003) defines the degree of hatchery outplanting in the Imnaha as 'medium', a rating which is based on an average of 50,000 to 500,000 fish released per year over the last ten years. Smolts have also been released in Big Sheep Creek since 2000. Smolt-to-adult survival rates have varied, but have typically been below the goal of 0.61%. Life history and genetic characteristics of adult hatchery and natural fish have remained similar in the Little Sheep Creek drainage, although characteristics of fish throughout other portions of the subbasin are unknown.

Averaged over the last five years, an estimated 10-25% of natural spawning fish are of hatchery-origin (TRT 2003). There is some genetic evidence of hatchery introgression, as Imnaha steelhead tend to have a high affinity to locally derived broodstock. The majority of releases of hatchery fish are from in-population broodstock (Table 62).

Table 62. Hatchery releases of Imnaha summer steelhead (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002*	% natural origin spawners 1980-1997*	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-2002
Imnaha River	IRMMT-s	79	88	Imnaha	36,395	296,999	172,948	291,158	2,375,992	1,383,580
				Wallowa	5,022	-	-	40,179	-	-
				L.Sheep	-	-	139,751	-	-	1,118,005
				All Stocks	**41,417**	**296,999**	**312,698**	**331,337**	**2,375,992**	**2,501,585**

*Average among those yeas in the indicated period for which data was available

A total of 1,354 adult steelhead returned to the Little Sheep Creek trap in 2001, compared with 520 in 2000. Of these, 127 were unmarked. State and tribal cooperators worked together to release 785 adults above the weir into Little Sheep Creek and 354 into Big Sheep Creek. A total of 457,800 green eggs were collected from 109 females. A total of 358,630 BY2001 eyed steelhead eggs were sent from the Irrigon FH to the Little Sheep Creek facility in 2001. In 2001, 242,456 steelhead smolt were delivered from the Irrigon FH to the Little Sheep Creek satellite facility for release. Big Sheep Creek received a direct release of 100,216 steelhead smolts from the Irrigon FH in 2001.

A consumptive steelhead recreational fishery was re-opened in 1986 after being closed since 1974. Catch rates in the Imnaha River are high and better than historical values, due in large part to the success of the mitigation program. Imnaha hatchery steelhead contribute to fisheries throughout the Columbia Basin. Despite meeting many production goals, the following obstacles to achieving management objectives remain: low smolt-to-adult survival, low success with hatchery fish supplementation, apparently low carrying capacity of Little Sheep Creek, low abundance of natural fish in the Little Sheep Creek, and lack of information on steelhead population dynamics in the Imnaha River.

Evaluations of stock status of wild steelhead in the Imnaha River subbasin were initiated in 2000 with operation of an adult escapement weir in Lightning Creek. This effort has been expanded to Cow Creek in 2001.

Future Plans

The steelhead program will continue to be managed to mitigate for lost sport and tribal harvest resulting from construction of lower Snake River dams. Co-managers will continue to monitor the success of the program at meeting LSRCP goals and the success of supplementing Little Sheep Creek with hatchery steelhead.

1.2.6 Bull Trout Population Delineation and Characterization

1.2.6.1 Population Data and Status—Bull Trout

Bull trout (*Salvelinus confluentus*) occurring in the Imnaha subbasin belong to the Imnaha-Snake Rivers Recovery Unity, which is a part of the Columbia River DPS, which includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (ICBEMP 1997b). The Columbia River Basin DPS has declined in overall range and numbers of fish. The population segment is composed of 141 subpopulations indicating habitat fragmentation, isolation, and barriers that limit bull trout distribution and migration within the basin.

Bull trout occupy portions of 14 major tributaries in the Snake River Basin of Idaho, Oregon, and Washington. The USFWS identified 34 bull trout subpopulations in the Snake River basin, four of which occur in the Imnaha subbasin. These subpopulations are the Imnaha River, Big Sheep Creek, Little Sheep Creek, and McCully Creek and include both resident and migratory fish. Bull trout have also been found throughout the Wallowa Valley Improvement Canal (Buchanan et al. 1997). Because resident fish found within the canal have no downstream passage opportunities and could originate from the Big Sheep, Little Sheep, or McCully creek subpopulations, bull trout found here have not been recognized as a distinct subpopulation.

Abundance and Trends

The status of the bull trout was first assessed in 1991 (Ratliff and Howell 1992), and all subpopulations within the Imnaha subbasin except the Imnaha River were rated of “special concern” because of passage barriers, downstream losses of migrants, and in Big Sheep and Little Sheep creeks, habitat degradation (USFWS 2002b). The Imnaha River subpopulation was rated at “low risk”. Additional monitoring led to a downgrading of the Little Sheep Creek subpopulation to “high risk of extinction”. McCully Creek was downgraded to “moderate risk of extinction” because of the isolation of this population caused by the canal (USFWS 2002b).

Based on sampling of bull trout densities (Table 63) ODFW believes there are greater than 2,000 bull trout in the upper Imnaha River and Big Sheep Creek and fewer than 500 in Little Sheep Creek (Smith, as cited in USFS 2003d). The resident population in Big Sheep Creek, estimated at less than 2,000 individuals, exists above and below the Wallowa Valley Improvement Canal in both the North and South forks of Big Sheep Creek, Salt Creek and Lick Creek (USFS 2001).

Bull trout redd counts have only occurred in the Imnaha River since 1998 (Table 64) (USFS 2003d), thereby precluding the establishment of any meaningful population trends. USFS and ODFW biologists will continue to conduct bull trout redd counts in the future.

Table 63. Estimated density of bull trout in selected streams in the Imnaha subbasin that were sampled in 1992 (ODFW data presented in Buchanan et al. 1997).

Stream	Site Number	Estimated density (fish/100 m^2 by size class[1])	
		1 to 75 mm	76 to 300 mm
Big Sheep Creek	1	0.00	0.00
	2	18.32	5.61
	3	0.00	7.40
Salt Creek	1	5.87	18.77
Lick Creek	1	0.66	0.00
	2	55.49	15.76
Little Sheep Creek	1	0.00	0.00
	2	0.00	0.00
McCully Creek	1	1.74	7.84
	2	0.57	7.35
	3	0.00	5.79

[1] Size class 1 to 75 mm are considered to be 0+ age, while fish 76 to 300 mm are considered to be older than 0+ age.

Table 64. Spawning survey results for bull trout in the Imnaha subbasin (reproduced from USFWS 2002b, USFS 2003d)

Stream	Year	Redds	Miles Surveyed	Redds/Mile	Comments
Mainstem Imnaha[1]	1998	18	2.6	6.9	
	1999	16	22.9	0.7	
	2000	18	18.0	1.0	
	2001	30	13.6	2.2	
	2002	17	14.2	1.2	Survey occurred from the Blue Hole to the fish weir (14.2 miles) (USFWS 2002b)
Mainstem Imnaha Tributaries[2]	1999	0	0.0	0	Bear, Cliff, Soldier, N. & M. Forks
	2000	30	2.8	10.9	Bear, Cliff, N. & M. Forks
	2001	261	17.1	15.3	Bear, Cliff, Soldier, upper Imnaha (Blue Hole to N. Fork), N., S., & M. Forks
	2002	96	16.3	5.9	Upper Imnaha—survey occurred from the headwaters to the Blue Hole (16.3 miles) (USFWS 2002b)
Big Sheep Creek[1]	1999	13	5.2	2.5	
	2000	2	2.0	1.0	

Stream	Year	Redds	Miles Surveyed	Redds/Mile	Comments
	2001	6	1.9	3.2	
	2002	40	9.1	4.4	Survey included Big Sheep Creek and its tributaries (9 miles) (USFWS 2002b)
Big Sheep Creek Tributaries[1]	1997	9	0.7	12.9	Lick Creek only
	1999	7	14.0	0.5	Lick, Salt, and Little Sheep creeks and canal above Little Sheep Creek
	2000	12	8.0	1.5	Lick and Salt creeks
	2001	18	6.7	2.7	Lick and Salt creeks

[1] Includes fluvial and resident bull trout

[2] Includes resident bull trout only

Except where the Wallowa Valley Improvement District Canal has prevented connectivity, the populations in many of the tributaries are resilient (USFS 2003d). All but the Little Sheep Creek subpopulation are stable, and have a high potential to produce surplus individuals due to the presence of large neighboring subpopulations (USFS 2003d). The probability of hybridization with other species is low to nonexistent in any of these subpopulations.

Life History Diversity

Adult Migration

In the lower Imnaha (below the Big Sheep Creek confluence), peak upstream migration of fluvial bull trout occurs in May and extends through the first half of June (Table 65). Adult upstream migration into the upper portion of the subbasin also initiates in May but extends through the first half of July, and sometimes into early August (Table 66). Fluvial adults appear to move downstream in the Imnaha River during the months of August, September, October, and perhaps November (USFWS 2002b).

Seasonal movements of fluvial fish may range up to 300 kilometers as migratory fish move from spawning and rearing areas into overwintering habitat in downstream reaches of larger basins (Bjornn and Mallet, as cited in USFS 2003d; Elle, as cited in USFS 2003d). It is certain that some fluvial bull trout from the Imnaha River migrate out of the Imnaha River and overwinter in the Snake River and, given recent radiotelemetry data (Chandler and Richter, as cited in USFWS 2002b), fish found in the Imnaha River below Summit Creek are probably moving between summer or spawning habitat and overwinter habitat in the lower Imnaha or Snake Rivers.

Table 65. Life history timing for nonanadromous species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Fluvial Migration												
Bull Trout Fluvial												
O. mykiss Resident												
Adult Spawning												
Bull Trout Fluvial												
O. mykiss Resident												
Adult/Subadult Rearing												
Bull Trout Fluvial												
O. mykiss Resident												
Egg Incubation through Fry Emergence												
Bull Trout Fluvial												
O. mykiss Resident												
Juvenile Rearing												
Bull Trout Fluvial												
O. mykiss Resident												
Juvenile/Subadult Migration												
Bull Trout Fluvial												
O. mykiss Resident												

Represents periods of peak[1] use, based on professional opinion
Represents lesser[2] level of use, based on professional opinion
Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

[1] Based on professional opinion, 70% of the life stage activity occurs during the time frame shown as the peak use period.
[2] Based on professional opinion, 30% of the life stage activity occurs during the time frame shown as the lesser use period.

Table 66. Life history timing for nonanadromous species in the Imnaha subbasin, from the Big Sheep Creek confluence to the headwaters (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Fluvial Migration												
Bull Trout Fluvial												
O. mykiss Resident												
Adult Spawning												
Bull Trout Fluvial												
O. mykiss Resident												
Adult/Subadult Rearing												
Bull Trout Fluvial												
O. mykiss Resident												
Egg Incubation through Fry Emergence												
Bull Trout Fluvial				1 1	1 1							
O. mykiss Resident												
Juvenile Rearing												
Bull Trout Fluvial												
O. mykiss Resident												
Juvenile/Subadult Migration												
Bull Trout Fluvial												
O. mykiss Resident												

Represents periods of peak[1] use, based on professional opinion

Represents lesser[2] level of use, based on professional opinion

Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

[1] Based on professional opinion, 70% of the life stage activity occurs during the time frame shown as the peak use period.

[2] Based on professional opinion, 30% of the life stage activity occurs during the time frame shown as the lesser use period.

Spawning

In the upper Imnaha, spawn timing peaks from September through the first half of October, but may initiate in the second half of August and extend through the end of October (Table 66). Resident bull trout were found to be sexually fecund at 160 mm, based on a sample of fish from Big Sheep, Salt, Lick, and McCully Creeks in 1992 (Buchanan 1997).

Incubation

Bull trout incubation through fry emergence in the upper Imnaha subbasin initiates in the latter part of August (depending upon spawn timing) and extends through the end of May (Table 66). Hatching may occur in winter or early spring, but alevins may stay in the gravel for an extended period after yolk absorption (McPhail and Murray 1979). Fry generally emerge from the gravels by the end of April (USFS 2003d). Optimum temperatures for incubation and rearing have been cited between 2 and 4 °C (35.6–39.2 °F) and 7 and 8 °C (44.6–46.4 °F), respectively (Rieman and McIntyre 1993).

Juvenile Rearing

Juvenile rearing occurs throughout the subbasin during winter months, while it is restricted to headwater reaches, or those maintaining sufficiently cold water temperatures during summer months (Table 65 and Table 66). Most known summer rearing and holding areas in the Imnaha River are on National Forest or wilderness lands above Summit Creek. Fluvial forms rear in natal tributaries for one to four years before moving to larger rivers to mature. Fluvial bull trout will inhabit a wide range of habitats ranging from second to sixth order streams and varying by season and life stage. They live for another two to four years in these larger systems, growing to much larger sizes than resident forms, before returning to natal tributaries to spawn (Pratt 1992).

Juvenile/Subadult Migration

Juvenile and/or subadult migration of fluvial bull trout initiates in September and extends through the end of April in all portions of the subbasin (Table 65 and Table 66). Migration of juvenile resident fish is uncommon, as they are typically restricted to headwater streams throughout their life. Both fluvial and resident forms are believed to exist together in some areas, but migratory fish may dominate populations where corridors and subadult rearing areas are in good condition (Rieman and McIntyre 1993).

Carrying Capacity

No information is available regarding bull trout carrying capacity within the Imnaha subbasin.

Unique Population Units

All bull trout found within the Imnaha subbasin are considered part of Bull Trout Recovery Unit 11 (Imnaha-Snake River Basins) as defined by the USFWS (2002b). Distinct subpopulations of bull trout have been identified in the Imnaha River above and below Imnaha Falls, Big Sheep Creek, Little Sheep Creek, and McCully Creek, and encompass both resident and migratory fish.

Genetic Integrity

Samples for genetic analysis were taken in 1995 from the North Fork Imnaha River, McCully Creek, and Lick Creek, and compared with bull trout throughout Oregon, Washington, and elsewhere in the Columbia Basin (Buchanan 1997). Analysis of these data shows that populations from the John Day Basin and Northeastern Oregon (including the Imnaha River basin) comprise major genetic lineages (Spruell and Allendorf 1997). More recently, work by Spruell et al. (2003), establishes that the Imnaha bull trout population is most closely associated (by allelic frequency) with fish of the Grande Ronde subbasin. These populations are further grouped with populations from the John Day, Walla Walla, Pine Creek, and Powder subbasins.

Population Risk Assessment

The risk of the Imnaha River local population going extinct is low (Ratliff and Howell 1992). The risk of either the local populations above or below the diversion in Big Sheep Creek going extinct is of special concern (see Ratliff and Howell 1992). The risk of the McCully Creek local population going extinct is considered moderate (Buchanan et al. 1997). The risk of the Little Sheep Creek local population going extinct is considered high (Buchanan et al. 1997).

1.2.6.2 Distribution—Bull Trout

Current Distribution

Bull trout are found from the headwaters to the mouth in the mainstem Imnaha River and in numerous tributaries. Spawning and rearing habitat occurs mainly in the upper reaches of the Imnaha River, Big Sheep Creek, Little Sheep Creek, and their associated headwater tributaries (Figure 58). Migratory life stages of bull trout have access to the Snake River and may use this habitat at various times of the year when cooler water temperatures are available, or for overwintering purposes (M. Hanson, ODFW, personal communication, April 23, 2001).

The Imnaha bull trout recovery unit team, a group comprised of participants from ODFW, USFS, USFWS, Grand Ronde Model Watershed Group, and Nez Perce Tribe, suspects that the Imnaha/Snake Recovery Unit contains up to two core areas, but for the purposes of recovery should be considered as one core area. These areas include the Imnaha Core Area, which is comprised of all tributaries containing local populations (both current and potential as identified by the recovery unit team), and the mainstem Imnaha River from the headwaters downstream to the confluence with the Snake River (M. Hanson, ODFW, personal communication, April 23, 2001). Populations occurring in Snake River tributaries such as Sheep and Granite Creek likely represent a separate core area. The lack of understanding of Snake River utilization by Imnaha bull trout currently represents a research need (M. Hanson, ODFW, personal communication, April 23, 2001).

A mixture of both resident and fluvial forms of bull trout occur above and below Imnaha falls. Resident forms are most common in the North Fork and Middle Fork of the North Fork Imnaha (USFS 2000). The Wallowa Valley Irrigation Canal has isolated resident populations in Big Sheep, Little Sheep, McCully, Ferguson, Canal, and Redmont creeks, all of which are estimated to be less than 2,000 individuals in size (USFS 2003d). Connectivity between populations above the canal is reestablished annually during irrigation season (April 1 to October 15). It has been estimated that the McCully Creek population is in excess of 800 individuals. The resident population in Big Sheep Creek exists above the diversion to the irrigation canal. This population is found in both the North and South Forks of Big Sheep Creek and is less than 2,000 individuals in size.

There may be some movement of bull trout into the Wallowa Valley Improvement Canal during certain times of the year but the canal does not promote connectivity among local populations. Some of the fish may move downstream, but there little opportunity for movement upstream. Fish from Big Sheep Creek may be the primary source of bull trout in the canal and some tributary segments above the canal. Bull trout in McCully Creek above the canal are isolated and can only move downstream. Although the miles of stream located above the canal is small compared to the total Imnaha system, these smaller streams are important spawning and rearing areas for bull trout, and would benefit from being more connected in an upstream and downstream direction.

Fluvial populations occur throughout the mainstem up to the junction of the South and North Forks of the Imnaha River (USFS 2000) (Figure 58). Fluvial forms are also found in Big Sheep Creek and Little Sheep Creek. The presence of fluvial fish, combined with a relatively high degree of connectivity between and within habitats, ensures genetic interchange and refounding potential between other spawning and rearing groups.

The migratory corridor for mainstem bull trout populations extends to just above the Grouse Creek confluence, at which point the habitat also becomes functional for rearing life history forms (Figure 58). Spawning occurs in Big Sheep Creek above its confluence with Carrol Creek (RM 25) and in Little Sheep Creek above the USFS boundary (RM 28) (USFS 2000). Presence of age 0+ fish has been documented in the South Fork Imnaha and its tributaries (Bear Creek, Blue Creek, Soldier Creek, Cliff Creek), the North Fork Imnaha, the Middle Fork Imnaha, in Big Sheep Creek and its tributaries (Lick and Salt Creek), and in McCully Creek, indicating that these streams are also used for spawning (Buchanan et al. 1997).

Historical Distribution

Historical accounts of bull trout populations in the Imnaha are limited. Short segments of historical resident bull trout spawning and rearing habitat have been identified in upper Little Sheep Creek and Cabin Creek (USFS 2000). Unlike other salmonids, it is doubtful that bull trout occupied all accessible streams at any one time (USFS 2000), due to their current patchy distribution in even pristine “stronghold” habitat types (Rieman and McIntyre 1993). In the Imnaha, historical distribution likely was similar to current distribution (M. Hanson, ODFW, personal communication, April 23, 2001).

1.2.6.3 Bull Trout Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

Current, direct/indirect, in-basin harvest levels of bull trout in the Imnaha are not available. In some years, standard creel surveys are conducted between September and April for a summer steelhead fishery (Flesher in litt., as cited in USFWS 2002b); however, because the surveys are geared to steelhead, they are not done in a manner conducive to estimating angling influence on bull trout populations.

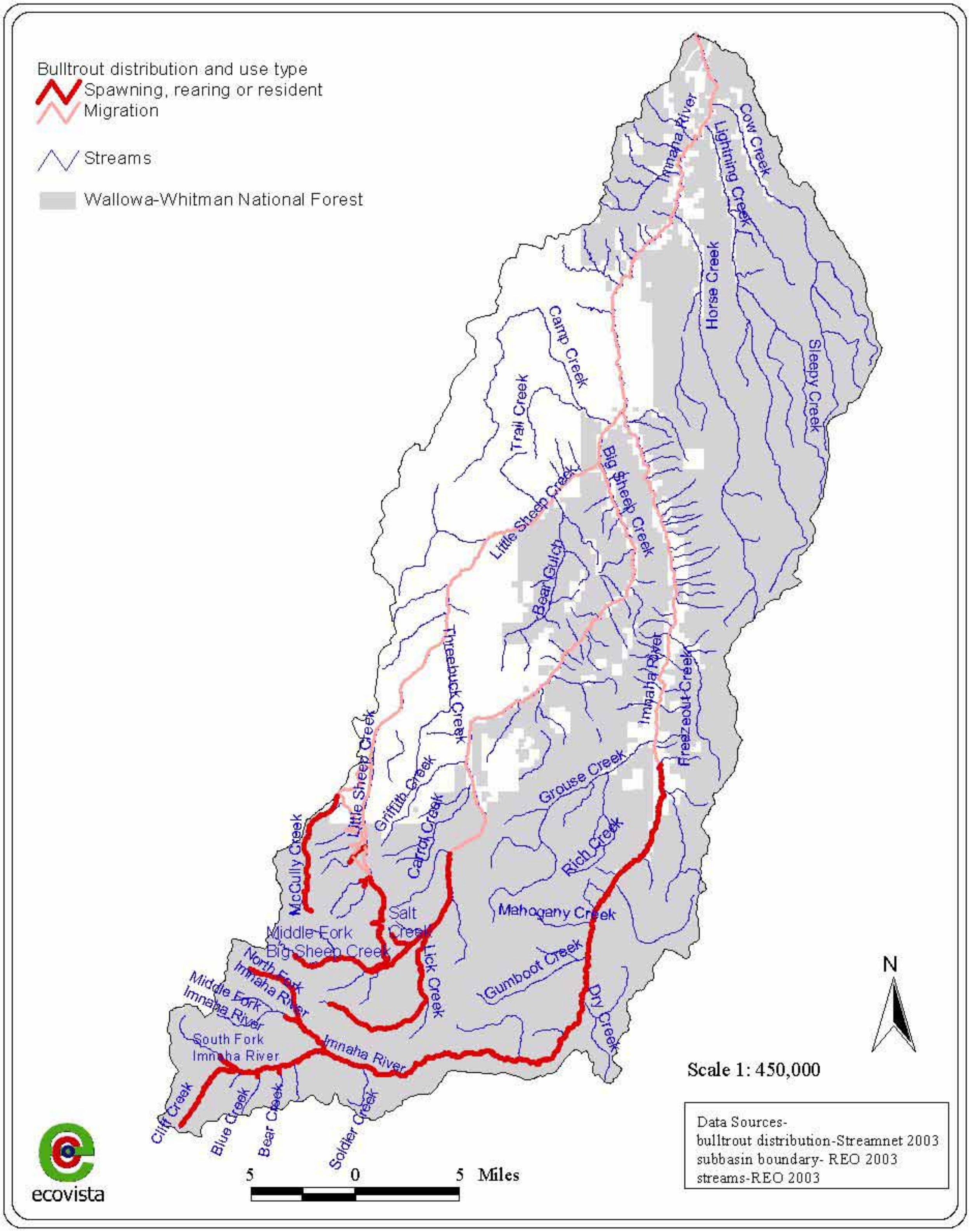

Figure 58. Bull trout distribution and use type, Imnaha subbasin

Regulations imposed in 1994 required the release of all bull trout caught by anglers. Despite these regulations, bull trout are still caught in the Imnaha subbasin. Angling pressure is highest near the many campground areas in the subbasin, but also occurs throughout other portions of the subbasin (USFWS 2002b). Incidental catches occur by anglers fishing for steelhead (USFWS 2002b). ODFW, Oregon State Patrol, the USFS, and local media work together to inform anglers of bull trout angling restrictions. Signs informing the public of fishing regulations have been placed at access sites near traditional bull trout fishing areas (Buchanan 1997).

