# 8 Management Plan

## 8.1.1 Introduction

The information below will be used by subbasin planners and state salmon recovery personnel to aid in the conservation and restoration of important habitat that will aid in the recovery of focal species.

The management plan is made up of five components: the vision for the subbasin; biological objectives; strategies; research, monitoring and evaluation; and ESA and CWA requirements. Since the biological objectives are linked to the working hypotheses, we have inserted them here also for better clarity.

## 8.1.2 Vision

The Vision Statement for the Lake Chelan Subbasin is largely based on the Chelan County Watershed Planning Association Goal Statements for water resources. These goals are based on a sustainable future for the landscape, the economy, and the people in our subbasin.

Our vision for the landscape is to balance habitat conservation with human uses to ensure the long-term health of plant, fish, wildlife and human communities.

Our vision for the economy is based on efficient management and use of natural resources including reliable water supplies, fish and wildlife populations, and aquatic and terrestrial habitats.

Our vision for the people is to manage natural resources to promote social and economic well-being and to improve or maintain our quality of life. We will work together to foster increased understanding of the importance of natural resource conservation.

## 8.2 Terrestrial

## 8.2.1 Biological Goals, Objectives and Strategies

## 8.2.2 Shrubsteppe

**Goal**

Provide sufficient quantity and quality shrubsteppe habitat to support the diversity of wildlife as represented by sustainable focal species populations. Emphasis should be placed on managing sagebrush-dominated shrubsteppe toward conditions 1, 2 and 3 identified in the Inventory and Assessment (Appendix A)..

***Habitat Objective 1***

Determine the necessary amount, quality, and juxtaposition of shrubsteppe by the year 2008.

Strategy

- Select and implement methodology, alternative to IBIS or GAP, to accurately characterize shrubsteppe habitat in the Lake Chelan subbasin.

***Habitat Objective 2***

Based on findings of Objective 1, identify and provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Strategies

- Utilize federal, state, tribal, and local government programs, such as USDA "Farm Bill" programs, to conserve shrubsteppe habitat.
- Achieve permanent protection of shrubsteppe through acquisition, conservation easement, cooperative agreements, etc.
- Emphasize conservation of large blocks and connectivity of high quality shrubsteppe habitat.
- Promote local planning and zoning to maintain or enhance