Historical In-Basin Harvest Levels

Historical in-basin harvest levels of bull trout in the Imnaha subbasin are not available. Anecdotal accounts from anglers who fished the Imnaha River in the 1940s describe the river as "a good Dolly Varden stream" with large bull trout being caught frequently (Buchanan et al. 1997).

Historical harvest of bull trout may have reduced the total numbers of fish within populations in small tributaries and contributed to the overall decline in the subbasin. For example, before the 1990s, bull trout angling was permitted in the State of Oregon. Angling in the Imnaha subbasin was controlled by standard statewide seasons and limits for trout.

1.2.7 Lamprey Population Delineation and Characterization

1.2.7.1 Population Data and Status–Lamprey

Population and status information documenting Pacific lamprey (*Lampetra tridentata*) in the Imnaha subbasin is limited. Descriptions of species, sex, length, weight, or life history stage are generally not available. The following discussions are based on empirical, historical, and/or anecdotal information.

Abundance and Trends

Current information suggests that lamprey populations are declining, and in January 2003, four species of lamprey, including *L. tridentata,* were petitioned for listing under the Endangered Species Act.

Throughout their range in the Columbia River Basin, Pacific lampreys have declined to only a remnant of their pre-1940s populations. Lower Snake Dam counts numbered over 30,000 in the late 1960s but have declined to less than 500 fish in recent years (Table 67). As early as the 1980s, "a lot" of adult Pacific lamprey could be seen clinging to fish-viewing windows in Columbia River dams. Devices were installed at the ladders to keep them away from fish-counting windows, as they were often abundant enough to obscure counting of salmon (Ocker et al., as cited in Kostow 2003). Currently, an estimated 3% of the lamprey that pass Bonneville Dam are counted at Lower Granite Dam (Close 2000). Based on adult lamprey observations at Lower Granite Dam, the current status in the Imnaha subbasin is thought to be extremely depressed (CBFWA 1999).

Table 67. Trends in counts of Pacific lamprey in fish ladders at mainstem dams between the Pacific Ocean and the Salmon subbasin, Idaho (Source: Fish Passage Center, http://www.fpc.org/adult.html).

Dam	Early 1960's	1996	1997	1998	1999	2000	2001	2002
Bonneville	350,000	---	20,891	---	---	19,002	27,947	100,476
The Dalles	300,000	---	6,066	---	---	8,050	9,061	23,417
John Day	*No dam*	---	9,237	---	---	6,282	4,005	26,821
McNary	25,000	---	---	---	---	1,103	2,539	11,282
Ice Harbor	50,000	737	668	---	---	315	203	1,127
L.Monumental	*No dam*	---	---	---	---	94	59	284
Little Goose	*No dam*	---	---	---	---	4	104	365
Lower Granite	*No dam*	---	1,122	---	---	28	27	128

According to Kostow (2003), Pacific lamprey appear to be at dangerously low numbers in the Snake River Basin, with fewer than 200 adults seen annually at Lower Monumental, Little Goose, and Lower Granite dams during the 1990s. Pacific lamprey may be gone from the upper Grande Ronde subbasin (Kostow 2003) and extirpated from the Imnaha.

Current abundance estimates for Pacific lamprey in the Imnaha subbasin are unknown. Screen-trap records collected between September 1964 and June 1967 from the lower mainstem Imnaha, downriver from the Horse Creek confluence, are of sufficient detail, however, to provide some indication as to relative abundance (Figure 59). The highest number of lamprey captured during any one month was 106 in June 1965. A total of two lamprey were caught over the four month period in 1964, 326 in 1965, 235 in 1966, and 126 over the six-month period in 1967. Although the catch data are of limited utility for making abundance estimates, they do illustrate that lamprey were fairly common in the mainstem, especially during late spring and/or early summer months.

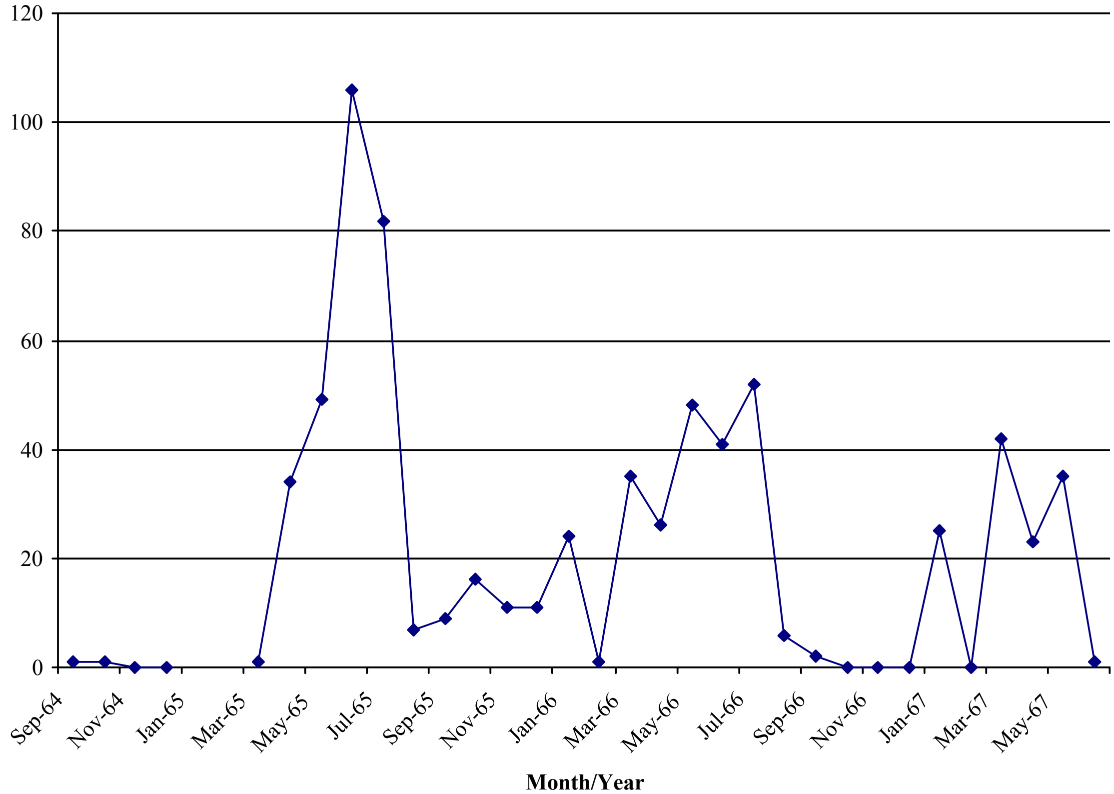

Figure 59. Summary of lamprey catch in the lower mainstem Imnaha River (Gaumer 1968).

Productivity

Productivity evaluations of lamprey populations in the Imnaha subbasin have not been made.

Life History Diversity

The following excerpts were taken from Kostow (2003).

Pacific lamprey is a member of the subgenus *Entosphenus*. It has the widest world distribution of any lamprey species in Oregon. It is the largest lamprey, as adults, in Oregon and represents the only species that is harvested.

Pacific lamprey is an anadromous, parasitic species with the period of parasitism occurring in the ocean. Ammocoetes live in fresh water where they are burrowing filter feeders. Lampreys undergoing metamorphism and spawning adults do not feed.

Lampreys emerge from spawning gravels at about 1 cm in length. Ammocoetes will grow to 17 or 18 cm and may remain at this life stage for up to seven years.

Metamorphism of Pacific lamprey is reported as occurring in July through November with out-migration to the ocean occurring November through June, peaking in the spring. Metamorphism may vary regionally. Lamprey do not feed during metamorphism since extensive changes in the gut are occurring. Rather they live on lipid reserves, and some individuals may shrink in size.

Most downriver movement occurs at night. Timing of migration may be based on temperature cues. Both eyed lamprey and ammocoetes will migrate. Ammocoetes move progressively downstream, eventually accumulating in the lower parts of basins while eyed lampreys are going to the ocean.

Pacific lamprey enter salt water and become parasitic, feeding on a wide variety of fish and also on whales. In turn, marine mammals and larger fish eat them. They move off-shore quickly and into waters up to 70 meters deep. The length of time spent in the ocean is not known, but ranges somewhere between 6 and 40 months.

Pacific lamprey are reported to return to fresh water between April and June but may enter the lower Columbia River as early as February. Long upriver migrations, such as up into the Snake River basin, can extend until as late as September. After entering fresh water and completing part of their migration, Pacific lamprey are thought to overwinter before spawning.

Spawning in the Snake River Basin is uncertain, but likely occurs between April and July. Lamprey select spawning gravels just upstream of riffles and often near ammocoete habitats (silty pools and banks). Spawners may be attracted to chemical stimuli produced by ammocoetes. Female fecundity is variable between individuals, ranging between 15,500 to 240,000 eggs per female.

Carrying Capacity

The capacity of lamprey habitat in the Imnaha subbasin has not been defined. It is agreed, however, that habitat availability in the Imnaha is not considered to be a factor limiting production and that underseeding is likely the primary cause for concern.

1.2.7.2 Distribution—Lamprey

Current Distribution

Current lamprey distribution in the Imnaha is unknown. As mentioned previously, it is possible that this species has been extirpated from the subbasin.

Historical Distribution

Historical distribution of Pacific lamprey in the Imnaha subbasin is unknown.

1.2.8 Aquatic Environmental Conditions

1.2.8.1 Habitat Conditions for Focal Species—Overview

General

The National Marine Fisheries Service has designated critical salmon and steelhead habitat for species endemic to the Snake River Basin to include all areas currently accessible to the species within the range of the Evolutionarily Significant Unit (U. S. Federal Register 2000). Critical habitat inherent to this definition includes "all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years)", which functionally provide "spawning sites, food resources, water quality and quantity and riparian vegetation" (U. S. Federal Register, 2000).

Spring/summer chinook

There are 137.7 miles of spring/summer chinook salmon Designated Critical Habitat in the subbasin, including 130.6 miles of presently used habitat for the Imnaha River mainstem (IRMAI) and Big Sheep Creek (IRBSH) populations combined and 7.1 miles of historical spawning habitat. Ecoregion-based (Level 4) habitat characteristics for the Imnaha population include mesic forest in the headwaters, canyons and dissected highlands in the middle reaches, and canyons and dissected uplands in the lower reaches (*refer to* Section 1.1.1.4 *and* Figure 4). The upper reaches of the Big Sheep population are characterized by dissected highlands, while the lower reaches are almost entirely canyons and dissected uplands.

For the Imnaha population, high quality, 'core' spawning habitat occurs on the mainstem from the Blue Hole (RM 69) downstream to Grouse Creek (RM 34.7; *refer to* Figure 50). Based on StreamNet data, spring chinook spawning/incubation also occurs above (the lower reaches of the South Fork) and below (upriver from the Freezeout confluence) the core reach and in the South Fork Imnaha. Spring/summer chinook spawning/incubation habitat has been defined in approximately 23.9 miles of the mainstem Big Sheep population. Included within these reaches is the TRT-defined core spawning area.

Fall chinook

Fall chinook (SNMAI) Designated Critical Habitat includes the 23 miles of the Imnaha River from its mouth to the town of Imnaha. Twenty-one miles of this reach is currently used by fall chinook for spawning and early rearing life history stages (USDA Forest Service 1994; S. Rocklage, NPT, personal communication, April 2004).

Although not specifically identified in TRT (2003), the lower Imnaha represents part of the current core spawning areas for the Snake River fall chinook population. The Canyons and Dissected Uplands subecoregion (Level 4) is the dominant habitat type throughout Imnaha stream reaches used by the SNMAI population (*refer to* Section 1.1.1.4 *and* Figure 4).

Summer steelhead

The total number of stream miles in the subbasin that are inhabited by the IRMMT-s steelhead population is estimated to be 397; 263 of which are used for spawning and rearing (USFS

1998a). Habitat conditions vary for spawning and rearing, primarily due to the species widespread distribution.

Core spawning and rearing habitat includes accessible mainstem and perennial tributary reaches. Because of their subbasin-wide distribution, conditions in all five subecoregions (Blue Mountain-11, Canyons & Dissected Highlands-11f, Canyons and Dissected Uplands-11g, Blue Mountain Basins-11k, Mesic Forest Zone-11l) are pertinent in describing habitat types for Imnaha steelhead (*refer to* Section 1.1.1.4 *and* Figure 4).

Bull trout

Bull trout habitat in the Imnaha subbasin has been modified largely as a result of legacy effects of land use activities. Timber harvest, road building, mining, grazing, irrigation development, and recreation have contributed to the current amount and condition of available bull trout habitat in the Imnaha (Buchanan et al. 1997). Most of these activities continue to take place, although to different degrees, locations, and manners from what occurred in the past.

Bull trout habitat in the mainstem Imnaha River is generally in good condition with respect to water quality, availability of spawning gravels, and suitability of rearing habitat (Buchanan et al. 1997). Water quality, specifically stream temperatures, may be compromised in some areas due to a lack of riparian vegetation. In the lower Imnaha, stream temperatures exceeding 20 °C have been recorded on occasion, which is nearing bull trout tolerance levels.

Bull trout habitat quality in the Big Sheep Creek subwatershed is mixed. The condition of riparian vegetation below the Wallowa Valley Improvement Canal, specifically that occurring along the lower 34 miles of Big Sheep and Lick creeks, is considered to be fair to poor (Buchanan et al. 1997). Riparian vegetation between Owl and Lick creeks, however, is unroaded and in excellent condition. Spawning and rearing habitat in Big Sheep Creek above the Wallowa Valley Improvement Canal occurs primarily within a wilderness area. Much of the habitat in this portion of the subwatershed suffers from legacy effects of heavy sheep grazing and effects from the Canal Fire of 1989. It is characterized by a relatively steep gradient. Land use activities, fires, flooding, and landslides have reduced the quality of bull trout habitat in Little Sheep Creek to what is characterized as the most at-risk population of fish in the subbasin (Buchanan et al. 1997).

Pacific lamprey

Habitat conditions for Pacific lamprey in the Imnaha are undefined. It is likely that habitat in the Imnaha is of sufficient quantity and quality to support spawning and rearing life history stages due to the abundance and diversity of spawning gravels and silty pools and banks (respectively).

1.2.8.2 Methods Used to Characterize Habitat Conditions

The Qualitative Habitat Assessment (QHA) model, developed by Mobrand Biometrics Inc., was used in conjunction with the Imnaha Multi-Species Biological Assessment (USFS 2003d) to characterize anadromous and resident fish habitat condition. The QHA represents a regionally accepted tool to guide planners in the identification and prioritization of where habitat protection and restoration efforts should occur. Results from the QHA model serve two purposes. First, they provide an indication as to current and reference habitat condition for focal salmonid species. Secondly, the QHA output provides planners with a general idea of which habitat attributes should be considered to be limiting the overall condition of habitat, and where in the subbasin these conditions are occurring. The QHA output is therefore referenced in both the habitat conditions section (below) and in the limiting factors section.

Perhaps the most recent and comprehensive review of fish habitat conditions in the Imnaha subbasin is contained within the Multi-Species Biological Assessment (BA) recently completed by the Wallowa-Whitman National Forest (USFS 2003d). The BA was conducted in response to objectives outlined in the Wallowa-Whitman National Forest Land and Resource Management Plan (Forest Plan), as amended by the Interim Strategies for Managing Anadromous/Nonanadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PacFish/InFish) (USFS 2003d). In a memo dated September 4, 1996, NMFS suggested the use of the Matrix of Pathways and Indicators (Matrix) for evaluations of aquatic habitat. The Matrix is a mix of Pacific Anadromous Fish (PACFISH) and Inland Fish (INFISH) habitat indicators. The indicator for each subwatershed is rated based on how the current baseline habitat condition compares with criteria given in the Matrix. Indicators are rated "properly functioning", "functioning at risk", or "not properly functioning" and recorded on a checklist (Appendix G).

Because the habitat characterization information contained within the 2003 BA was applicable to the entire subbasin, the Imnaha subbasin Technical Subcommittee felt it appropriate to include in this assessment. And because of the similarities between habitat attributes used in the BA and in the Qualitative Habitat Assessment (QHA) model, planning group participants agreed to use the results from the BA to initially populate the QHA model.

Results from the Matrix of Pathways and Indicators, as presented in the 2003 BA (USFS 2003d), were used to populate the QHA model at the 6th field HUC scale (see Appendix L Table 5). The subcontractor spatially summarized the BA data on a HUC-by-HUC basis based on the attributes called for in the QHA model (see Appendix L) for additional discussion regarding methods used). The GIS layers and associated spreadsheets were then presented to a panel of local fisheries biologists representing the ODFW, NMFS, Nez Perce Tribe, USFWS, and USFS. The "pre-populated" spreadsheets and GIS layers facilitated discussion between the biologists as to whether there was a consensus agreement with the BA data that were used in the model. In the event where the panel disagreed with the BA data or where documentation was not in accordance to the BA output, appropriate changes were made and incorporated.

1.2.8.3 Evaluation of Habitat Attributes

Riparian Condition—Characterization of Current Conditions

The condition of riparian vegetation is least favorable on private lands, areas that have always had a riparian community dominated by grasses, or in portions of the subbasin that have burned, been subjected to insect infestations, or have had extensive windthrow damage.

In their Multi-Species Biological Assessment (USFS 2003d), the USFS rated the entire Big Sheep Creek drainage as "functioning at risk" for riparian reserves. The 1989 Canal Fire, which burned several thousand acres in the upper Sheep Creek drainage, contributes to this rating, as does the extensive amount of harvesting that occurred following the fire. Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations (USFS 2001). The absence of spruce and other overstory species in Big Sheep Creek has resulted in a dominance of 6- to 10-foot high trees/shrubs along with grasses/forbs (USFS 2001). In the upper reaches of Big Sheep Creek, above the diversion canal, the river flows through steep-sided, unconsolidated, colluvial and glacial outwash material. The slope, coarse texture, and low water holding capacity in this area limits vegetation growth (USFS 2003d).

Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower Big Sheep Creek subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000). For example, the Little Sheep Creek Highway (Oregon State Highway 350) borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. It is important to note, however, that primary riparian communities throughout many of the lower-elevation reaches in Big and Little Sheep Creek have historically never been comprised of shade-providing vegetation, and have always been bordered by basalt cliffs, shrubs, and/or grass/sedge plant communities.

The 2003 BA defines riparian condition as "functioning appropriately" for the upper and lower Imnaha watersheds, with some lower reaches of the mainstem Imnaha trending toward "functioning at risk". In the upper watershed, a moderate loss of riparian function has occurred in areas such as the Gumboot, Summit, and Grouse Creek subwatersheds, which were subjected to the effects of the January 1997 flood event. Riparian vegetation bordering the mainstem Imnaha between the Cow Creek and Horse Creek confluence is largely dominated by grasses and forbs, but has been compromised in areas by grazing, the presence of the lower Imnaha River Road, and hazard tree harvesting near campgrounds. Reach-specific comments about riparian condition that were generated during the QHA modeling process are shown in Table 68.

Table 68. QHA-generated comments about riparian condition.

Subwatershed/Reach	HUC	Comment
Lightning	07G	Riparian condition is degraded
Squaw/mainstem	07L	Road runs up bottom of drainage—compromises riparian function
Squaw/South Fork	07L	Road runs up bottom of drainage—compromises riparian function
Marr Creek	07N	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/mainstem	08B	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/Stubblefield Fork	08B	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/Dodson Fork	08B	Road runs up bottom of drainage—compromises riparian condition

Subwatershed/Reach	HUC	Comment
Imnaha (RM 4)/Tulley Creek	08B	Road runs up bottom of drainage—compromises riparian condition
Grouse Creek/upper	09F	Grazing has degraded riparian condition and contributed to temperature problems in the upper end of Grouse Creek (plateau area primarily)

Riparian Condition—Characterization of Historical Conditions

Based on input from local biologists, riparian vegetation throughout the majority of the Imnaha subbasin was historically more diverse and functional than current conditions. Based on anecdotal accounts, mature cottonwood galleries historically dominated some of the lower-elevation stream reaches (i.e., lower Camp Creek and the mainstem Imnaha near the town of Imnaha) that are currently shade-limited, while medium-sized conifer species (Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) were comparatively dense in unconstrained, higher-elevation reaches (i.e., upper Big and Little Sheep Creeks) that are currently limited by windthrow, pathogens, and/or fire impacts. Additional descriptions of potential streamside vegetation are provided in section 1.1.2.4 (p. 70).

Characterization of Restoration Needs

Improvements to current riparian conditions in select areas are likely to produce long-term benefits to anadromous salmonids. Areas where riparian restoration efforts are most critical are primarily associated with stream reaches on private lands, and will therefore only be feasible provided there is sufficient landowner participation. The estimated restoration effort required in these areas is unknown. Restoration projects specifically designed to address riparian deficiencies in the Imnaha subbasin are provided in the Inventory of Existing Activities volume of the subbasin plan.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous riparian enhancement/restoration efforts occurring in the Imnaha subbasin. The cessation of these activities would likely result in a marked overall reduction in riparian health, and would contribute to the decline in anadromous salmonid habitat condition. The specific degree to which a cessation of riparian restoration/enhancement efforts would affect anadromous salmonid populations in the future is unknown.

Channel Stability—Characterization of Current Conditions

Imnaha River streambank stability (percentage of both banks in a stable condition) was measured during stream surveys in 1991 and 1998. At the subbasin scale, bank stability was rated as moderate to high and streambank vegetation cover was rated as moderate (USFS 2003d). Reaches where channel stability is low occur in geologically unstable areas, in select portions of the Big Sheep Creek watershed, and in areas impacted by the January 1997 flood event.

Grande Ronde basalt flows form the canyon through which much of the lower 18.4 miles of the mainstem Imnaha flow, and contribute to its high degree of bank stability (USFS 2003d). In some areas, such as the central portions of the mainstem, quaternary alluvial deposits have formed natural river terraces comprised of river rock from upstream, colluvial basalt from the canyon side slopes, and Mazama ash and windblown silt. It is in these areas where bank stability is compromised due to the ability of the mainstem to meander through the unconsolidated sediment. Nevertheless, a study found that 84% of the riverbanks in the subbasin, including these terraces, are stable due mainly to establishment of vegetation and coarse (large boulder-sized) sediment (USFS 1993).

Some of the high-gradient, mainstem tributaries have channel instability issues due to their flashy flow regimes. For example, the upper reaches of Lightning, Sleepy, and Cow Creek (including tributaries) are defined by naturally occurring high flows, and contribute to considerable bedload movement at the bottom of the reach. Management effects are considered to be secondary to natural disturbance pressures in the majority of these areas.

The mainstem Imnaha River, from RM 20.1 to RM 49.6, flows primarily through private lands. Although pastures are found throughout these reaches (some within 30 feet of the river), there were few bank areas damaged by cattle, primarily due to the presence of riparian fencing (USFS 2003d). Evidence of moderate grazing activity on the west bank was found throughout the stretch from RM 53.7 to RM 56.9 (USFS 2003d). A powerline right-of-way follows the west bank of reach 16 through its length and is preventing development of riparian vegetation in some locations (RM 56.9–RM 60).

In the Big Sheep Creek drainage, streambank stability was rated moderate to high for the mainstem, and moderate for reaches above the diversion canal (USFS 2003d). The slope, coarse texture, and low water holding capacity in the upper reaches of Big Sheep Creek contribute to the lower channel stability rating, especially in areas where the river flows through steep-sided, unconsolidated, colluvial and glacial outwash material (USFS 2003d). In the Marr Flat area, streambank stability has been compromised due to livestock trampling. Riparian improvement projects specifically designed to discourage trailing were implemented between 1997 and 2001 in headwater portions of Skookum Creek, Mahogany Creek, Shadow Canyon, Marr Creek, and a tributary to Gumboot Creek (USFS 2003d). A marked improvement in streambank condition has been observed by Unit biologists since the projects have been completed.

Depending on the subwatershed and its associated land use, streambank condition typically ranges between the classification of "functioning appropriately" in the upper and lower Imnaha watersheds and "functioning at risk" in the Big Sheep Creek watershed. Reach-specific comments about channel stability that were generated during the QHA modeling process are shown in Table 69.

Table 69. QHA-generated comments about channel stability.

Subwatershed/Reach	HUC	Comment
Upper Camp Creek	07C	Pond on upper end; likely to blow out without management action
Bear Gulch/Summit Creek	07E	Channel stability in lower reaches is poor due to private ownership
Lightning Creek	07G	High-gradient channel limits channel stability
Middle Little Sheep Creek	07H	Portions of Little Sheep Creek have low channel stability due to historical hydro-operations; penstock blew out, resulting in considerable bedload movement
North Fork Imnaha River/mainstem	09O	Channel stability and fine sediment a problem due to blow-outs
North Fork Imnaha River /unnamed tributary	09O	Channel stability and fine sediment a problem due to blow-outs

Channel Stability—Characterization of Historical Conditions

Based on input from local biologists, the stability of Imnaha stream channels was historically greater than current conditions. Bank stability values used to define the reference conditions spreadsheet in the QHA model were all rated as 100% of normative, with the exception of the North Fork Imnaha 6th field HUC, which received an 80% of normative rating.

The high channel stability ratings reflect the inherent geologic stability of the Imnaha subbasin. The bedrock canyons and large boulder substrate that line the majority of the stream channels afford the Imnaha and its tributaries unique constancy with regards to natural disturbance pressures.

Characterization of Restoration Needs

Many of the areas where bank stability is considered a problem occur on private land, and will require landowner participation to restore. Restoration needs specifically related to bank stability problems in the Imnaha subbasin are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As presented in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, several streambank stability restoration efforts in the Imnaha subbasin. Although the effects associated with the cessation of these activities is unknown, it is likely that erosion rates would eventually increase and contribute to the decline in anadromous salmonid habitat condition.

Habitat Diversity[4]—Characterization of Current Conditions

Similar to other river systems, the diversity of habitat in the Imnaha is highest in lower-order, high-elevation stream reaches and generally declines with an increase in river size. Differences in habitat diversity between similar-sized river segments do exist, however, especially when comparing federally managed lands to privately owned lands.

Large woody material (LWM), which contributes substantially to habitat diversity, is functionally absent throughout the lower 16 miles of the mainstem Imnaha, and in the lower reaches of Lightning Creek (USFS 2003d). It is important to note, however, that the majority of the lower Imnaha is bordered by an arid grassland and basalt rock landscape, which has never been conducive to the generation of instream wood. LWM frequency is also considered to be "functioning at unacceptable risk" in the lower reaches of Big and Little Sheep creeks, Bear Creek, and the middle reach of Little Sheep Creek (USFS 2003d). Similar to the lower mainstem Imnaha, many of the lower-elevation reaches in the Sheep Creek system are arid and treeless; however, alteration of the riparian reserves has reduced the current condition below what is thought to be natural potential (USFS 2003d). Overall, LWM frequency in the upper Imnaha is considered to be "functioning appropriately", with the exception of the first 19 miles of the mainstem above the town of Imnaha which are rated as "functioning at unacceptable risk".

In terms of off-channel habitat, there are no areas in the Imnaha subbasin that are considered to be "functioning at unacceptable risk" (USFS 2003d). Off-channel habitat in the lower Imnaha is limited, however, and based on USFS stream surveys conducted in the early 1990s it comprises only 4% of the overall habitat (Mays 1992). The relatively low amount of off-channel habitat in this and other portions of the subbasin is likely due to a combination of steep gradient and conversion of floodplains to pastures and cultivated fields. Although, no recent information quantifies current amounts of off-channel habitat available in the watershed, off-channel habitat likely increased during the flood of 1997. Pending collection and review of this updated information, this indicator is "functioning at risk" at the subbasin scale (USFS 2003d).

Habitat refugia, as provided through undercut banks, large boulder substrate, overhanging riparian vegetation, bedrock shelves, etc., is abundant throughout the majority of federally managed lands and is rated as "functioning appropriately" at the subbasin scale. Refugium is notably lower in the Sheep Creek system, especially throughout the middle and lower mainstem reaches of Big and Little Sheep Creek. In the mainstem Imnaha, refugia is considered to be "functioning at risk" from RM 16 to RM 37, a factor possibly due to the presence of the Imnaha River road and/or the conversion of floodplain areas to cultivated fields. Reach-specific comments about habitat diversity that were generated during the QHA modeling process are shown in Table 70.

[4] Incorporation of USFS BA data into the QHA model required several adjustments, including how habitat diversity was assessed. The USFS BA uses Physical Barriers, Large Woody Material, Pool Quality/Frequency, Off-Channel Habitat, and Refugia to define the habitat elements metric, while the QHA model relies on Multiple Channels and Large Woody Material in its habitat diversity metric. Based on discussions with the Imnaha Technical Subcommittee (09/09/2003), it was agreed that the USFS ratings of Large Woody Material, Off-Channel Habitat, and Refugia would be used to define the QHA habitat diversity metric. Pool Quality/Frequency was omitted due to inconsistencies in data collection and interpretation. The three USFS habitat attributes were averaged to come up with a single habitat diversity rating used in the model.

Table 70. QHA-generated comments about habitat diversity.

Subwatershed/Reach	HUC	Comment
Big Sheep Creek (RM 4)/lower	07K	Private land grazing contributes to lack of habitat diversity
Big Sheep Creek (RM 4)/upper	07K	Private land grazing contributes to lack of habitat diversity
Horse Creek	08G	No multiple channels

Habitat Diversity—Characterization of Historical Conditions

The diversity of habitat in the Imnaha subbasin was undoubtedly greater during presettlement times than currently. Habitat simplification has occurred through riparian harvest, conversion of floodplain areas, road construction, streambank fortification, and other land use activities.

Habitat diversity values used to define the reference conditions spreadsheet in the QHA model were rated as 100% of normative for all focal species, with the exception of the lower Camp Creek HUC, which was rated at 80% of normative due to the elimination of a historical cottonwood gallery that added complexity to the channel.

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to habitat diversity, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous enhancement/restoration efforts designed to improve instream habitat diversity throughout various portions of the Imnaha subbasin. If the efforts that are designed to mitigate for the effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and type of diverse habitat units. This reduction would undoubtedly force focal salmonids into less desirable habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to improve instream habitat diversity would affect anadromous salmonid populations in the future is unknown.

Fine Sediment—Characterization of Current Conditions

Fine sediment problems in the Imnaha are localized. The geology of the subbasin is a primary reason that instream sedimentation is only problematic in certain areas, as it is largely comprised of nonerodible Columbia River Basalt, metamorphosed volcanic rock, coarse alluvium, and hydrophyllic volcanic ash overlying upland areas.

Accumulation of fine sediment does occur in depositional areas, areas affected by wildfire, insects, and/or pathogens, reaches bordered by geologically unstable uplands, and in reaches that are subjected to various land use activities. The magnitude of which these and other sedimentation processes have affected salmonid habitat, as assessed by the Wallowa-Whitman National Forest (2003), is a “functioning at risk” classification for the Big Sheep and lower Imnaha watersheds and a “functioning appropriately” classification for the upper Imnaha watershed. Reach-specific comments about fine sediment that were generated during the QHA modeling process are shown in Table 71.

Livestock grazing, rural home sites, and pasture creation are cited as among the primary land use activities causing alterations to sediment availability and routing to stream reaches in Big Sheep Creek (RM 31.9), and lower and middle Little Sheep Creek (USFS 2003d). Operation of the Wallowa Valley Improvement District irrigation canal on Big Sheep (RM 31.9–RM 33.7) has also led to a change in sediment availability and transport capacity due to decreased flows.

Several of the low-gradient reaches of Big Sheep Creek are defined by streambed “pavement”, which has occurred due to an absence of flushing flows related to the Wallowa Valley Irrigation Canal and hydropower operations (USFS 2003d). In 1997, hydropower operations were ceased. Hydropower operations used to divert water into the irrigation canal during April, May, and June. Without hydropower operations in the spring, the additional flows in the lower reaches of Big Sheep Creek are available to transport and process sediment (USFS 2003d).

Other important processes of sedimentation affecting focal species’ habitat in the Sheep Creek system include streambank erosion, sheet erosion, gully erosion, and rill erosion. Landslide and debris flow hazard ratings were found to be at natural levels (USFS 2003d). Low-gradient reaches in Lick Creek (RM 3.4) are impacted by fine sediments sloughing off the erodible streambanks. Accelerated sheet and rill erosion has been documented in various portions of the Big Sheep Creek watershed (subwatersheds 07J, 07O, 07P, 07Q, 07R; see Figure 3 for locations) and has been related to a combination of effects resulting from timber harvest and the Canal and Twin Lakes Fires (USFS 2003d). Accelerated gully erosion hazard was noted in subwatersheds 07J, 07O, and 07R, again the result of fires and timber management. Fire effects are also contributing to fine sediment problems in the upper reaches of Horse Creek.

The “functioning at risk” classification for the mainstem Imnaha River below Nine Point Creek is due in large part to the high quantity of bedload moved during the 1997 flood (USFS 2003d). Sedimentation in mainstem tributaries is most problematic in headwater reaches. Roading, timber, and grazing are cited as the primary land use activities in these areas, and have acted cumulatively to modify sediment transport and storage (USFS 2003d).

Although landslides are generally not considered a primary vehicle of sediment delivery to streams in the subbasin, there have been two notable occurrences that substantially altered fish habitat. On North Fork Imnaha River, inside the wilderness area, a thunderstorm in August 1992 triggered a debris flow in a tributary. The debris fan formed at the confluence of the tributary and North Fork Imnaha, shifting the thalweg of the North Fork and initiating a landslide (USFS 2003d). Then, on January 1, 1997, the Imnaha River reached a record high discharge of 20,200 cfs during a rain-on-snow flood event, triggering landslides and debris flows within its tributaries. The event modified stream channel morphology through mass movements of bedload material causing the formation of mid-channel and lateral gravel and cobble bars (USFS 2003d). This material will continue to move in pulses downstream until stabilized by large woody material (LWM), riparian vegetation, or channel processes resulting in elevated levels of sediment.

Table 71. QHA-generated comments about fine sediment.

Subwatershed/Reach	HUC	Comment
Lower Camp Creek/lower	07B	Fine sediment a problem due to alluvium
Devils Gulch	07F	Fine sediment a problem due to alluvium
Horse Creek	08G	Fines a problem due to fire effects
Rich Creek/mainstem	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Rich Creek/Shadow Canyon	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/mainstem	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/Morgan Creek	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 1	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 2	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 3	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek Creek/mainstem	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/North Fork	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 1	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 2	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
North Fork Imnaha River/mainstem	09O	Channel stability and fine sediment a problem due to blow-outs
North Fork Imnaha River/unnamed tributary	09O	Channel stability and fine sediment a problem due to blow-outs

Fine Sediment—Characterization of Historical Conditions

The amount and distribution of fine sediment in streams and rivers throughout the Imnaha subbasin was historically lower prior to the introduction of livestock, the removal of soil-stabilizing vegetation, or construction of road networks.

Fine sediment ratings used to define the reference conditions spreadsheet in the QHA model were rated as 100% of normative for all focal species, with the exception of the North Fork Imnaha HUC, which was rated at 80% of normative (all species).

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to fine sediment, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous enhancement/restoration efforts designed to reduce the amount of fine sediment throughout various portions of the Imnaha subbasin. If the efforts that are designed to mitigate for the effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would assumedly force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease fine sediment would affect anadromous salmonid populations in the future is unknown.

High Flow—Characterization of Current Conditions

Based on hydro data from the Imnaha and Gumboot stream gages, peak flow and flow timing characteristics of the Imnaha River appear to be comparable to, or slightly elevated above, an undisturbed watershed of similar size, geology, and geography ("functioning appropriately" or "functioning at risk"; USFS 2003d). As discussed previously (see section 1.1.3.3, p. 89), changes to vegetation, increases in drainage density from road construction, off-site watering, and irrigated agriculture have altered peak flow characteristics in some portions of the subbasin, which may be causing reductions in salmonid habitat quality and quantity.

Wildfire, pathogens, insect outbreak, and windstorms have acted cumulatively to modify vegetative characteristics within the Big Sheep Creek watershed, and have subsequently altered peak flow characteristics (USFS 2003d). The Canal Fire of 1989 burned an estimated 9,320 acres in the Sheep Creek watershed, 5,996 of which were burned at a high intensity level. The reduction of timber led to a reduction in hydrologic storage capacity in the upper Little Sheep and Big Sheep creek (RM 34) subwatersheds, resulting in a "functioning at risk" classification for increased peak flows (USFS 2003d). The Carrol Creek subwatershed was also affected by the Canal Fire, as well as insect outbreak and windstorms, resulting in a "functioning at an unacceptable risk" from increased peak flows classification. This indicator has recently been upgraded to "functioning at risk" because of vegetative regrowth, especially lodgepole pine, within the drainage (USFS 2003d).

The naturally high gradient of some tributary reaches, combined with effects from land use activities, produces a very flashy flow regime that is often capable of mobilizing bedload and disrupting salmonid habitat. According to local biologists, these problems are most common in perennial tributaries to the upper Imnaha (Table 72).

Table 72. QHA-generated comments about high flows.

Subwatershed/Reach	HUC	Comment
Lightning Creek	08H	High flows contribute to considerable bedload movement at bottom of reach
Lower Cow Creek	08K	Naturally occurring high flows contribute to considerable bedload movement at bottom of reach
Freezeout Creek/lower	09B	Naturally flashy flow regime contributes to high bedload movement

Subwatershed/Reach	HUC	Comment
Freezeout Creek/upper	09B	Naturally flashy flow regime contributes to high bedload movement
Rich Creek/mainstem	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Rich Creek/Shadow Canyon	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/Morgan Creek	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 1	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 2	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 3	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/mainstem	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/NF	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 1	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 2	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition

High Flow—Characterization of Historical Conditions

Because of the nearly 75 years of flow records, it is reasonable to assume that we have sufficient information to characterize historical conditions in the Imnaha and establish whether high flow magnitude, frequency, and timing have changed. Based on analyses conducted by the Wallowa-Whitman National Forest, peak flows have remained relatively unchanged over the period of record, and are estimated to be slightly above high flows common in an unmanaged subbasin sharing similar biophysical characteristics (USFS 2003d). However, Thompson (1960, as cited in Mundy and Witty 1998) reported that flow records during the period 1929–1957 (28 years) indicate flow discharge was 21 times greater than which exists during the egg deposition period and that these flows occur every year during spring months. The ramifications of flows of this magnitude include the potential for fall chinook embryo dislodgement.

Prior to settlement, high flows in the Imnaha were likely ameliorated by denser stands of vegetation, and weren't subjected to the runoff-channeling effects caused by the current road network. In some drainages, such as Devils Gulch, it is likely that high flows had always restricted salmonid use.

All of lower and upper Camp Creek were rated as "80% of normative" in the QHA reference conditions assessment. Devils Gulch, Lightning Creek, Cow Creek, Freezeout, the mainstem Imnaha (from RM 37 to RM 55), Summit Creek, Crazyman Creek, and Mahogany Creek were considered to historically have high flow problems, and were all rated as 80% of normative.

High flow ratings used to define reference conditions for all other reaches and species in the QHA model were rated as 100% of normative.

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to high flow effects, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to reduce the effects of high flows in the Imnaha subbasin. Based on the current lack of peak flow restoration activities, it is difficult to state what a continued lack of action would do to fish habitat. It is likely that high flow problems are being addressed indirectly through other projects, such as improvements to habitat diversity, and that a cessation of these activities would do little to further population restoration goals.

Low Flow—Characterization of Current Conditions

Excessively low base flow conditions in the Imnaha subbasin, and specifically in the Big Sheep Creek watershed, are considered to affect resident and anadromous habitat availability. Operation of the Wallowa Valley Improvement District canal is considered to limit streamflow for bull trout during the peak irrigation season (NPT and ODFW 1990), and may act cumulatively during low precipitation years to limit anadromous spawning and rearing habitat availability (USFS 2003d). Decommissioning of three hydropower facilities from this canal has reduced the amount of water withdrawn from Big Sheep and Little Sheep creeks; however the ditch continues to be operated near or at capacity from June through September for irrigation purposes (USFS 2003d). During these months, a major portion of the flow of Big Sheep Creek is diverted into the canal. Seeps from the diversion and other downstream tributaries, such as Johnson Creek, reestablish minimum instream flows within a half-mile of the diversion.

The low flow problems that exist in other portions of the subbasin are primarily related to natural phenomenon as opposed to land use practices. As mentioned previously, coarse-grained alluvium is common in several portions of the subbasin. Streamflows occurring in these areas during summer months are said to “sub-out” or run subsurface. Subsurface base flows are most common in areas defined by a flashy flow regime, and/or near low-gradient confluence reaches at the base of otherwise high-gradient systems. The only QHA-based comment specifying a stream reach that is limited by low flow conditions was for Corral Creek, within which salmonid migration is likely impeded (during some years) at the confluence by low flows.

The Big and Little Sheep Creek watersheds have been identified as areas of high priority for streamflow restoration (Figure 60). ODFW and OWRD have established priorities for restoration of streamflow from consumptive users, as part of the Oregon Plan for Salmon and Watersheds (Measure IV.A.8). ODFW has identified the “need” for streamflow restoration through ranking of biological and physical factors, water use patterns and the extent to which water is a primary limiting factor. OWRD ranked the opportunities and likelihood for achieving meaningful streamflow restoration. Rankings were performed for subwatersheds at approximately the 5th field HUC. OWRD watermasters will incorporate the priorities into their fieldwork activities as a means for implementing flow restoration measures. The “needs” priorities will be used by the Oregon Watershed Enhancement Board as one criterion in determining funding priorities for enhancement and restoration projects. Watershed councils and other entities may also use the needs priorities as one piece of information determining high priority restoration projects.

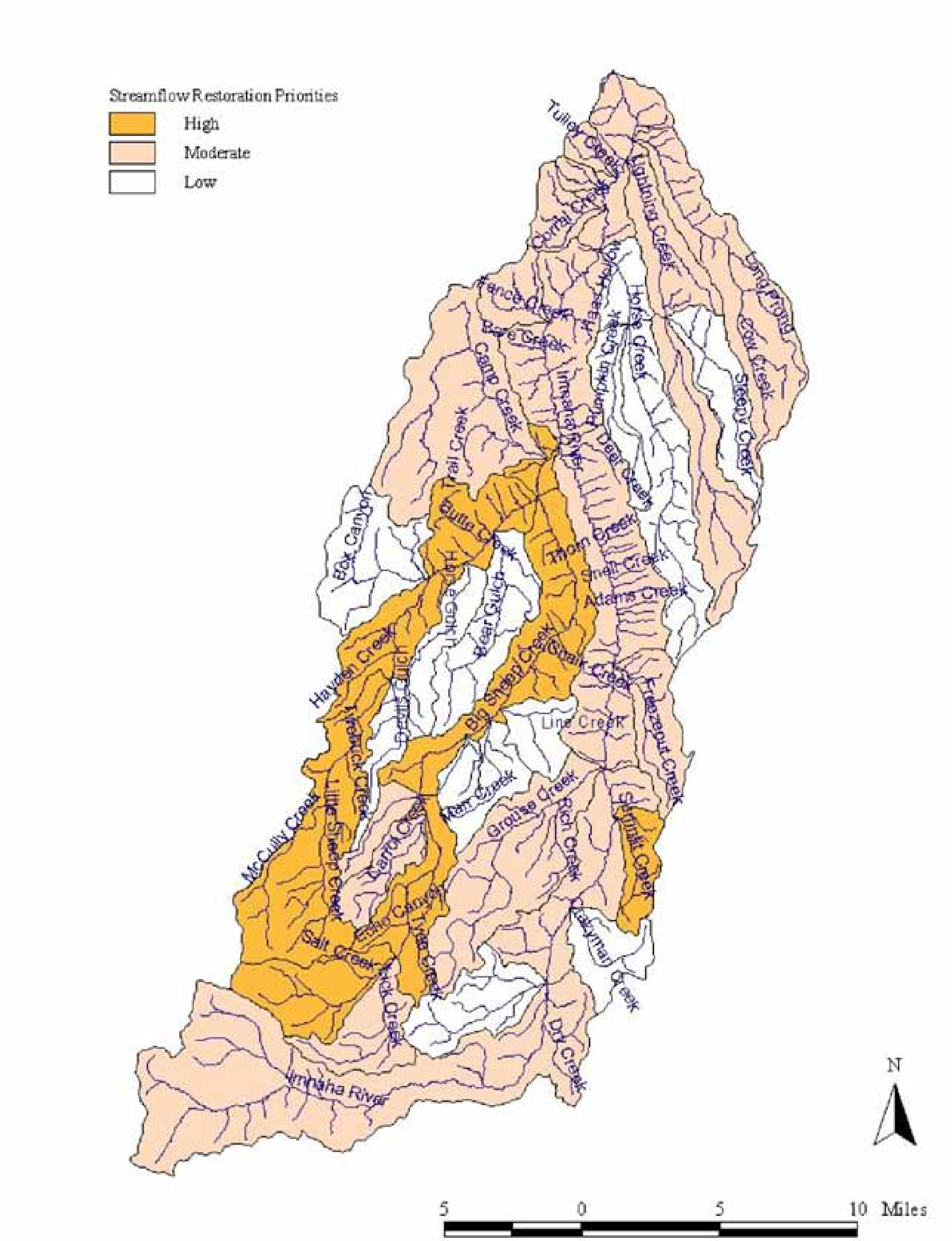

Figure 60. Streamflow restoration priorities in the Imnaha subbasin (ODFW 2001a).

Low Flow—Characterization of Historical Conditions

Natural base flows in Big Sheep Creek and in the lower mainstem Imnaha were historically higher prior to the arrival of settlers and irrigated agriculture. In 1930, a decree was filed for 23.16 cfs of water to be diverted out of McCully Creek from April 1–July 31 for irrigation, plus an undefined amount for stock and domestic use, which was estimated to be about 0.09 cfs (Bliss 2001). The decree of 1905 is considered to be the first water right filed associated with the Wallowa Valley Improvement Canal, granting an undefined contribution of as much as 162.74 cfs from McCully Creek, Little Sheep Creek, and all tributaries crossed by the ditch up to but not including Big Sheep Creek during the months April–July (Bliss 2001; NPT et al. 1990). In 1983, three small hydropower production facilities, upper Little Sheep Creek, Canal Creek, and Ferguson Ridge were constructed along the Wallowa Valley Improvement Canal in the Big Sheep Creek watershed, bringing the amount of water that could potentially be removed from the watershed to 200.53 cfs (Mason et al. 1993, USFS 2000; 2003d).

With the decommissioning of the hydropower facilities in 1997, the season of water withdrawal for irrigation purposes has been reduced to the June to September period (USFS 2003d). Thus, the opportunity for extended flushing spring flows is likely.

QHA-based discussions of historical low flow problems identified lower Camp Creek (HUC 07B) as an area where flows likely went subsurface during summer months, and Devils Gulch (HUC 07F) as an area that has always had low flow problems due to its inherently flashy flow regime.

Characterization of Restoration Needs

Restoration efforts throughout the subbasin should be coordinated with all ongoing prioritization efforts currently being implemented by OWRD and ODFW. Low flow restoration needs, as defined through the QHA modeling process, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to increase low flows in the Imnaha subbasin[5]. Based on the current lack of "low flow restoration" activities, it is difficult to state what a continued lack of action would do to fish habitat. It is likely that low flow problems are being addressed indirectly through other projects, such as improvements to riparian areas, and that a cessation of these activities would do little to further population restoration goals.

Oxygen—Characterization of Current Conditions

Highly oxygenated water occurs in all habitats throughout the Imnaha subbasin year-round.

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[5] It is apparent that the streamflow prioritization efforts by OWRD and ODFW were omitted in the Inventory of Existing Activities volume of the subbasin plan; however, no other "low flow restoration" projects were identified at the time of this document's preparation.

Oxygen—Characterization of Historical Conditions

Although historical water quality data are limited, there is little evidence suggesting that oxygen levels were once different from what they are currently.

Characterization of Restoration Needs

Because salmonid habitat throughout the subbasin is well-oxygenated year-round, there are no restoration needs that are based on this parameter.

Characterization of Future with No New Actions

(See information in the section above.)

Low Temperature—Characterization of Current Conditions

Low winter stream temperatures in the Imnaha are currently common in most reaches and are not considered to substantially impair the condition of habitat for focal salmonid species. According to Mundy and Witty (1998), there is some concern that water temperatures may be too cold for the sufficient development of fall chinook embryos. Mundy and Witty (1998) state that water temperatures at the confluence of the Imnaha and Snake River drop below 4 °C, which has been found to inhibit embryo survival, especially if the eggs were deposited late in the fall and had not advanced to a stage that is tolerant of prolonged cold temperatures (e.g., Cramer 1993, as cited in Mundy and Witty 1998). Ice floes are also common during winter months, and may or may not be responsible for dislodging some salmon embryos. Reach-specific comments about low stream temperatures were not made.

Low Temperature—Characterization of Historical Conditions

Historical [and current[6]] winter stream temperature data for the Imnaha are limited. It is likely that during presettlement conditions, winter stream temperatures weren't as severe as current due to the higher degree of insulation provided through the historically denser riparian canopy.

Characterization of Restoration Needs

Refer to the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to increase winter stream temperatures in the Imnaha subbasin. Based on the current lack of low temperature restoration activities, it is debatable to state what a continued lack of action would do to fish habitat. It is likely that low winter stream temperature problems are being addressed indirectly through other projects, such as improvements to riparian areas, and that a cessation of these activities would do little to further population restoration goals.

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[6] USFS temperature probes are not installed during winter months due to the amount of damage to these probes.

High Temperature—Characterization of Current Conditions

As discussed in the Water Quality section of this document (see section 1.1.2.3), the §303(d)-listed streams within the Imnaha subbasin, which includes the entire Imnaha River mainstem and some stream reaches in key tributaries (see Table 11 and Figure 25), exceed the numeric criteria of the water quality standard for temperature (see Table 12). Land use activities and/or natural environmental conditions act alone or in combination to cause reach listings.

Based on the PacFish and Bull Trout Matrix criteria used in the Wallowa-Whitman National Forest's *Multi-Species Biological Assessment* (2003d), most subwatersheds should be classified as "functioning at an unacceptable risk" for the high temperature indicator. The USFS does not believe that this rating is justified, however, and does think that most streams are at or near their environmental potential, justifying a "functioning appropriately" or "functioning at risk" classification (USFS 2003d).

According to the Wallowa-Whitman National Forest, these streams are at or near environmental potential because 1) temperature probes are not necessarily installed in cool water areas, 2) good shrub and tree cover exist within riparian areas, and 3) temperatures are suitable during spawning through emergence (USFS 2003d). See Table 73 and Appendix C for stream temperature observations within the subbasin.

Operation of the Wallowa Valley Irrigation District Canal has been a major influence on stream water temperature in the middle and lower reaches of Big Sheep Creek. As mentioned previously, the canal operates near or at capacity June through September, and diverts a major portion of Big Sheep Creeks flow (USFS 2003d). Downstream habitat is affected directly by the loss of potential flow volume, and indirectly by the accordant increases in stream temperature. As shown in Table 73, high stream temperatures occur near the end of July or first of August, which is coincident with low streamflows and warm ambient temperatures. By the end of August, stream temperatures are dropping. Above the irrigation canal, stream water temperatures are at environmental potential and "functioning appropriately" (USFS 2003d). The only influence to riparian vegetation above the diversion has been from the 1989 Canal Fire, insect damage, snow avalanches, and debris flows, all of which have had minimal influences on overall stream temperature.

In the Little Sheep Creek drainage, stream temperatures are considered to be below environmental potential for bull trout, and "functioning at risk" (USFS 2000). Elevated summer stream temperatures are naturally common in the lower-elevation portions of Little Sheep Creek due to its biophysical attributes. The inherently high July/August stream temperatures have been elevated, however, by riparian modification. Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000), and have been reduced in upper portions of the watershed by fire, windthrow, and insect infestation. For example, the Little Sheep Creek Highway borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. Compounding this problem are the effects from the Canal Creek Fire of 1989 and subsequent insect infestations, which have reduced effective stream shade-providing riparian vegetation in the upper portions of the subwatershed.

Table 73. Seven-day moving maximum stream temperatures (°F) recorded at USFS monitoring sites (USFS 2003d).

Location	Year	May	June	July	August	September	October
Sheep Creek Watershed (07)							
Big Sheep at Echo Canyon	89	36	38	40	42	45	46
	90	49	59	66	68	63	57
	91	47	52	65	67	62	56
	92	50	62	N/A	N/A	N/A	56
	93	51	55	60	65	61	54
	94	48	64	71	71	63	50
Big Sheep at Lick Creek	91	56	51	65	66	61	55
	92	N/A	67	67	68	59	50
	93	51	54	59	64	59	52
	94	N/A	63	70	69	61	N/A
	95	N/A	48	54	61	59	48
	96	N/A	N/A	64	64	60	52
Big Sheep below Canal	93	47	N/A	54	59	55	49
	94	N/A	57	65	65	57	N/A
	95	N/A	42	52	55	54	44
Big Sheep above Canal	96	N/A	N/A	51	51	50	46
	97	N/A	N/A	57	55	53	48
Lick Creek at Mouth	90	47	57	64	65	60	53
	91	45	50	63	64	56	N/A
	92	N/A	N/A	65	66	51	N/A
	94	46	61	67	67	58	46
	95	N/A	51	58	60	57	48
	96	N/A	N/A	63	62	58	51
	97	N/A	N/A	59	60	56	50
Little Sheep at USFS Boundary	96	N/A	N/A	59	58	57	54
Cabin Creek above Canal	96	N/A	N/A	51	51	50	46
McCully Creek at USFS Boundary	96	N/A	N/A	52	51	49	44
Redmont Creek above Canal	89	45	54	56	N/A	N/A	N/A
Lower Imnaha Watershed (08)							
Lightning Creek	93	57	57	61	67	63	57
Upper Lightning	94	N/A	N/A	59	N/A	51	51
Cow Creek	93	55	60	67	75	69	N/A
Fence Creek	91	64	68	69	70	66	60
Imnaha at Marr Ranch	91	55	69	N/A	67	71	55
Upper Imnaha Watershed (09)							
Grouse Creek	92	N/A	N/A	64	65	56	50
Gumboot Creek	92	N/A	66	65	66	59	55
	97	N/A	55	54	55	52	48
Rich Creek	97	N/A	53	58	60	57	51
Dry Creek	97	N/A	53	57	67	66	57
Skookum Creek	97	N/A	55	60	62	59	51
Imnaha at Nine Point Creek	93	N/A	N/A	57	62	60	55
	94	N/A	N/A	71	72	64	58
	96	N/A	N/A	60	62	61	55
Imnaha at Indian Crossing	94	N/A	N/A	63	63	56	46
	95	N/A	N/A	54	56	54	47
	96	N/A	N/A	56	57	55	49
	97	N/A	N/A	N/A	56	55	50

Summer stream temperatures in the lower mainstem Imnaha and associated perennial tributaries typically exceed the 50° F state standard (Table 73; Appendix C). In Lightning Creek, stream size, natural grassland vegetation, drainage size, and the limited amount of riparian area modifications are considered to be the primary drivers of high temperatures, which, according to the Wallowa-Whitman National Forest, justifies the stream to be delisted by the state (USFS 2003d). These concerns have yet to be addressed by ODEQ.

High stream temperatures in the upper Imnaha (RM 24 to headwaters) are also largely driven by natural conditions. Several subwatersheds/reaches on the §303(d) list for high temperatures, including Gumboot Creek, and the upper reaches of the Imnaha River, are arguably at or near their natural potential for this particular indicator due to the grassland ecosystem, the size of the drainage basin, and few riparian area modifications (USFS 2003d).

Other temperature-listed subwatersheds/reaches in the upper Imnaha are in excess of state standards due to land use activities. Riparian modification is known to have influenced stream temperatures throughout private land parcels bordering the mainstem (roughly from the town of Imnaha upriver to Gumboot Creek) (USFS 2000). Cultivation, farming, and settlement have reduced the occurrence of riparian species in certain areas, and are believed to be primary contributors to stream temperature increases. For instance, stream temperatures below the Imnaha River Woods Development (RM 50–RM 54) have increased following the removal of forest canopy for the establishment of a powerline right-of-way (RM 57–RM 60) (USFS 2000). The modification has shifted a historical cold water to cool water transition zone upriver several miles. In 1992 the seven-day moving average of daily maximum temperatures recorded on Grouse Creek was 65.3°F (ODEQ data).

Most of the QHA-based comments dealing with high stream temperatures are related to the condition of riparian vegetation (Table 74).

Table 74. QHA-generated comments about high stream temperatures.

Subwatershed/Reach	HUC	Comment
Big Sheep Creek (RM 25)/tributary	07P	High temperature rating reflects riparian condition
Big Sheep Creek (RM 25)/main.1	07P	High temperature rating reflects riparian condition
Big Sheep Creek (RM 25)/main.2	07P	High temperature rating reflects riparian condition
Lower Grouse Creek/main.1	09D	High temperature rating reflects riparian condition
Lower Grouse Creek/main.2	09D	High temperature rating reflects riparian condition
Lower Grouse Creek/Road Creek	09D	High temperature rating reflects riparian condition
Upper Grouse Creek	09F	Grazing has degraded riparian condition and contributed to temperature problems in the upper end of Grouse Creek (plateau area primarily
Summit Creek/main.1	09H	High temperature rating reflects riparian condition
Summit Creek/main.1	09H	High temperature rating reflects riparian condition

High Temperature—Characterization of Historical Conditions

Historical summer stream temperature data for the Imnaha are limited. It is reasonable to assume that during presettlement conditions (pre-1850s) summer stream temperatures weren't as high as current due to the higher degree of shading provided through the historically denser riparian canopy, and the higher volume of cool water which is currently intercepted by the Wallowa Valley Improvement Canal. Because the canal has been in operation prior to the collection of water quality data, the degree to which it has modified downstream temperatures is unknown.

Characterization of Restoration Needs

Restoration needs that address high stream temperatures are provided in the Limiting Factors Section of this document. Prior to initiation of any restoration efforts, there should be consultation with local biologists to determine the degree to which temperatures are above their natural potential.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, multiple enhancement/restoration efforts specifically designed to decrease summer stream temperatures in the Imnaha subbasin. If the efforts that are designed to mitigate for high temperature effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would assumedly force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease stream temperatures would affect anadromous salmonid populations in the future is unknown.

Pollutants—Characterization of Current Conditions

Excluding thermal modification and temperature as pollutants, currently none of the Imnaha subwatersheds are on Oregon's §303(d) list for chemical contamination or nutrients, and based on analyses conducted by the USFS, all three watersheds (Big Sheep Creek, upper Imnaha River, and lower Imnaha River) have been classified as "functioning appropriately" for this indicator.

Despite the lack of listing, localized problems with chemical and organic pollutants have been reported in some portions of the subbasin. Septic tanks and feedlots have been cited as potential sources of chemical contaminants to some habitats in the Big Sheep Creek watershed (USFS 1996; Wallowa County and NPT 1999). The Nez Perce Tribe and ODFW (1990) also report that feedlots, located on private lands along Little Sheep Creek and the upper and lower mainstem Imnaha, contribute varying amounts of nutrients to surface water, most notably following localized, high-intensity thunderstorms (B. Smith, ODFW, personal communication, April 12, 2001). The impacts of this pollution on the aquatic environment are, however, considered to be short in duration and scope due to the volume and velocity of flows in the affected areas (B. Smith, ODFW, personal communication, April 12, 2001).

With the exception of the Devils Gulch (HUC 07F) and Lightning Creek (HUC 07G) subwatersheds, all subwatersheds were rated as currently being at least 80% of normative for the pollutant metric in the QHA modeling process. No pollutant-specific, QHA-generated comments were made.

Pollutants—Characterization of Historical Conditions

Documentation of pollutants historically compromising aquatic habitat conditions in the Imnaha subbasin are not available. Since livestock were historically free-ranging, there was not the current problem of localized impacts from feedlots. Septic tanks, however, have probably always posed somewhat of an organic enrichment problem in the subbasin, as sewer systems have never serviced outlying homesteads. Aquatic pollution prior to settlement of the subbasin was likely never a threat to aquatic habitat conditions, despite the considerable number of livestock (between four and five thousand head in the lowlands) owned by the Nez Perce Tribe.

Characterization of Restoration Needs

Restoration needs that address pollutant problems are provided in the Limiting Factors Section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there is currently only one Plan specifically designed to deal with nonpoint source pollutants. The Oregon Senate Bill 1010 is designed to reduce water pollution from agricultural sources and protect beneficial uses of watersheds. If these efforts were to terminate, while agriculturally-generated pollution continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would assumedly force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease pollution would affect anadromous salmonid populations in the future is unknown.

Obstructions—Characterization of Current Conditions

Irrigation diversions, culverts, and low flow conditions currently represent the primary problems to focal species migration. The USFS (2003d) rated a total of ten subwatersheds as "functioning at risk" due to culverts, and one subwatershed as "functioning at unacceptable risk" due to an irrigation diversion. Comments specific to obstructions that were generated during the QHA modeling process are shown in Table 75.

A diversion ditch for the Wallowa Valley Improvement District canal currently impedes upstream migration of steelhead and bull trout into the upper Little Sheep Creek subwatershed and into creeks such as Big Sheep, McCully, Ferguson, Canal, Redmont, and Salt (USFS 2003d). Irrigation diversions obstructing migration were also identified in lower Camp Creek and in lower Grouse Creek (during low flow periods). Stock ponds in the upper Camp Creek subwatershed and in the Lightning Creek subwatershed were also considered to impede the migration of salmonids into otherwise usable habitat areas (see QHA comments, Table 75). Fish weirs on Little Sheep Creek and the Imnaha River are manmade physical barriers, but because nontarget fish are allowed passage, the facility is not considered a permanent barrier (USFS 2003d).

Culverts on streams within the middle Little Sheep Creek (07H), McCully Creek (07I), Carrol Creek (07Q), Big Sheep Creek (RM 25) (07P), Lick Creek (07Q), Big Sheep (RM 34) (07R), Imnaha River (RM 51) (09J), Gumboot Creek (09K), Imnaha River (RM 55) (09L), and Imnaha River (RM 58) (09M) subwatersheds act as barriers to juveniles only (USFS 2003d). These obstructions are currently considered to represent fish passage barriers at least part of the year and are being evaluated for replacement or removal by the USFS. A culvert on Summit Creek was identified during the QHA modeling process as an obstruction to salmonids, although the specific life history stage impeded was not defined (see QHA comments, Table 75).

Table 75. QHA-generated comments about instream obstructions.

Subwatershed/Reach	HUC	Comment
Lower Camp Creek/main.1	07B	lower end of reach has a diversion, hence the score of 2 in the obstructions cell
Upper Camp Creek/main.2	07C	pond on upper end represents an obstruction; likely to blow out without management action
Summit Creek	07E	culvert limits fish distribution (lower reach)
Lightning Creek	07G	pond limits fish distribution (obstruction)
Lower Grouse Creek/main.1	09D	diversion screen problems in lower end of creek; represents an obstruction during low-flow periods

Obstructions—Characterization of Historical Conditions

Obstructions to focal salmonid species habitat were historically not present in the Imnaha subbasin. The Imnaha falls may have impeded migration during certain times of the year; however, they are not considered to impede year-round movement into headwater habitats. Construction of the Wallowa Valley Improvement District canal in 1877 represented the first known year-round migratory impediment to anadromous and resident species.

Characterization of Restoration Needs

Instream obstruction restoration needs are provided in the Limiting Factors section of this document. All restoration activities should be coordinated with the Wallowa-Whitman National Forest, which is currently in the process of addressing physical passage barriers throughout the subbasin.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, several programs/projects specifically dealing with fish passage issues. If the efforts that are designed to improve habitat connectivity/access were to terminate, the current distribution of resident and anadromous salmonids would remain the same, which for bull trout would mean a there would be a continued “high risk of extinction” for the Imnaha subpopulation.

1.2.9 Terrestrial Focal Species Habitat Use and Population Characterization

Detailed information about population status and trend is limited for most of the terrestrial wildlife species in the subbasin, including the focal species (USFS 1995, 1998). Collection of inventory data and the development of a monitoring program for terrestrial species would greatly aid the wildlife managers of the subbasin. Range maps showing the present distribution of select wildlife species in the Columbia Basin have been developed by IBIS, but these maps were unavailable for the terrestrial focal species selected by the Imnaha subbasin terrestrial subcommittee (IBIS 2003). What is known about the populations of terrestrial focal species in the Imnaha subbasin is discussed below; when subbasin-specific data were not available, regional data were used to infer potential trends within the subbasin. As discussed in section 1.2.2.2, terrestrial focal species were selected for the Imnaha subbasin primarily because they were good indicators of broader habitat conditions. Because of this, the following section is organized first by the WHT that the species was selected to represent. The descriptions of terrestrial focal species biology, habitat use, and population trends are intended to be illustrative of the importance of the habitat type for wildlife in the subbasin and the factors that may be influencing the quality of that habitat for the native wildlife of the subbasin.

1.2.9.1 Ponderosa Pine Forest and Woodlands

Flammulated Owl

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on flammulated owl biology.

The flammulated owl (*Otus flammeolus)* is a tiny owl with dark brown eyes, dark body, and small ear tuffs (USFS 2003c). These owls are one of the most migratory of all North American owls, going south of Mexico during most of the fall and winters. They are found in the Imnaha subbasin from late-spring to early fall to breed. The flammulated owl is a species dependent on large diameter Ponderosa pine forests (Hillis *et al.* 2001). The mature and older forest stands that are used as breeding habitat by the flammulated owl have changed during the past century due to fire management and timber harvest. Concerns that the narrow habitat requirements of the flammulated owl make it susceptible to populations declines led the State of Oregon to designate the flammulated owl a state-sensitive critical species (Marshall *et al.* 1996). Partners of flight uses the flammulated owl as a focal species for the dry forest habitat type (see section 1.2.1).

Flammulated owls are entirely insectivores; nocturnal moths are especially important during spring and early summer (Reynolds and Linkhart 1987). As summer progresses and other prey become available, lepidopteran larvae, grasshoppers, spiders, crickets, and beetles are added to the diet (Goggans 1986). The flammulated owl is distinctively nocturnal although it is thought that the majority of foraging is done at dawn and dusk.

Flammulated owl predators include spotted and other larger owls, accipiters, long-tailed weasels (Zeiner *et al.* 1990), felids and bears (McCallum 1994).

Males arrive on the breeding grounds before females. In Oregon, they arrive at the breeding sites in early May and begin nesting in early June (Goggans 1986). They call to establish territories and to attract arriving females. Birds pair with their mates of the previous year, but if one does not return, they often pair with a bird from a neighboring territory. The male shows the female potential sites from which she selects the one that will be used, usually an old pileated woodpecker or northern flicker hole (Ashley and Stoval 2004).

The laying of eggs happens from about mid-April through the beginning of July. Generally 2 - 4 eggs are laid and incubation requires 21 to 24 days, by female and fed by male. The young fledge at 21 -25 days, staying within about 100 yards of the nest and being fed by the adults for the first week. In Oregon, young fledge in July and August (Goggans 1986). The young leave the nest around after about 25 days but stay nearby. In Colorado, owlets dispersed in late August and the adults in early October (Reynolds and Linkhart 1987).

The flammulated owl occurs mostly in mid-level conifer forests that have a significant Ponderosa pine component (McCallum 1994). In the northern Blue Mountains they typically occur at elevations above 700 meters and below 1,400 meters. Flammulated owls habitat in the Imnaha subbasin consists primarily of mature to old, open canopy Ponderosa pine, Douglas-fir, and grand fir (Bull and Anderson 1978; Goggans 1986; Powers *et al.* 1996).

Flammulated owls are obligate secondary cavity nesters (McCallum 1994), requiring large snags in which to roost and nest. The owls nest primarily in cavities excavated by flickers (*Colates spp*.), hairy woodpeckers (*Picoides villosus*), pileated woodpeckers (*Dryocopus pileatus*), and sapsuckers (*Sphyrapicus spp*.) (Bull *et al.* 1990; Goggans 1986; McCallum 1994). For 33 nests studied in northeastern Oregon by Bull et al. (1990), 67 percent were created by pileated woodpeckers, 27 percent by northern flickers (*Colaptes auratus*), and 6 percent by decay. Flammulated owls used pileated woodpecker cavities significantly more than expected based on availability.

In northeastern Oregon, Bull and Anderson (1978) found that Ponderosa pine was an overstory species in 73 percent of flammulated owl nest sites. Powers *et al.* (1996) reported that Ponderosa pine was absent from their flammulated owl study site in Idaho and that Douglas-fir and quaking aspen (*Populus tremuloides*) accounted for all nest trees. Flammulated owls will nest only in snags with cavities that are deep enough to hold the birds, and far enough off the ground to be safe from terrestrial predators.

In studies from northeastern Oregon and south central Idaho, nest sites were located 16-52 feet high in dead wood of live trees, or in snags with an average diameter at breast height (DBH) of >20 in. (Goggans 1986; Bull *et al.* 1990; Powers *et al.* 1996). Bull *et al.* (1990) found that stands containing trees greater than 20 in. DBH were used more often than randomly selected stands. Reynolds and Linkhart (1987) suggested that stands with trees >20 in. were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns. Some stands containing larger trees also allow more light to the ground that produces ground vegetation, serving as food for insects preyed upon by owls (Bull *et al.* 1990).

Both slope position and slope aspect have been found to be important indicators of flammulated owl nest sites (Goggans 1986, Bull *et al.* 1990). In general, ridges and the upper third of slopes were used more than lower slopes and draws (Bull *et al.* 1990). It has been speculated that ridges and upper slopes may be preferred because they provide gentle slopes, minimizing energy expenditure for carrying prey to nests. Prey may also be more abundant or at least more active on higher slopes because these areas are warmer than lower ones (Bull *et al.* 1990).

Flammulated owls prefer to forage in older stands because the open crowns and park-like spacing characteristic of these stands permits maneuverability during feeding (USFS 1994b). Grasslands in and adjacent to forest stands are thought to be important foraging sites (Goggans 1986). A pair of owls appears to require about 2-10 acres during the breeding season, and substantial patches of brush and understory to help maintain prey bases (Marcot and Hill 1980). Areas with edge habitat and grassy openings up to 5 acres in size are beneficial to flammulated owls (Howle and Ritcey, 1987) for foraging.

Flammulated owls are present throughout the northern Blue Mountains in appropriate habitat types. Their presence has been documented in the subbasin (USFS 1995), but due to their secretive nocturnal nature observations are rare and it is not possible to determine population trends for the species. Population data are also inadequate for trend assessment at the scale of the western united states, but loss and fragmentation of mature forest habitat suggests that populations are declining (USFS 1998; Sauer et al. 2003; NatureServe 2003).

Flammulated owls prefer late seral ponderosa pine forests, activities that alter or remove these habitats pose the greatest threat to the species. Several studies have shown a decline in flammulated owl numbers following timber harvesting (Marshall 1957; Howle and Ritcey 1987). Management practices that remove snags reduce the availability of cavities suitable for nesting and are also a threat (Reynolds *et al.* 1989). The suppression of wildfires has allowed many ponderosa pines to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957; Reynolds *et al.* 1989; see section 1.5.2)

Aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds *et al.* 1989).

Flammulated owls come late to breeding grounds, and competition for nest sites may be a factor limiting breeding success (McCallum 1994). Saw-whet owls, screech owls, and American kestrels compete for nesting sites, but flammulated owls probably have more severe competition with non-raptors, such as woodpeckers, other passerines, and squirrels for nest cavities (Zeiner *et al.* 1990, McCallum 1994). Birds from the size of bluebirds upward are potential competitors. Owl nests containing bluebird eggs and flicker eggs suggest that flammulated owls evict some potential nest competitors (McCallum 1994). The introduced European starling also uses and competes with flammulated owls for flicker cavities. Encouraging the maintenance and growth of pileated woodpecker and northern flicker populations will help maintain high numbers of cavities, thereby minimizing this competition (Zeiner *et al.* 1990).

White-Headed Woodpecker

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on white-headed woodpecker biology.

The White-headed Woodpecker (*Picoides albolarvatus*) is a nonmigratory bird that is a year round resident of lower elevation ponderosa pine habitats in the subbasin. White headed woodpeckers have been designated sensitive by the State of Oregon. They are considered sensitive by Regions 1 and 4 of the Forest service and sensitive by the BLM. Partners in Flight uses the white-headed woodpecker as a focal species for ponderosa pine in the blue mountains (see section 1.2.1). White-headed woodpeckers are particularly vulnerable due to their highly specialized winter diet of ponderosa pine seeds (Ashley and Stoval 2004).

White-headed woodpeckers feed primarily on the seeds of large Ponderosa pines. This is makes the white-headed woodpecker quite different from other species of woodpeckers who feed primarily on wood boring insects (Blood 1997; Cannings 1995). White-headed woodpeckers do use secondary food sources including insects, mullein seeds, and suet feeders during the spring and summer (Blood 1997; Joy *et al.* 1995). By late summer, white-headed woodpeckers shift to their exclusive winter diet of ponderosa pine seeds. This dependence is likely the key limiting factor to the white-headed woodpecker's distribution and abundance (Ashley and Stoval 2004).

White-headed woodpeckers are monogamous and may remain associated with their mate throughout the year. They build their nests in old trees, snags or fallen logs but always in dead wood. Every year the pair bond constructs a new nest. This may take three to four weeks. The nests are, on average 3m off the ground. The old nests are used for overnight roosting by the birds (Ashley and Stoval 2004).

The woodpeckers fledge about 3-5 birds every year. During the breeding season (May to July) the male roosts in the cavity with the young until they are fledged. The incubation period usually lasts for 14 days and the young leave the nest after about 26 days. White-headed woodpeckers have one brood per breeding season and there is no replacement brood if the first brood is lost. The woodpeckers are not very territorial except during the breeding season. They are not especially social birds outside of family groups and pair bonds and generally do not have very dense populations (about 1 pair bond per 8 ha) (Ashley and Stoval 2004).

Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers. There is also predation by the great horned owl on adult white-headed woodpeckers. However, predation does not appreciably affect the woodpecker population (Ashley and Stoval 2004).

White-headed woodpeckers live in montane, coniferous forests. Studies in Oregon show abundance of the species is positively associated with increasing abundance of large diameter ponderosa pines (Marshall et al. 1996) Although most abundant in uncut forest stands it will utilize areas where forested vegetation treatments provide sufficient densities of ponderosa pine. Closed canopy stands with heavy shrub or young conifer regeneration are less likely to support the species than open stands with 50% or less canopy cover (USFS 2003c). Highest abundances of white-headed woodpeckers occur in old-growth stands (Ashley and Stoval 2004).

The bird excavates its nest cavities in moderately decayed wood usually in large diameter snags (USFS 2003c). Generally large ponderosa pine snags consisting of hard outer wood with soft heartwood are preferred by nesting white-headed woodpeckers. In British Columbia 80 percent of reported nests have been in ponderosa pine snags, while the remaining 20 percent have been recorded in Douglas-fir snags. Excavation activities have also been recorded in Trembling Aspen, live Ponderosa pine trees and fence posts (Cannings *et al.* 1987). Breeding territories in Oregon were found to be 104 ha in continuous forest and 321 ha in fragmented forests (Dixon 1995).

Although systematic surveys for this species have not been conducted in the subbasin the species is occasionally observed (USFS 1995; 2003c). Declines in the availability of mature ponderosa pine have resulted in a severe decline in abundance of this species in the Blue Mountains (Csuti et al. 2001). Many late/old structure stands of ponderosa pine still exist in the HCNRA and this area may provide source habitats for white-headed woodpeckers colonizing adjacent areas (USFS 2003c).

Nesting and foraging requirements are the two critical habitat attributes limiting the population growth of this species of woodpecker. Both of these limiting factors are very closely linked to the habitat attributes contained within mature open stands of Ponderosa pine. Past land use practices, including logging and fire suppression, have resulted in significant changes to the forest structure within the Ponderosa pine ecosystem (Ashley and Stoval 2004).

1.2.9.2 Eastside and Montane Mixed Conifer Forests

American Marten

The American marten *(Martes american*a) is a medium-sized carnivorous mammal that inhabits boreal forests of North America. In the western U.S., marten ranges include Oregon, Idaho, Washington, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, and California (Strickland et al. 1982). It is globally distributed throughout Canada and Alaska, south through the Rockies, Sierra Nevada, northern Great Lakes Region, and northern New England. Total population size is unknown but probably is at least several hundred thousand. Martin populations are considered secure in Idaho but vulnerable in Oregon (NatureServe 2003). The species was assigned Oregon state sensitive status due to declining habitat quantity and quality due to harvest of mature and old-growth timber (Turley and Holthuijzen 2002).

The American marten breeds in summer the summer and delayed implantation results in an average litter of 3-4 in spring. The young are usually born in a hollow tree, sometimes in rock den. Young are weaned in 6 weeks, and males are sexually mature in 1 year, females in 1-2 years (NatureServe 2003).

The diet of the American marten consists mainly of small mammals, birds, insects, and carrion. When in season berries and other vegetative matter contribute to their diet. American marten forage both on the ground and in trees and are expert at exploiting subnivean prey (voles, red squirrels, etc.) (NatureServe 2003).

American marten prefer structurally complex habitats with multiple canopy layers and abundant down woody debris and under story shrubs (Koehler and Hornocker 1977). They prefer mature forests with closed canopies but sometimes use openings in forests if there are sufficient downed logs to provide cover. The type of forest is less important to martens than forest structure. In Oregon, populations may be declining due to loss of mature forest habitat. This species is a furbearer in Oregon (Csuti et al. 2001).

In northern California, 74% of 155 daytime resting sites of nine radio-tracked martens were in snags, logs, stumps, and tree canopies. The average size of logs, snags, and stumps used by martens was significantly greater than the average size of those available. Martens commonly use elevated perches from which to pounce on terrestrial prey. Short-rotation timber harvest, clearcutting and single-species replanting, and burning or otherwise removing slash, snags, and downed logs likely are detrimental to marten populations (Verts and Carraway 1998).

Home range size is variable, but usually averages less than 10 sq km, although it may be larger when food sources are scarce (Slough 1989). In the Blue Mountain region American marten inhabit mesic coniferous forests typically above 4,500 ft (BLM 2002). The marten is considered a valuable furbearing species and historic overharvest caused marten population declines in many areas. Today loss of habitat and fragmentation are the primary factors impacting American marten populations (NatureServe 2003).

American martens are known to occur in the subbasin, but little other population information exists (USFS 1998). Recent winter track snow surveys located some marten tracks, with most of them occurring in late or old growth forest habitat (USFS 1998). Two sightings of American marten have been reported to the ONHP one adult was observed in upper Big Sheep in 1988 and a juvenile was observed in upper Little Sheep in 1992 (ONHP 2003). Two museum specimens collected in the Big Sheep Creek drainage are now housed in Oregon State University's fish and wildlife department (Verts and Carraway 1998).

Boreal Owl

The boreal owl (*Aegolius funereus*) breeds in North America from treeline in central Alaska east to Newfoundland; south central Oregon in the Cascade and Blue Mountains, and in the Rocky Mountains south through Washington, Idaho, Montana, Wyoming, and Colorado to northern New Mexico; then east through central Saskatchewan, southern Manitoba, northern Minnesota, southern Quebec and Ontario. Breeds in Eurasia from treeline in northern Scandinavia, Russia, and Siberia, south in the mountains to southern Europe, the western Himalayas, and western China (AOU 1983, Hayward and Hayward 1993). Winters mainly in the breeding range, however it may move south in the eastern U.S. and Europe during eruption years (AOU 1983, Hayward and Hayward 1993) (NatureServe 2003). Oregon is the southern limit for this species on the west coast. Its habitat is isolated to the islands of mature subalpine fir and Engelmann spruce. Its early breeding season is usually associated with deep snow; consequently, there have been very few surveys for this species. Boreal owls were virtually unknown in Oregon prior to 1987. The species is now known to occur on a limited basis in northeastern Oregon and western Idaho, but no population estimates have been made. Obtaining population estimates for this species is complicated by nomadism caused by fluctuating prey density (Hayward and Hayward 1993). Boreal owls are listed as a Sensitive-status undetermined by the State of Oregon (Table 33).

Boreal owls nests in abandoned woodpecker holes or natural cavities in standing snags. Usually in older forests with complex physical structures. Some success has been achieved in getting them to use artificial nest boxes (Harrison 1978). Females typically occupy the nest cavity 1-3 weeks prior to egg laying. In Idaho, nesting was initiated between mid-April and late May. After the female incubates the eggs for between 25-36 days a clutch of 4-6 hatches. The young owls fledge at about 4-5 weeks and are independent after 5-6 weeks. Boreal owls reach sexually mature by 1 year (NatureServe 2003).

Boreal owls hunt from a perch and captures prey on ground (DAI 2004). They eat primarily small mammals, also sometimes birds and insects. They typically forage mostly at night. The best foraging habitat for boreal owls is in spruce/fir stands (DAI 2004).

Large stand replacement fires can destroy the structure of stands that serve as boreal owl habitat. This is thought to be a major adverse impact to the species. Returning to a more natural fire regime through prescribed burning would reduce the threat of large-stand replacement fires to boreal owl habitat in the subbasin (USFS 2003c). Timber harvest may also be a threat to Boreal owls as it affect their habitat by removing nest trees, and forest structure, and can reduce prey populations. However, harvest has been very limited in the subalpine habitats of the HCRNA (USFS 2003c).

Olive-Sided Flycatcher

The olive-sided flycatcher (*Contopus cooperi*) is a rather large (18-20 cm) flycatcher with a large-head, with a proportionately short tail. Plumage is brownish-olive above (browner on juveniles) with a dull white to yellowish throat, breast, and belly. The streaked or mottled chest patches are darker. The olive-sided flycatcher is migratory and winters in Central and South America. It breeds from Alaska across Canada and south to North Carolina in the East, and the mountains of northern Baja California, Arizona, and New Mexico in the West. It is not found in the great plain and most of the southeastern United States (NatureServe 2003).

North American Breeding Bird Survey (BBS) data indicate declines since 1966 across much of North America; significant overall decline of 68% (3.3%/year) from 1966 to 2000, 49% (3.3%/year) from 1980 to 2000 (Sauer et al. 2001). Declines are relatively similar across range, although they appear to be more severe in the central and eastern regions of the continent (Sauer et al. 2001). Abundance estimates suggest that this bird is thinly distributed throughout its range in the province, although it can reach densities of 100 pairs per sq km in some areas (Cheskey 1987). The olive-sided flycatcher has been designated as an Oregon State sensitive-vulnerable species, and is used by Partners in Flight as a focal species for mesic mixed conifer forest types (see section 1.2.1).

As a neotropical migrant that may spend only three to four months of the year on its North American breeding grounds, the olive-sided flycatcher is at risk from deforestation on its wintering grounds in Central and South America. In California, Marshall (1988) found that olive-sided flycatcher disappeared from breeding ranges on Redwood Mountain California in the 1980s, even though highly suitable habitat remained. Marshall (1988) speculated that the disappearance from suitable, unchanged habitat was caused by the destruction of corresponding forests in Central America, where these birds maintain their winter territories. Olive-sided flycatchers display strong year-to-year site fidelity on the breeding (Altman 1997) and wintering grounds (Marshall 1988, Altman 1997).

In Oregon the olive-sided flycatchers breeding season commences in May and by October it departs the breeding ground for its migration south. The nest is typical of most passerine birds and is a small cup made of plant material (Csuti et al. 1997). Nests are placed most often in conifers on horizontal limbs from two to 15 m from the ground (Harrison 1979). The clutch of 2-4 eggs is incubated by the female for 16-17 days. The young are independent 2-3 weeks after hatching (Csuti et al. 1997).

Like most flycatchers the olive-sided flycatcher flies out from a perch to catch insects in flight. It eats bees, flying ants, flies, small beetles, mosquitoes, and any other small flying insect that approaches(Csuti et al. 1997). Olive-sided flycatchers have been documented to show a preference for honeybees and other Hymenoptera (Terres 1980).

In the western United States, breeding habitat for the olive-sided flycatcher consists of uneven canopy coniferous forests. Specific cover types that occur in the subbasin and serve as source habitats include Engelmann spruce-subalpine fir, Douglas fir and grand fir (Wisdom et al. 2001).   The species requires large blocks of habitat, and at least 20 ha may be necessary to sustain a single territorial pair (Peterson and Fichtel 1992).   The olive-sided flycatcher prefers forests with openings containing dead standing trees that overtop the forest below. Such snags are used as perches from which to survey territory and launch insect attacks. Olive-sided flycatchers are often found along the forested edges of beaver (Castor canadensis) ponds and rivers, and in areas of burns or blowdown (Cheskey 1987). In winter, olive-sided flycatcher migrants in Costa Rica were found to occur in habitats similar to their breeding habitats broken canopy forests containing tall snags and semi-open areas (Stiles and Skutch 1989).

Some studies in western North America have conclude that the olive-sided flycatcher is more abundant in some types of logged forest (especially those with suitable structural features retained) than it is in unlogged stands (Altman and Sallabanks 2000). However, the continuing increase in availability of logged forest openings is at odds with the documented overall decline in numbers of this species. Perhaps logged forest, although attractive to flycatchers, is an 'ecological trap' (Altman and Sallabanks 2000) and is actually a low quality breeding habitat. This hypothesis is supported by preliminary study in western Oregon, where nest success was substantially higher in postfire habitat than it was in several types of harvested forests (Altman and Sallabanks 2000) (NatureServe 2003).

The presence of the olive sided flycatcher in the subbasin has been documented by the Wallowa-Whitman National Forest (USFS 1995). The species has also been detected on both the Imnaha and Zumwalt breeding bird survey routes in the subbasin (Sauer et al. 2003). However, the data are not long-term or consistent enough to indicate trends.

The primary threat to the olive-sided flycatcher is habitat degradation in both its winter and breeding range. Efforts to reverse the declining population trends of olive-sided flycatchers could selective use of small patch clearcuts or wildfire, beaver restoration or flooding or girdling of trees where there were once historic beaver populations. Snags of varying heights but particularly tall snags should be retained after harvest or fire (Altman 1997). Altered fire regimes that result in fewer but larger more destructive fires will reduce the amount of edge area between early and late seral forests; these areas are important forage areas for olive sided flycatcher (Wisdom 2001).

Rocky Mountain Elk

Elk (*Cervus elaphus*) require a mosaic of early forage-producing stages and later cover-forming stages of forest development, both in close proximity.

Management of elk in the subbasin is guided by Oregon's Elk Management Plan (ODFW 2003d). The plan was developed through a public review process and identifies acceptable population numbers and management options for each big game management unit.

Big game management units all or partially contained by the Imnaha subbasin include Chesnimnus, Pine Creek, Snake River, and Imnaha. These units are within the Wallowa district. Elk populations in the Wallowa district met or exceeded the management objective of 17,050 for most of the 1980s. Since 1990, elk populations have declined; an estimated elk population of 11,800 was reported for the Wallowa district in 2001 (ODFW unpublished data). Potential factors in this decline include poor calf survival, large predator populations, and the spread of noxious weeds on elk range. In the last three years, the ODFW has spent an estimated $20,000 on habitat improvements in the lower Imnaha subbasin. These projects were done in collaboration with private landowners and include weed control, seedings, fertilizing, burnings, and water developments (ODFW unpublished data). The majority of the elk range in the subbasin is publicly owned, and damage reports are rare. The number of hunting tags issued in the area has declined by 5,000 tags in recent years, yet elk hunting opportunities remain good (Nowak 2001).

1.2.9.3 Alpine Grassland and Shrublands

Rocky Mountain Goat

The Rocky Mountain goat (*Oreamnos americanus*) is found on ridges and forage in alpine meadows in the subbasin. The species eats sedges, willows, and forbs in warmer months but turns to lichens, moss, and conifer browse in winter. Where available, grass is grazed throughout the year. In the Wallow Mountains, areas intensively used by mountain goats had less timber and more slide rock and cliff rock than surrounding areas did. The goats tended to move to slightly lower elevations in winter (ODFW 2003c).

In the Wallowa Mountains, mountain goats fed along ridgetops in July, in meadows in August and September, and in slide-rock areas in October. In December and January, goats fed along ridges blown free of snow, but during storms, goats were restricted to timber areas, where they fed on conifers and mountain mahogany (Vaughnan 1975). With snowmelt and concomitant growth of plants in spring, mountain goats foraged in open areas.

Younger goats face higher mortality than adults. Few predators can catch mountain goats on cliff faces, but elsewhere, they fall prey to mountain lions, bears, coyotes, and bobcats. Golden eagles may eat newborns or knock young off cliffs (Csuti et al. 2001).

The historical distribution of the mountain goat in Oregon is debated. Some documents indicate that the mountain goat is not native to the state of Oregon and that its presence there is a result of introductions (Verts and Carraway 1998, Thomas and O'Neil 2001). However, a review of literature documenting archaeological evidence of the species' presence, accounts of observations in the journals of Oregon's early explorers, and early scientific accounts and descriptions of the species led the ODFW to conclude that mountain goats were part of Oregon's native wild fauna up until or just prior to the time of European settlement (ODFW 2003c). The wildlife managers of the subbasin concur with this conclusion and have decided to treat the mountain goats as extirpated and subsequently reintroduced in this document.

Mountain goats have been released in Oregon on 12 separate occasions. Animals from 8 of these releases could move into the Imnaha subbasin: those released on Hurricane Creek (a tributary to the Wallowa River in the Grande Ronde subbasin, just outside the upper western side of the subbasin); those released at Pine Creek and Summit Pt. (just south of the subbasin divide in the Middle Snake subbasin); and those released at Sluice Creek in the Hells Canyon subbasin. These releases resulted in the reintroduction of 95 sheep (35 males, 60 females) and have formed three herds in the area surrounding the subbasin: the Wallowa Mountain, Elkhorn Mountain, and Hells Canyon herds (Table 76).

Table 76. Rocky Mountain goat introductions in the area surrounding the Imnaha subbasin.

Year	Origin of stock	Male	Female	Total Released	Herd	Release Site
1950	Chopaka Mt., WA	3	2	5	Wallowa Mountains	Joseph Mountain
1983	North Fork Clearwater River, ID	3	3	6	Elkhorn Mountains	Pine Creek
1985	Olympic National Park, WA	2	6	8	Wallowa Mountains	Hurricane Creek
1985	Olympic National Park, WA	4	4	8	Wallowa Mountains	Pine Creek
1986	Misty Fjord, AK	3	5	8	Wallowa Mountains	Hurricane Creek
1986	Misty Fjord, AK	2	5	7	Elkhorn Mountains	Pine Creek
1989	Olympic National Park, WA	8	9	17	Wallowa Mountains	Hurricane Creek
2000	Elkhorn Mountains, OR	3	13	16	Hells Canyon	Sluice Creek
2002	Elkhorn Mountains, OR	7	13	20	Elkhorn Mountains	Summit Point
Total		35	60	95		

The Wallowa Mountain herd was established with five releases (Table 76). The population grew from 5 to 30 animals by 1966. Over the next 20 years, the population remained relatively static until kid recruitment improved following additional releases. The 2002 population estimate for the Wallowa Mountains was 200 goats. Dispersal into vacant habitat adjacent to core areas is occurring throughout the Wallowa Mountains, and habitat is available to support 600 goats (ODFW 2003c).

The Elkhorn Mountain herd was established from three releases. Kid-to-adult population ratios have been high, and the herd's population has increased rapidly. In 2002, this population was estimated to contain 150 goats. Although the area is capable of supporting an estimated 300 goats, 36 animals have been removed from the herd for transplant to other areas (ODFW 2003c).

Mountain goats transplanted to Hells Canyon in July 2000 are continuing to be monitored. Reproduction has been good, and the 2002 population estimate was 30 animals. Hells Canyon could potentially support a population of 200 goats (ODFW 2003c).

1.2.9.4 Eastside Grasslands

Bighorn Sheep

Bighorn sheep (*Ovis canadensis*) were historically widespread throughout the drier, non-forested regions of western North America. Nowak (1991) estimated that 1.5 to 2 million individual *Ovis Canadensis* may have inhabited North America prior to their decline in the nineteenth century. Bighorns were an important historical resource for Native Americans. Horns and bones were used to make tools and ornaments, hides were used for clothing, and the meat was an important protein source (Valdez and Krausman 1999). Bighorn sheep were especially abundant in the Wallowa Mountains of Oregon (ODFW 2003c).

Overhunting, poor range conditions, and domestic sheep diseases led to the extirpation of bighorn sheep from Oregon in the 1940s (ODFW 2003c). Bighorn populations have increased since the 1900's due to a series of reintroductions, but much of their previous range is still unoccupied (Wisdom et al. 2000). Transplanting is necessary to stimulate new populations in unoccupied habitats because bighorn are extremely loyal to their territories and will not readily move into new ranges (Parker 1985). Between 1979 and 1984, 36 bighorns were released into the lower subbasin; these animals originated from the Salmon River and Jasper National Park bighorn sheep populations (IDFG et al. 1997). The population of the lower Imnaha herd was estimated to be 115 in 1999 (ODFW unpublished data) in 2003 the population of this herd was 165 (ODFW 2003c). The population trend of the lower Imanha herd is expected to continue increasing (ODFW 2003c).

Bighorn hunting permits are in high demand but their issue is carefully controlled by ODFW. Between 1979 and 1996, 48 bighorn sheep permits were issued for the Imnaha bighorn sheep herd through auction and lottery. These permits resulted in the harvest of resulting in the harvest of 45 bighorns; the Imnaha herd provides more hunting opportunities than neighboring herds (IDFG et al. 1997).

Bighorn sheep habitat consists of steep rocky open terrain with abundant bunchgrasses. Lambing occurs on steep cliffs, which helps the young avoid predation (USFS 1999). The pumpkin creek drainage was highly rated as a potential release site based on the availability of lambing and winter range habitat and a low risk of exposure to domestic sheep populations.

Aggressive non-native plants and other noxious weeds are the primary factor negatively impacting habitat quality in the subbasin. Across their range in Washington, Idaho, and Oregon bighorn habitat has suffered encroachment from yellow-star thistle (*Centaurea solstitialis*), knapweed (*Centaurea* spp.), common crupina (*Crupina vulgaris*), rush skeleton weed (*Chondrilla juncea*), leafy spurge (*Euphorbia esula*), and other plants, which reduce forage quality and vigor. In the Imnaha subbasin, habitat conditions are generally good but the spread of invasive species are threats to the continued quality of Rocky Mountain bighorn sheep range.

Reestablishment of bighorn populations in surrounding areas has been hampered by reoccurring pneumonia die-offs. *Pasteurella haemolytic* and multicida bacteria have been identified as the primary causes of pneumonia in bighorns and are often the result of contact with domestic sheep. Sheep grazing, once prevalent in the Imnaha subbasin, no longer occurs (D. Bryson, Nez Perce Tribe, personal communication, May 2001).

Grasshopper Sparrow

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on grasshopper sparrow biology.

The grasshopper sparrow (*Ammodramus savannarum*) is a small migratory bird that breeds throughout most of the lower 48 states, but it is often locally distributed and even uncommon to rare in parts of its range (Vickery 1996). Grasshopper sparrows arrive on the breeding grounds in mid-April and depart for the wintering grounds in mid-September (Vickery 1996). They winter across the southern tier of states, south into Central America.

In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s. Based on breeding bird survey data, the grasshopper sparrow has exhibited a declining population trend at the scales of the United States, the western United States, and Oregon between 1966 and 2002. Breeding bird surveys conducted within or near the Imnaha have occasionally documented the species (Sauer et al. 2003). Surveys conducted by The Nature Conservancy on the Zumwalt Prairie in 2001 also documented the occurrence of the species in the subbasin (TNC 2002). It is not possible to determine grasshopper sparrow population trends in the Imnaha subbasin from the data available.

Their diet of the grasshopper sparrow varies by season. In the spring and summer grasshopper sparrows rely on invertebrates for 3/5 of their diet, and seeds for the remainder. In the fall, seeds become a greater component of the diet making up 71% of the total with invertebrates making up the remainder no data was available on the composition of the winter diet. (Martin *et al.* 1951 in Vickery 1996).

Grasshopper sparrows are monogamous throughout the breeding season and nest in semi-colonial groups of 3-12 pairs (Ehrlich et al. 1988). The female incubates the eggs alone (Ehrlich et al 1988), while the male defends the pair's territory (Smith 1963). The incubation period lasts from 11 to 13 days (Smith 1963, Ehrlich et al 1988, Harrison 1975), with a nestling period of 6 to 9 days after hatching (Harrison 1975, Hill 1976, Kaspari and O'Leary 1988). Hatchlings are blind and covered with grayish-brown down (Smith 1968). After the young hatch, both parents share the responsibilities of tending the hatchlings (Smith 1963). Brood parasitism by brown-headed cowbirds has been documented but rates are generally low (Vickery 1996).

Throughout most of their range, grasshopper sparrows can produce two broods, one in late May and a second in early July (Smith 1968, Vickery 1996). However, in northern portions of its range like the Imnaha subbasin, one brood is probably most common (Vickery et al. 1992, Wiens 1969).

Predators of the grasshopper sparrow include hawks, Loggerhead Shrikes, mammals and snakes (Vickery 1996). Nest predators cited include: raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), northern black racers (*Coluber constrictor constrictor*), blue jays (*Cyanocitta cristata*), and common crows (*Corvus brachyrhynchos*) (Johnson and Temple 1990, Wray et. al 1982).

Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968, Blankespoor 1980, Vickery 1996). Vickery (1996) states that exposed bare ground is the critical microhabitat type for effective foraging. Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Wiens 1969, 1970; Arnold and Higgins 1986). In east central Oregon grasshopper sparrows occupied relatively undisturbed native bunchgrass communities dominated by *Agropyron spicatum* and/or *Festuca idahoensis* (Holmes and Geupel 1998). Vander Haegen *et al.* (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but did find one with the percent cover perennial grass. Grasshopper sparrows are area sensitive, preferring large grassland areas over small areas (Herkert 1994a,b, Vickery et al. 1994). Key habitat features of grasshopper sparrow habitat are displayed in Table 30.

Grasshopper sparrows occasionally inhabit cropland, but at lower densities than are found in grassland habitats (Smith 1963, Smith 1968, Ducey and Miller 1980, Basore et al. 1986, Faanes and Lingle 1995). Early season mowing of hayfields causes major nest failures in grassland nesting species. Areas where hayfields are adjacent to bunchgrass grasslands may serve as population sinks for grasshopper sparrows (Wisdom et al 2000).

Table 77. Key habitat relationships required for breeding grasshopper sparrows (Altman and Holmes 2000).

Conservation Focus	Key Habitat Features			
	Vegetative Composition	**Vegetation Structure**	**Landscape/Patch Size**	**Special Considerations**
native bunchgrass cover	native bunchgrasses	bunchgrass cover >15% and >60% total grass cover; bunchgrass >25 cm tall; shrub cover <10%	>40 ha (100 ac)	larger tracts better; exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.

Primary threats to the species have been identified as loss, degradation, and incompatible management of grassland habitat (Nature Serve 2003). Maintaining the quality, size and connectivity of the remaining bunchgrass habitat in the subbasin should be a priority for maintaining grasshopper sparrows. See section 1.5.2 for more discussion of the loss and degradation of grassland habitats as a limiting factor to wildlife species and the Imnaha Management plan for strategies for addressing this limiting factor.

1.2.9.5 Wetland and Riparian Areas

Mountain Quail

The mountain quail *(Oreortyx pictu*s) is the largest North American quail north of Mexico. Rangewide mountain quail are distributed in five western states including California, Washington, Oregon, Nevada, and Idaho as well as Baja Norte Mexico. They are also found in small disjunct populations as introduced birds on Vancouver, Island, British Columbia and the San Juan Islands of Washington (USFWS 2003d). Mountain quail are found in relatively high numbers throughout suitable habitat in the Coast and Cascade Ranges and the Rouge Umpqua and Willamette valleys of western Oregon. However population numbers in the eastern portion of their range, which includes the Imnaha subbasin have declined dramatically since the 1930s. Due to these declines the eastern population of mountain quail was considered for listing under ESA. On July 2003 the USFWS found that this listing was not warranted in large part due to concerns over the discreteness of the two populations (USFWS 2003d).

Mountain quail habitat in relatively arid areas like the Imnaha subbasin consists of tall dense shrubs close to water, usually in riparian areas (Heekin et al 1993). Mountain quail are usually elevational migrants and winter in coveys below the snow line. In March, pairs start moving to nesting areas, often up in elevation to open forest (Cassirer 1995). Mountain quail nest in a concealed depression on the ground. The female typically lays two clutches of 7-10 eggs, one of which is incubated and raised by the male (Heekin et al 1993). Nest sites in the Imnaha subbasin were most commonly located in Douglas-fir/ common snowberry associations (Crawford and Pope 1999). Nests are usually within 0.5 mile of water. Breeding territories range from 5 to 50 acres. Coveys of 3 to 20 birds form in the fall and break up in the late winter prior to the breeding season (Csuti et al. 2001).

Mountain quail eat primarily plant material throughout the year based at least partially on abundance including perennial seeds, fruits, flowers and leaves annual forbs, legumes and mushrooms. Invertebrate animal matter makes up only 0 to 5 percent of the adult diet but a larger percentage of the juvenile diet (USFWS 2003d). Mountain quail food-producing shrubs found in the subbasin and surrounding area were white alder, serviceberry, hackberry, black hawthorn, smooth sumac, poison ivy, currant, black locust, elderberry, and snowberry. Other shrub species such as chokecherry, ninebark, and syringa have not been identified as food sources but are important components of mountain quail habitat (see summary of food sources contained in Rocklage and Edelmann 2001).

Mountain quail are prey to numerous predators but are especially vulnerable to hawks. Other known predators include great horned owl (*Bubo virginianus*) coyote (*Canis latrans*), bobcat

(*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*) and rattlesnake (*Crotalus sp*.) (USFWS 2003c). Results from predation studies conducted in the subbasin indicate predation rates of more than 60% a year (Pope and Crawford 2002 cited in USFS 2003b).

The species has recently declined in the Blue Mountains area (Csuti et al. 2001) and throughout the Intermountain West (Rocklage and Edelmann 2001). Recent estimates suggest that mountain quail are rare or extirpated in central and southeastern Oregon and present but only in low numbers in northeastern Oregon (Crawford and Pope 1999). Wallowa County is the only county in northeastern Oregon with an open hunting season (ODFW 2003f). Small populations of mountain quail persist in several locations in the subbasin, and a population was recently reintroduced to the Horse Creek drainage where the species had been previously extirpated (Pope and Crawford 1998). The reason for declines in mountain quail populations in the area are not entirely clear, mountain quail have been extirpated from many areas just outside the subbasin where habitat condition remains good (Cassirer 1995; Rocklage and Edelmann 2001).

Yellow Warbler

The yellow warbler (*Dendroica petechia*) is closely associated with various types of riparian vegetation including willows and cottonwoods. It occupies riparian thickets in valleys and follows them upward to mid-elevation mountains. It makes use of willow thickets in mountain meadows and moist quaking aspen groves. The species is susceptible to nest parasitism by brown-headed cowbirds. This susceptibility has caused population declines in some areas (Csuti et al. 2001).

This species was found to have a significant declining population trend based on data from the Central Rocky Mountain Breeding Bird Survey Physiographic Region (Sauer et al. 1999, as cited in Altman 2000) (Figure 61). The yellow warbler has been consistently detected along the Imnaha and Joseph breeding bird survey routes between 1971 and 2002. The Imnaha Route runs from Corral Creek up stream to Adams Creek along the Imnaha River. The Joseph Creek route runs north–south near the town of Joseph, just west of the subbasin. Surveys on these routes show a declining trend in the numbers of yellow warbler detected between 1971 and 2002. The relevance of this observation to population numbers or possible reasons for the decline is not clear (Sauer et al. 2003).

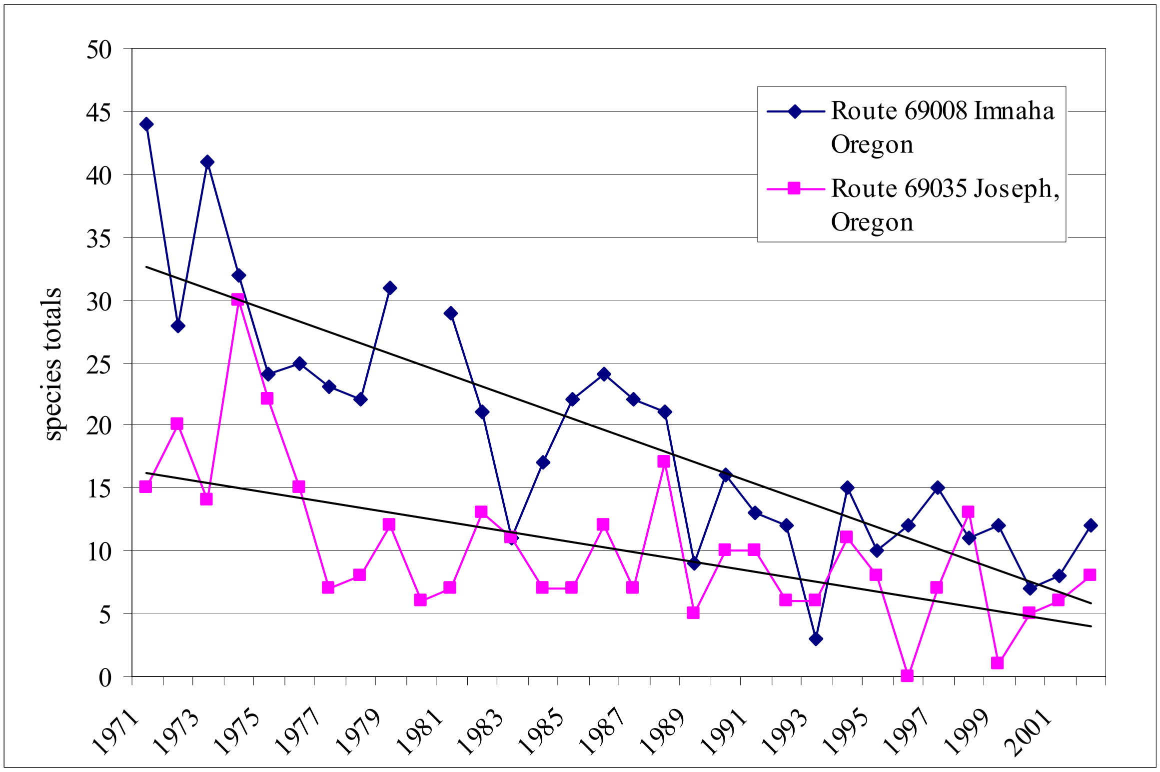

Figure 61. Breeding bird survey counts for the yellow warbler for two routes in or just outside the Imnaha subbasin 1971–2002.

Long-Toed Salamander

The long-toed salamander (*Ambystoma macrodactylum*) is the most common and widespread species of *Ambystoma* in the northwest (Csuti et al. 1997). It is distributed in northern British Columbia south along the coast to central Oregon and inland to the Rocky Mountains of Idaho (Csuti et al. 1997) and western Montana (Petranka 1998 cited in Amphibia Web 2004). It is found more spottily to the south in the Sierra Nevada Mountains of California. An isolated population inhabits Santa Cruz County California (Csuti et al. 1997). The long-toed salamander is dark gray to black with a yellow, tan or olive green dorsal stripe often broken up into blotches (Stebbins 1951). The sides have some white speckling. The ventral side is gray or black (Petranka 1998 cited in AmphibiaWeb 2004).

Both adults and juvenile long-toed salamanders feed primarily on invertebrates. Larvae feed on zooplankton, immature insects, snails, and occasionally other salamander larvae, including conspecifics. Adults eat terrestrial and aquatic invertebrates including: insects, insect larvae, spiders, slugs, earthworms, amphipods, etc. (NatureServe 2003). Predators of larvae probably include aquatic insects and garter snakes; garter snakes and bullfrogs eat adults (Nussbaum et al. 1983).

Long-toed salamander adults are commonly found under bark, rocks or below ground outside of the breeding season. They inhabit a wide variety of terrestrial habitats, including semiarid sagebrush desert, dry woodlands, humid forests, and alpine meadows (Csuti et al. 1997, NatureServe 2003).

Each season adults migrate form non-breeding areas to breeding ponds; the males arrive at the breeding ponds earlier in the season and stay later than females (Beneski et al 1986). Migrations usually occur at night in conjunction with precipitation. At low elevations this migration may be in October or November, but at higher elevations it does not occur until snowmelt in late spring (Petranka 1998 cited in AmphibiaWeb 2004).

Long-toed salamanders breed in temporary or permanent ponds in quiet water at the edge of lakes, ponds streams. In riverine habitats long-toed salamanders tend to use low gradient-moderate gradient pools, in lacustrine habitats they are most commonly found in shallow water habitats and in palustrine habitats they use riparian areas and temporary pools. During the breeding season adults may be found under logs, rocks, and other debris near water (NatureServe 2003).

All but the most extreme upper elevation areas of the subbasin are considered within the range of the long-toed salamander (Csuti et al. 1997). No know surveys for the species have been conducted in the Imnaha subbasin but in the neighboring Snake Hells Canyon Subbasin the species was found to use primarily pools with emergent vegetation and used these structures to attach their eggs. Long-toed salamanders were found to be widespread and abundant in the Craig Mountain Area of the Snake Hells Canyon Subbasin (Llewellyn and Peterson1998). They were most common in upper elevation pools, particularly those that had been influenced by human activities. This is probably because in that subbasin natural pools tend to be associated with wet meadows or are attached to a relatively high gradient creek system. These habitats did not have the shallow areas and emergent vegetation for egg mass attachment preferred by long-toed salamanders (Llewellyn and Peterson 1998).

Threats to the long-toed salamander are similar to those that threaten amphibian populations worldwide. Eggs exposed to ambient levels of UV-B radiation have been shown to have increased mortality and incidence of deformities than those shielded from UV-B (Blaustein et al 1997). A trematode has been found that disrupts both limb development and regeneration and has been proposed as an explanation of why individuals with supernumerary limbs are found (Sessions and Ruth 1990). Both juvenile and adults are susceptible to environmental contaminants, which may reduce breeding success or cause mortality. Introduction of non-native fish and bull frogs may also threaten this species. Bull frogs have been documented to prey on long-toed salamanders (Nussbaum et al. 1983); In Montana, introduced trout populations clearly excluded salamanders from lakes (Funk and Dunlap 1999). Roads have also been identified as a threat to long-toed salamanders migrating between breeding and non-breeding habitats. High mortality rates of long-toed salamander crossing roads have been documented and salamanders attempting to cross high-speed transportation corridors such as interstate highways were found to almost never successfully transverse the roads and such roads are thought to present functional barriers. No high speed transportation corridors of this type occur within the Imanha subbasin but roads may be having some impact on the subbasins long-toed salamander populations (NatureServe 2003). The destruction of wetland habitats is probably the greatest threat to long-toed salamanders across their range (AmphibiaWeb 2004); this is likely particularly true in the Imnaha subbasin where the impacts of environmental contaminants, introduced species, and roads remain relatively low (see sections 1.1.1.10 transportation , 1.1.2.3 water resources, 1.1.3.4 invasive plants).

1.2.9.6 Agriculture, Pastures, and Mixed Environs

Mule Deer

Rocky Mountain mule deer (*Odocoileus hemionus*) are native to eastern Oregon. Mule deer occupy a wide range of habitat types; some live in desert shrubs, some in woodlands, and some in conifer forests. Typically, however, mule deer occupy the more open, but more rugged areas (ODFW 2001b). The species is common in the grassland habitats of the subbasin. Shrub species—including antelope bitterbrush (*Purshia tridentata*), rabbitbrush (*Ericameria* and *Chrysothamnus* spp.), juniper, and mountain mahogany (*Cercocarpus* spp.)—provide critical nutrition in the critical winter months.

Fluctuations in mule deer populations appear to be a naturally occurring phenomenon. For example, early explorers of the area reported a scarcity of big game, but 20 years later gold miners found abundant deer herds.

Fluctuations in mule deer populations can be attributed to both natural and human influenced factors. Drought conditions reduce forage and cover values, while severe winter weather conditions can result in large loss of deer. Both conditions can cause poor deer condition and result in lower deer survival. Overgrazing by livestock in the late 1800s and early 1900s resulted in rangelands that were dominated by shrubs and forb species that were more favorable for deer, and populations increased. Increased fire suppression activities by the middle of the twentieth century allowed the encroachment of less nutritious woody vegetation that supports smaller deer populations (ODFW 2001b).

Mule deer in Oregon are managed following Oregon's 2002 *Mule Deer Management Plan*, which represents an update of the 1990 mule deer plan. The plan includes issues and concerns identified in 2002 through input from constituent groups, agency biologists and the public and identifies issues, objectives, and strategies for mule deer management that will be considered in development of the Imnaha subbasin management plan (ODFW 2003e).

Mule deer populations have been generally declining throughout western North America during the last several years. The estimated population of mule deer in Oregon was 260,700 in 1996, which was 18% below the established statewide management objective of 317,400 mule deer. In 2001, this number had grown to 283,000 but still remains below the management objective (ODFW 2001b). Mule deer population estimates for the Wallowa district have been below the ODFW management objective of 26,800 for many years. Mule deer populations in the area have trended upwards for the last five years from a low of 17,400 in 1996 to 20,000 in 2001 (ODFW unpublished data).

The Imnaha subbasin is comprised of part of four ODFW game units: Imnaha, Snake River, Chesnimnus, and Pine Creek. These units were estimated to support a combined total of 3,669 mule deer in 2001. The Imnaha unit covers the largest area in the subbasin and supported an estimated 654 mule deer in 2001 (Table 78) (ODFW 2001b). Management goals in the area are limited by the problem of mule deer foraging on private agricultural lands. Although agricultural lands are very limited in the subbasin, the protection of lands in neighboring subbasin restricts the mule deer population numbers ODFW strives for. The green forage was created in 1983 to assist landowners who are experiencing damage caused by wildlife. The objective of the green forage program is to alleviate or prevent big game damage on private lands while benefiting wildlife by improving forage quality and quantity on public or private lands (ODFW 2003e).

Table 78. Mule deer herd composition in 2001 for the game units partially contained in the Imnaha subbasin (ODFW 2001b).

Unit	Percent of unit in Imnaha Subbasin	Bucks	Does	Fawns	Total
Imnaha	87	68	383	203	654
Snake River	57	93	704	348	1,145
Chesnimnus	23	64	423	229	716
Pine Creek	10	93	704	348	1,145
Total		**318**	**2,214**	**1,128**	**3,660**

1.2.9.7 Open Water–Lakes, Rivers, and Streams

Bald Eagle

This Section draws heavily from the species description prepared by Keith Paul (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on bald eagle biology.

The bald eagle (*Haliaeetus leucocephalus)* was first protected in the lower 48 states by the Bald Eagle Protection Act of 1940; it was federally listed as endangered in 1967. In 1995, the bald eagle was reclassified as threatened in all of the lower 48 States. No critical habitat has been designated for the bald eagle (USFWS 2003c). In 1963, a National Audubon Society survey reported only 417 active nests in the lower 48 states. In 1994, about 4,450 occupied breeding areas were reported (USFS 2003c). Due to positive trends like this the bald eagle was proposed for delisting on July 6, 1999; a decision on whether to delist the bald eagle is pending (64 FR 36453). The bald eagle was listed as threatened under the Oregon ESA in 1987 (Marshall et al. 1996).

The bald eagle historically ranged throughout North America except extreme northern Alaska and Canada and southern Mexico. Bald eagles can be resident year-round where food is available; otherwise they will migrate or wander to find food. In Oregon, historic bald eagle nests have been documented in 32 of 36 counties. Those counties where historic breeding records did not occur include Sherman, Gilliam, Morrow, and Malheur counties (Isaacs and Anthony 2001). The current range in the lower 48 states has been divided into five recovery areas: Chesapeake Bay, Pacific, Southeastern, Northern States, and Southwestern (USFS 2003c). The Imnaha Subbasin lies within the Pacific recovery area.

A recovery plan for the Pacific population of the bald eagle was completed in 1986. The plan identifies the following de-listing goals which are necessary to obtain a self-sustaining population of bald eagles: 1) a minimum of 800 nesting pairs with an average reproductive rate of one fledged young per pair and an average success rate per occupied site of not less than 65 percent over a five-year period, 2) attainment of breeding population goals should be met in at least 80 percent of the management zones, 3) wintering populations should be stable or increasing (USFS 2003b).

The Pacific recovery area was divided into zones, and the Imnaha subbasin is part of the Snake River zone. Recovery goals for the Snake River zone are to: 1) locate, monitor, and protect nesting, roosting, and feeding areas, 2) develop nest site plans for nesting and roost areas, 3) monitor productivity, 4) prevent significant habitat disturbance and direct human interference at nest sites and feeding areas, and 5) re-establish six breeding pairs (USFS 2003b).

[Bald eagles consume a variety of prey that varies by location and season. Prey are taken alive, scavenged, and pirated (Frenzel 1985, Watson et al. 1991). Fish were the most frequent prey among 84 species identified at nest sites in south-central Oregon, and a tendency was observed for some individuals or pairs to specialize in certain species (Frenzel 1985). Wintering and migrant eagles in eastern Oregon fed on large mammal carrion, especially road-killed mule deer, domestic cattle that died of natural causes, and stillborn calves, as well as cow afterbirth, waterfowl, ground squirrels, other medium-sized and small rodents, and fish. Proportions varied by month and location. Food habitats are unknown for nesting eagles over much of the state (Isaacs and Anthony 2003a) (Paul 2004)]. Reductions in anadromous fish runs are considered a factor limiting the use of the Imnaha subbasin by bald eagles (USFS 1995; 1998; 2003b).

Bald eagles are most abundant in Oregon in late winter and early spring, because resident breeders (engaged in early nesting activities), winter residents, and spring transients are all present. Nest building and repair occur any time of year, but most often observed from February to June (Isaacs and Anthony unpublished data). Bald eagles are territorial when breeding but gregarious when not (Stalmaster 1987). The size and shape of a defended breeding territory varies widely (1.6 to 13 square miles) depending upon the terrain, vegetation, food availability, and population density of an area (USFS 2003b). Bald eagles exhibit strong nest-site fidelity (Jenkins and Jackman 1993. Both sexes build the nest, incubate eggs, and brood and feed young (Stalmaster 1987). Egg laying (1-4 eggs) occurs mid-February to late April; hatching late March to late May (after about 35 days of incubation); and fledging late June to mid-Aug (Isaacs and Anthony 2003a). After a month of continued partial parental care the young eagles are on their own mortality rates tend to be highest in young eagles and can be caused by disease, food shortages, bad weather, or human interference (USFWS 2003c). During the nest building, egg laying and incubating periods, eagles are extremely sensitive and will abandon a nesting attempt if there are excessive disturbances in the area during this time (USFWS 2003c).

Bald eagles nest in forested areas near the ocean, along rivers, and at estuaries, lakes, and reservoirs (Isaacs and Anthony 2001). Eighty-four percent of Oregon nests were within 1 mi (1.6 km) of water (Anthony and Isaacs 1989). Nest sites in forested areas show a strong preference to multi-layered, mature forest stands. Eagles usually nest in mature conifers with gnarled limbs that provide ideal platforms for nests. Ponderosa pine, Douglas fir, and black cottonwood are preferred nest trees in the Pacific recovery area (USFS 2003b).

Wintering eagles in the Pacific Northwest perch on a variety of substrates; proximity to a food source is probably the most important factor influencing perch selection by bald eagles. Favored perch trees are invariably located near feeding areas, and eagles consistently use preferred branches (Stalmaster 1976). Most tree perches selected by eagles provide a good view of the surrounding area (Servheen 1975, Stalmaster 1976), and eagles tend to use the highest perch sites available (Stalmaster 1976; USFWS 1986). Dead trees are used by eagles in some areas because they provide unobstructed view and are often taller than surrounding vegetation (Stalmaster 1976). Isolation is also an important feature of bald eagle wintering habitat. In Washington, 98% of wintering bald eagles tolerated human activities at a distance of 300 m (328 yards) (Stalmaster and Newman 1978). However, only 50% of eagles tolerated disturbances of 150 m (164 yards) (USFWS 1986).

Habitat requirements for communal night roosting are different form those for diurnal perching. Communal roosts are invariably near a rich food resource and in forest stands that are uneven-aged and have at least a remnant of the old-growth forest component (Anthony et al. 1982). Close proximity to a feeding area is not the only requirement for night roosting sites, as there are minimum requirements for forest stand structure. In open areas, bald eagles also use cottonwoods and willows for night roosting (Isaacs and Anthony 1983). Most communal winter roosts used by bald eagles offer considerably more protection from the weather than diurnal habitat. Roost tree species and stand characteristics vary considerably throughout the Pacific Northwest (Anthony et al 1982) (USFWS 1986) (Paul 2004)].

Bald eagle use of the Imnaha subbasin is currently and has been historically relatively rare. Suitable habitat for both nesting and wintering bald eagle exists along the larger river systems in the subbasin including the lower Imnaha and Big Sheep Creek (USFS 1995; 1998). Bald eagles are occasionally observed in the subbasin but no nest sites have been documented. Bald eagle nests in closest proximity to the subbasin include two recent active nests located on private land in the Enterprise, Oregon municipal watershed along the Wallowa River and a new nest found in 1999 along the Hells Canyon Reservoir on the Payette National Forest in Idaho). A pair of bald eagles has occupied this nest for the last four years (USFS 2003b).

The status and distribution of bald eagle populations in the decades before World War II are poorly understood. Declines probably begin in some populations in the 19th century (USFWS 1986). By 1940, the bald eagle had "become rather an uncommon bird" except along the coast and Columbia River, and in Klamath Co. (Gabrielson and Jewett 1940). Habitat loss (cutting of nest trees) and direct persecution (shooting, trapping, poisoning), probably caused a gradual decline prior to 1940. However, the major factor leading to the decline and subsequent listing of the bald eagle was disrupted reproduction resulting from contamination by organochlorine pesticides, particularly DDT (USFWS 2003c).

Between 1945 and 1974 over 4.5 million acres (1.8 million ha) of National Forest in Oregon were sprayed with DDT an agricultural pesticide, (Henny and Nelson 1981). Undocumented quantities were also applied on private forests and agricultural crops, and for mosquito control around municipalities. In the late 1960s and early 1970s, it was determined that dichorophenyl-dichloroetheylene (DDE), the principal breakdown product of DDT, accumulated in the fatty tissues of adult female eagles. It impaired calcium release necessary for egg-shell formation, thus inducing thin-shelled eggs that are not viable, leading to reproductive failure (USFS 2003b). The deleterious effects of DDT on reproduction (Stalmaster 1987) joined habitat loss and direct persecution as causes of decline through the early 1970's when the population may have reached its historical low. By then, nesting pairs were extirpated in northeastern Oregon (Isaacs and Anthony 2001), where applications of DDT on National Forest land were common and widespread (Henny and Nelson 1981) (Isaacs and Anthony 2003a). On December 31, 1972, DDT was banned from use in the United States (USFS 2003b).

Loss of habitat, loss of prey and human disturbance are the greatest current threats to bald eagle populations. Actions identified by the Wallowa-Whitman National Forest and currently being implemented in portions of the subbasin that should result in continued improvement in bald eagle habitat include; implementation of management standards for livestock grazing to improve riparian conditions, maintaining snags to provide perches and/or nest trees, restoring fire regimes to maintain large tree species preferred by bald eagles like ponderosa pine and Douglas fir that respond to periodic burns, and continued efforts to protect and restore anadromous fish runs (USFS 2003b). Further development and expansion of these strategies is contained in the Imanha Subbasin Management Plan.

1.2.10 Environmental Conditions for Focal Species

Characterizing the overall habitat requirements of a wildlife species requires the consideration of three interrelated elements: the cover type (or WHTs), structural conditions, and environmental correlates. These features should be viewed as hierarchical in nature with WHTs occurring at the broadest scale, structural conditions occurring at the stand level and environmental correlates at a site specific or local level (Johnson and O'Neil 2001). This section evaluates the elements of habitat most important to the sensitive species in the subbasin. The technical team felt that while the focal species they selected were good species to use to focus discussions of the issues and habitat concerns of the subbasin a broader group should be used when identifying important habitat elements for management consideration. For this reason wildlife species designated as Federal and State T+E, State sensitive, BLM sensitive, USFS sensitive or Partners in Flight focal species were also included in the following habitat association analysis (see section 1.2.1 for species lists). This group of 69 species will be collectively referred to as 'concern species' in the following discussion.

1.2.10.1 Wildlife Habitat Types

The WHTs and their general vegetative species composition were introduced in section 1.1.1.9. As described in sections 1.1.1.10 and 1.1.3.3, land use activities and human alterations to ecological processes have altered the distribution, and composition of these WHTs. These changes have influenced the composition and population dynamics of the wildlife communities dependent on the WHTs. Unfortunately, the paucity of historical records and issues of scale make quantifying these changes difficult and estimates of change should be viewed cautiously. The best attempt at quantifying changes in the distribution of WHTs in the subbasin has been conducted by the Northwest Habitat Institute, and their data are presented in Table 79; maps showing historical and current distributions of WHTs visible at the scale of the subbasin are shown in Appendix D. Due to scale differences between the current and historic WHT layers, an analysis of changes in WHT distributions at the 6th field HUC scale was not considered appropriate by the Technical team.

Table 79. Changes in wildlife habitat types (WHTs) distribution in the Imnaha subbasin from historical to current (changes viewed to be most significant to the wildlife of the subbasin based on local knowledge, regional knowledge, and subbasin habitat data in bold).

WHT	Historical WHT Distribution (acres)	Current WHT Distribution (acres)	Change in WHT distribution from current to historical (acres)	Percent (%) change in WHT distribution from historical to current	Change from historical to current in % of subbasin covered by WHT
Montane Mixed Conifer Forest	16,627	52,661	36,034	217	7
Eastside (Interior) Mixed Conifer Forest	96,042	162,903	66,861	70	12
Lodgepole pine forest and woodlands	4,715	0	–4,715	–100	–1
Ponderosa pine forest and woodlands	**47,649**	**25,154**	**–22,495**	–47	–4
Upland Aspen Forest	248	0	–248	–100	0
Subalpine Parklands	30,277	0	–30,277	–100	–6
Alpine Grasslands and Shrublands	9,927	28,365	18,438	186	3
Eastside (Interior) Grasslands	**330,562**	**275,555**	**–55,007**	–17	–10
Shrub-Steppe	6,452	50	–6,402	–99	–1
Agriculture, Pasture, and Mixed Environs	0	1,189	1,189	—	0
Lakes, Rivers, Ponds, and Reservoirs	3,226	82	–3,144	–97	–1
Herbaceous Wetlands	0	16	16	—	0
Montane Coniferous Wetlands	0	420	420	—	0
Eastside (Interior) Riparian Wetlands	**248**	**0**	**–248**	–100	0

The degree of impact changes in the availability of a WHT will have on a particular species depends on the degree of association a species has with the WHT. A species widely known to depend on a habitat for part or all of its life history requirements is considered closely associated with that WHT. A species identified as having a close association with a WHT has an essential need for this habitat for its maintenance and viability. Some species may be closely associated with more than one WHT, during different times of the year or for different activities. Some species are not closely associated with any WHT but are rather generally associated with a number of WHTs. In this case the WHTs play a supportive role in the species maintenance and viability but the species may be more dependent on a particular structural condition (see Section 1.2.10.2) (Johnson and O'Neil 2001).

Habitat types closely associated with the broad wildlife groups of the Imnaha subbasin are displayed in Figure 62 more detailed species specific relationships are contained in Appendix A. Amphibian and reptile species in the subbasin tend to be most commonly closely associated with the wetland and open water WHTs of the subbasin, while close relationships between the subbasins bird and mammal species and their habitat are more evenly distributed among the WHTs. The open water and herbaceous wetland WHTs have the greatest total number of closely associated species (Figure 62). This indicates that alterations in these WHTs are likely to have the most widespread impacts on the ecosystem of the subbasin.

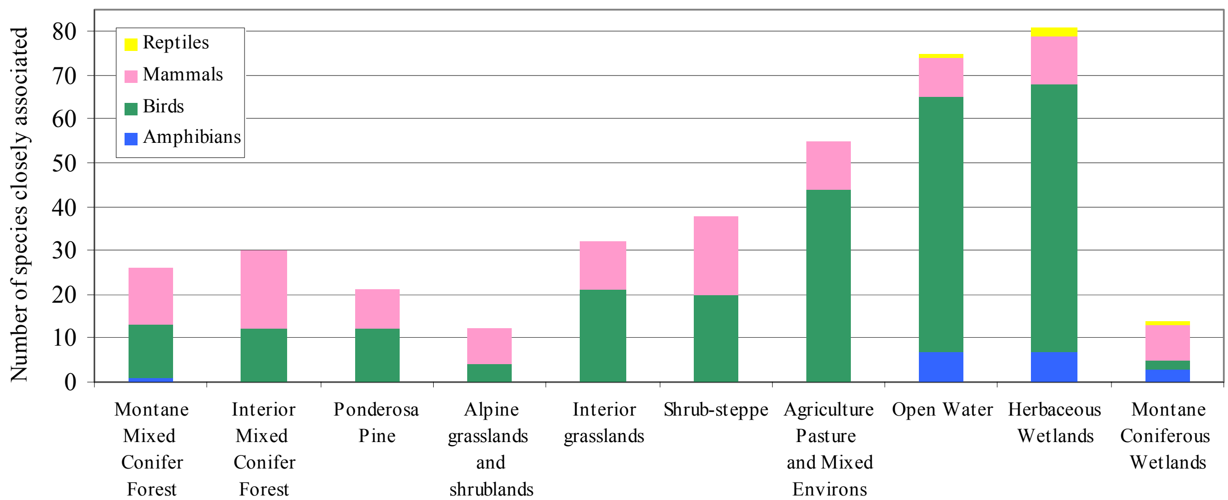

Figure 62. Distribution of close habitat associations among current WHTs in the Imanha subbasin and species groups.

Table 79 indicates that declines in the availability of the lodgepole pine, ponderosa pine, subalpine parklands, shrub-steppe, lakes, rivers and ponds, and riparian wetland WHT have occurred in the subbasin. Some of these changes are likely the result of differences in the spatial scale and mapping techniques at which the historic and current WHT maps were compiled. Discussions with biological resource experts, subbasin specific literature, and the results of regional assessments indicate that the reductions in the extent and quality of riparian wetlands, interior grasslands and ponderosa pine habitats have likely had the most significant impact on the wildlife species of the subbasin. For this reason degradation and reductions in extent of these three habitat types were identified as primary limiting factors to wildlife in the subbasin. See section 1.5.2 for a more detailed discussion of these limiting factors and the Imnaha Subbasin Management Plan for objectives and strategies geared towards reducing the impact of theses limiting factors on the wildlife populations of the subbasin.

In contrast, the NHI data indicates that acres of the subbasin covered by montane and eastside conifer forests, alpine grass and shrublands, and montane and herbaceous wetland habitat types have increased between historical and current times. If the availability of habitat were the only factor influencing populations of the wildlife species closely associated with these habitats, their populations could be expected to have increased; however, as illustrated in section 1.2.9, this is not always the case. Many of the species dependent on these WHTs have experienced population declines, which may be partially explained by the influence of structural condition and habitat elements on wildlife habitat (discussed in the following section), as well as out-of subbasin conditions (see section 1.3).

1.2.10.2 Structural Condition

Structural condition is another important feature determining the use of a habitat by a wildlife species. Similarly to WHTs, species widely known to depend on a structural condition for part or all of its life history requirements is considered closely associated with that structural condition. A species identified as having a close association with a structural condition has an essential need for this habitat for its maintenance and viability. Grassland, forest agricultural and urban habitats all exhibit structural conditions that influence wildlife habitat use. Due to the relatively small amount of the agriculture and urban habitats contained in the subbasin, the relatively small number of closely associated species, and time constraints; wildlife use of different structural conditions in these WHT was not considered.

Forest

Forest structural conditions are based on the following forest stand features: 1) tree size, 2) percent canopy cover (or percent grass/forb cover), and 3) number of canopy layers. Johnson and O'Neil (2001) defined 26 different classes of forest structure conditions based on classifying these forest stand feature using the attributes described in Table 80. Appendix H contains detailed descriptions of the characteristics of the forest structure classes.

Table 80. Attributes used to differentiate forest structure classes (Johnson and O'Neil 2001).

Tree Size (dbh)	
Shrub/Seedling	<1"
Sapling/Pole	1-9"
Small Tree	10-14"
Medium Tree	15-19"
Large Tree	20-29"
Giant Tree	≥ 30"

Percent Canopy Cover	
Open	10-39%
Moderate	40-69%
Closed	70-100%

Number of Canopy Layers	
Single Story	1 stratum
Multi-story	2 or more strata

Similarly to WHTs, species widely known to depend on a structural condition for part or all of its life history requirements is considered closely associated with that structural condition. A species identified as having a close association with a structural condition has an essential need for this habitat for its maintenance and viability. The degree of association with a structural condition was assessed for the Federal and State Endangered, Threatened, State Sensitive Forest Service Sensitive, Partners in Flight Priority Species and Focal Species (hereafter referred to as concern species). Nineteen of the concern species with habitat in the subbasin are closely associated with a forest structural condition for a life activity (Figure 63). All of these species were closely associated with more than one structural condition. In general the greatest number of species is closely associated with large to giant size class forests or early seral structural conditions, but some concern species were closely associated with all of the structural conditions (Figure 63). This illustrates the importance of maintaining a diversity of structural conditions on the landscape.

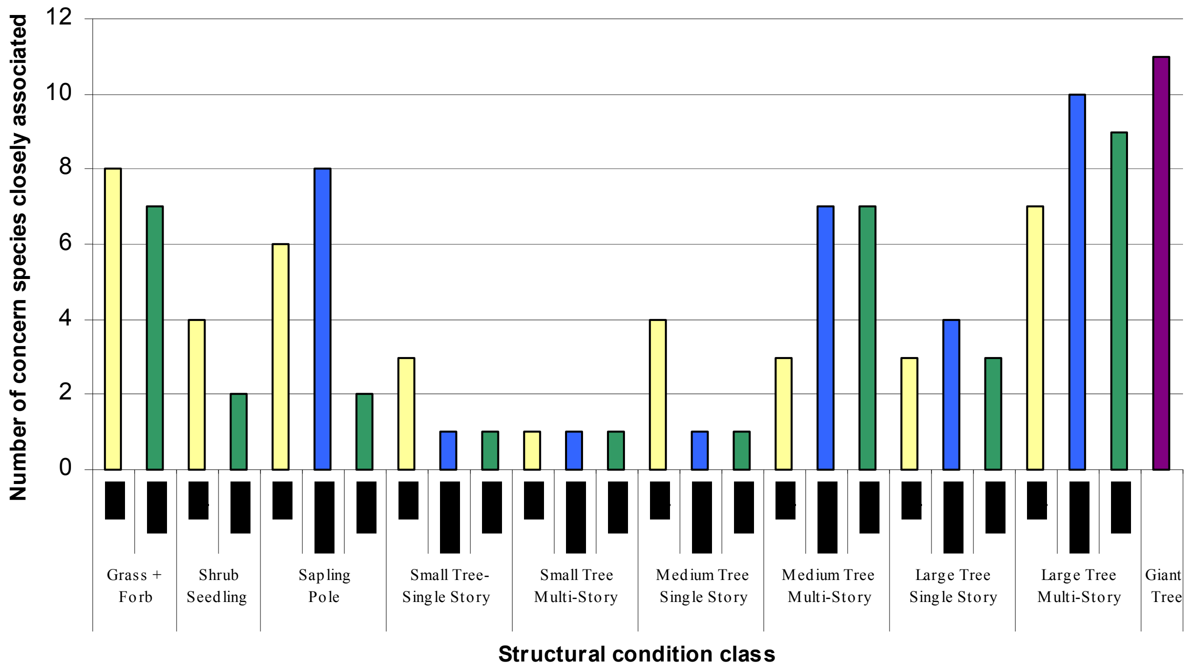

Figure 63. Number of concern species closely associated with forest structural conditions

Comparison of historic and current availability of structural conditions

Historic

Historic range of variability (HRV) is defined as the natural fluctuation of ecological and physical processes and functions that would have occurred in an ecosystem during a specified previous period of time. The Wallowa-Whitman National Forest (USFS) has developed a HRV for the subbasin and surrounding area that identifies a range of forest structural stages that was likely to have occurred prior to the settlement of northeastern Oregon by Euro-Americans (approximately 1850) (USFS 2003a).

Table 81. Historic Range of Variability for Forested Structural Stages by Biophysical Environment, reference point used for analysis by WWNF denoted in parenthesis

<table>
<tr><th rowspan="2"></th><th colspan="4">Structural Stage (%)</th></tr>
<tr><th>Very early</th><th>Early</th><th>Mid</th><th>Late</th></tr>
<tr><td>Group 1 --- Alpine fir and lodgepole pine cool-cold/moist</td><td>1-10 (10)</td><td>5-25 (10)</td><td>5-70 (45)</td><td>5-70 (35)</td></tr>
<tr><td>Group 2 --- Alpine fir and lodgepole pine cold/dry</td><td>1-10 (10)</td><td>5-25 (10)</td><td>5-70 (45)</td><td>5-70 (35)</td></tr>
<tr><td>Group 3 --- Alpine fir and lodgepole pine cool/dry</td><td>1-10 (10)</td><td>5-25 (20)</td><td>5-50 (40)</td><td>5-60 (30)</td></tr>
<tr><td>Group 4 --- Grand fir cool/dry</td><td>1-10 (10)</td><td>5-50 (15)</td><td>5-50 (50)</td><td>5-60 (25)</td></tr>
<tr><td>Group 5 --- Douglas-fir warm/dry</td><td>1-15 (10)</td><td>5-25 (15)</td><td>5-55 (50)</td><td>5-55 (25)</td></tr>
<tr><td>Group 6 --- Douglas-fir warm/moist</td><td>1-15 (10)</td><td>5-25 (15)</td><td>10-55 (45)</td><td>5-55 (30)</td></tr>
<tr><td>Group 7 --- Ponderosa pine hot/dry</td><td>1-15 (10)</td><td>5-25 (15)</td><td>5-70 (45)</td><td>5-70 (30)</td></tr>
<tr><td>Group 8 --- Ponderosa pine hot/moist</td><td>1-15 (10)</td><td>5-25 (15)</td><td>5-70 (40)</td><td>5-50 (35)</td></tr>
<tr><td rowspan="2">Average reference point across all biophysical groups</td><td rowspan="2">10.0</td><td>14.4</td><td>45.0</td><td rowspan="2">26.9</td></tr>
<tr><td colspan="2">29.7</td></tr>
</table>

Current

Current forest structure condition data for the subbasin was derived by performing a GIS overlay of three layers containing information on forest conditions in the subbasin. A subbasin wide layer on tree size has been compiled by the Oregon Natural Heritage Program (ONHP) using data collected from the Wallowa-Whitman National Forest, Oregon GAP, and the Natural Resource Conservation Service. Data on percent canopy cover and the number of canopy layers available through the Wallowa-Whitman National Forest (These data sets are displayed in Figures in Appendix I). In areas where all three data layers overlapped (66 percent of the forested area within the subbasin) it was possible to determine forest structure and assign structural condition classes based on attributes described in Table 80. Available information on current forests structural conditions in the Imnaha subbasin is displayed in Figure 64, and Table 82.

A number of challenges across in assigning structural condition classes that should be considered when evaluating the data. Due to difference in class breaks between the ONHP tree size data and the size classes recommended by Johnson and O'Neil (2001) the shrub/seedling and sapling/pole classes and the small and medium tree classes were combined. In areas classified as grassland in the source data layers, it was difficult to differentiate between areas where grasslands were the climax community and where grasslands were seral to forests. For this reason, the grass/forb structural condition (which is supposed to contain only grassland areas seral to forests) is likely overrepresented by the data. The final issue encountered in assigning structural conditions resulted from differences in classification of tree size data. The tree size data from the ONHP made the break between the seedling/sapling pole and small tree size classes at 9 inches dbh while Johnson and O'Neil recommend the break at 10 inches dbh (Table 80). It was not possible to obtain the raw unclassified data so it was necessary to move the break between the classes to 9 inches dbh.

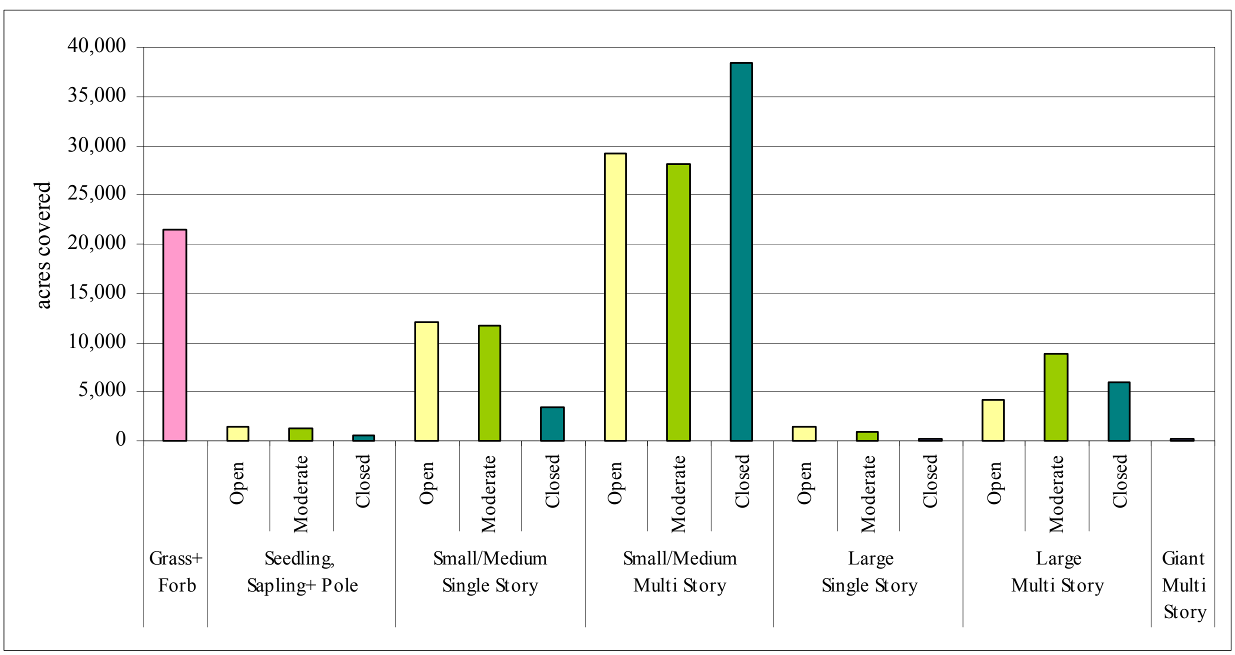

Figure 64. Distribution of current forest structural condition classes in the Imnaha subbasin

Table 82. Acreages and percent of area with data covered by current structural condition classes in the Imnaha subbasin

Structural Condition		Acres Covered	% of area with structural condition data covered
Grass and Forb		21,459	12.69
Seedling, Sapling and Pole	Open	1,403	0.83
	Moderate	1,266	0.75
	Closed	601	0.36
	Total	**3,270**	**1.93**
Small/Medium Single Story	Open	12,100	7.16
	Moderate	11,750	6.95
	Closed	3,363	1.99
	Total	**27,213**	**16.09**
Small/Medium Multi Story	Open	29,174	17.25
	Moderate	28,197	16.67
	Closed	38,345	22.67
	Total	**95,716**	**56.60**
Large Single Story	Open	1,525	0.90
	Moderate	988	0.58
	Closed	106	0.06
	Total	**2,618**	**1.55**
Large Multi Story	Open	4,070	2.41
	Moderate	8,801	5.20
	Closed	5,859	3.46
	Total	**18,730**	**11.08**

Changes in availability of forest structural conditions

Comparisons of current structural conditions with historical conditions are complicated by difference in the classification systems used in the available data. The USFS developed classes based on structural stages in their development of the HRV for the subbasin. Descriptions of the structural stage classifications used by the USFS and described in the HCNRA-CMP (2003a) indicate that the very early seral stage classification is roughly comparable to the grass/forb and seedling/sapling/pole structural conditions, the early and mid seral stages are roughly comparable to the small and medium tree structural conditions, and the late seral stage is roughly comparable to the large and giant structural conditions. A comparison of historic and current structural conditions in the Imnaha subbasin based on these assumptions is contained in (Table 83).

The structural conditions of the forested communities of the subbasin appear to be within the HRV but small-medium tree forests are near the top of the range of their representation historically while large and giant forests are very low in the range of their representation historically. The data is inconclusive on the seedling, sapling, pole, structural condition (Table 83). As discussed earlier the grass/forb structural condition is probably over-represented in the current data due to the likely inclusion of areas where the climax community is grasslands.

When these areas are included in the analysis the current abundance of very young forests is high in the HRV, when only the seedling sapling pole structural condition is considered the representation of very young forests is very low in the HRV (Table 83). Actual conditions are likely represented by some intermediate between the two states.

Table 83. Comparison of historic structural stages to current structural conditions

Historic			Current		Change	
Historic Structural Stage	HRV[1]	Average reference point[2]	Current Structural conditions combined by size class	% of forested area with structure data covered	Current conditions within HRV?	Current conditions above or below historic reference point?
Very Early	1-15	10.0	Grass/forb and seedling sapling pole	14.6	yes	above
			Seedling, sapling, pole only	1.9	yes	below
Early -Mid	10-100	29.7	Small -Medium	73.0	yes	above
Late	5-70	26.9	Large and giant	12.6	yes	below

Changes in the availability of structural conditions in the subbasin have the potential to impact the wildlife species in the subbasin. The greatest number of concern species in the subbasin were closely associated with the large tree-multi storied and giant tree structural conditions (Figure 65). The representation of large trees in the subbasin is on the low end of the HRV. Reductions in the representation of large tree structural conditions in the subbasin are a particular concern because structural conditions are not uniformly distributed across the subbasin. Table 84 shows the distribution of structural conditions by 6th field HUC. Large trees can be seen to be concentrated in a few areas, while they are very rare in most others. Large-single storied stands comprised more than 20 % of the area with data in only one HUC 07N. Large multi-storied stands are better distributed and comprise more than 20% of the area with data in HUCs 07A, 07E, 07K, 07M, 07O, 08F, 09M. Older forests contain numerous Key Environmental Correlates for wildlife, maintaining these elements is a management priority (see Section 1.2.10.3 for details).

Changes in the abundance and distribution of tree age classes in the subbasin are not the only type of structural changes that have occurred in the subbasins forests since historic. As discussed in section 1.1.1.10, fire suppression has resulted in increased forest densities, which have increased the susceptibility of the subbasins forests to insects and disease. Also due to the impacts of fire suppression, wildfire intensities have increased dramatically over historical levels (USFS 1995). A greater extent of the forested areas in the subbasin can be classified as Fuel Models 9 and 10 than were present historically; these areas are characterized by closed timber stands with heavy/dense understories (USFS 1998). Fires burning in Fuel model 9 and 10 tend to be large, intense stand replacing fires, which can have significant negative impacts of both fish and wildlife populations.

Due to the potential for widespread impacts on numerous wildlife species, changes in forest structural conditions and the underlying changes in forest disturbance regimes that caused them were selected as a terrestrial limiting factor by the terrestrial technical team. This issue is discussed further in the terrestrial limiting factors section (1.5.2); strategies for working toward restoring forest structural conditions in the subbasin were developed by the technical team and are presented in the Imnaha Subbasin Management Plan.

Table 84. Distribution of forest structural condition classes by 6th field HUC, Imnaha subbasin (see Figure 3 for HUC locations).

6th HUC[1]	Total area of 6th HUC (acres)	% of 6th HUC w/ forest structure data	Structural condition class distribution (% of area with forest structure data in 6th HUC)																	
			Grass/ Forb	Seedling/sapling/ pole			Small Tree Single Story			Large Tree Single Story			Small/Medium Tree Multi Story			Large Tree Multi Story			Giant Tree
				Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	
07A	2,900	8.9	0	0	0	0	2	0	0	0	0	0	0	0	0	0	98	0	0
07E	14,891	10.7	1	0	0	0	0	3	0	1	3	0	4	14	23	4	23	25	0
07I	7,288	20.9	18	0	0	0	0	0	6	0	0	0	16	5	53	0	0	0	0
07J	12,438	11.6	0	0	0	3	1	7	1	0	0	0	28	37	17	0	6	0	0
07K	18,800	44.0	2	0	0	0	1	0	0	1	1	0	3	6	9	5	45	27	0
07L	6,339	10.7	58	0	0	0	5	5	0	1	12	0	5	13	0	1	0	0	0
07M	14,301	14.1	11	0	0	0	4	8	0	5	4	0	4	1	0	41	18	3	0
07N	6,669	14.5	36	0	0	0	8	0	0	41	1	0	0	3	0	7	2	1	0
07O	6,979	7.6	0	0	0	0	8	2	0	0	0	0	24	22	19	0	23	1	0
07P	13,585	26.1	5	0	0	0	1	11	0	1	5	0	15	39	12	2	7	1	0
07Q	10,209	38.8	7	5	1	0	10	21	6	0	0	0	9	16	21	0	1	3	0
07R	12,224	32.9	0	12	1	0	1	3	3	0	0	0	25	23	32	0	0	0	0
08A	5,657	5.2	0	0	0	0	0	0	0	0	0	0	10	2	88	0	0	0	0
08B	15,190	14.1	1	0	0	0	3	8	0	0	0	0	27	31	29	1	1	0	0
08C	13,940	8.3	0	0	0	0	4	59	0	0	0	0	16	16	0	0	0	4	0
08D	12,632	0.9	0	0	0	0	19	18	44	0	0	0	2	11	7	0	0	0	0
08E	5,580	22.7	1	0	0	0	0	52	0	0	0	0	2	29	17	0	0	0	0
08F	7,164	33.1	0	0	0	0	2	9	12	0	8	1	1	10	14	19	9	13	0
08G	22,009	59.3	0	1	2	0	4	32	2	1	1	0	12	30	11	1	3	0	0
08H	10,892	7.8	10	0	0	0	8	0	3	0	0	0	48	27	5	0	0	0	0
08I	11,694	44.3	35	0	0	0	6	2	2	0	0	0	42	11	3	0	0	0	0
08J	16,657	56.7	5	0	0	0	1	14	3	0	0	0	39	18	20	0	0	0	0
08K	11,919	19.9	10	4	0	0	57	1	0	0	0	0	13	10	5	0	0	0	0
08L	13,800	75.3	4	0	0	0	10	2	6	0	0	0	21	35	23	0	0	0	0
09A	22,971	57.2	1	0	0	0	22	10	1	0	0	0	20	32	11	1	1	0	0
09B	9,840	56.1	0	0	0	3	1	1	2	0	1	0	40	29	20	0	1	0	0
09C	8,991	21.0	0	0	0	0	3	4	7	0	0	0	12	64	10	0	0	0	0
09D	10,607	6.5	6	0	0	0	7	6	14	0	9	0	20	13	22	0	0	3	0

6th HUC[1]	Total area of 6th HUC (acres)	% of 6th HUC w/ forest structure data	Structural condition class distribution (% of area with forest structure data in 6th HUC)																
			Grass/ Forb	Seedling/sapling/ pole			Small Tree Single Story			Large Tree Single Story			Small/Medium Tree Multi Story			Large Tree Multi Story			Giant Tree
				Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	
09E	5,694	8.2	27	0	5	0	20	8	0	7	1	0	5	7	5	6	1	7	0
09F	11,522	23.2	14	0	3	1	6	8	0	2	1	0	14	32	11	1	8	0	0
09G	11,962	53.1	26	0	0	0	6	2	8	0	0	0	20	21	17	0	0	0	0
09H	6,287	54.5	28	0	0	0	15	2	0	0	0	0	20	25	9	0	0	0	0
09I	8,169	88.0	52	0	0	0	8	0	0	3	0	0	15	7	6	3	5	0	0
09J	6,382	81.1	25	0	0	0	8	0	0	1	0	0	14	20	24	3	2	2	0
09K	11,983	70.0	19	0	0	0	5	3	0	1	0	0	9	17	30	5	4	6	1
09L	8,925	92.8	32	0	0	0	6	2	0	4	0	1	14	18	9	1	6	7	0
09M	12,567	82.6	24	0	0	0	3	1	0	2	0	0	12	18	12	7	9	11	0
09N	10,687	60.9	5	0	7	0	14	1	3	0	0	0	19	24	24	0	1	1	0
09O	13,625	37.2	13	7	2	0	6	2	1	0	0	0	1	20	48	0	0	0	0
09P	17,773	32.5	8	0	4	4	1	0	0	0	0	0	18	47	17	0	0	0	0

1 forest structure data was available for <5% of 6th field HUCs 07A, 07B, 07C, 07D, 07E, 07F, 07H, 07G these HUCS are not represented in this table

Grassland

Grassland structure is determined by: 1) shrub height, 2) percent shrub cover (or percent grass/forb cover), and, 3) shrub age class. Johnson and O'Neil (2001) defined 20 different classes of grassland structure conditions based on the attributes described in Table 85. Appendix H contains more detailed descriptions of the characteristics of the grassland structure classes.

Table 85. Attributes used to differentiate grassland structure classes Johnson and O'Neil 2001.

Shrub Height	
Low	≤1.6 ft
Medium	1.6-6.4 ft
Tall	6.5-16.5 ft

Percent Shrub Cover	
Open	10-69% shrub cover
Closed	70-100% shrub cover

Shrub Age Class	
Seedling/Young	negligible crown decadence
Mature	≤ 25% crown decadence
Old	26-100% crown decadence

Wildlife species can also exhibit close associations with grassland structural conditions. Twelve of the concern species in the subbasin have been demonstrated to have a close-association with a grassland structural condition. Each of these species has a close association with more than one grassland structural condition (see Appendix A). Open grass-forb and young low shrub habitats with closed overstories have the greatest number of closely associated concern species (Figure 65).

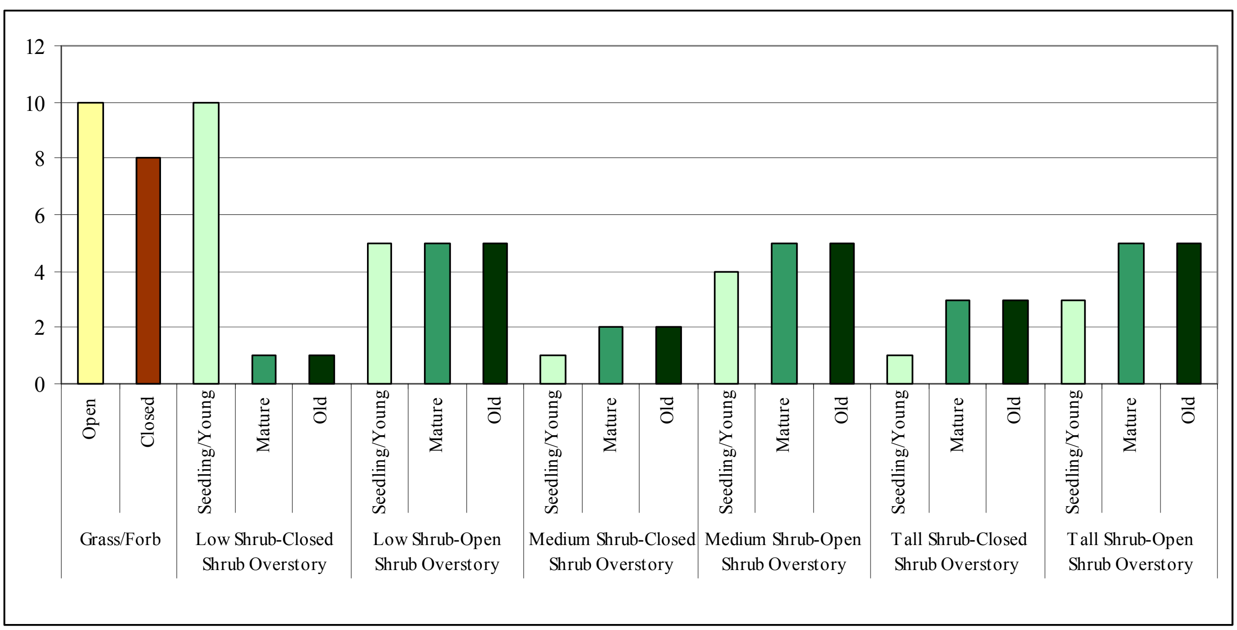

Figure 65. Number of concern species closely associated with grassland structural conditions.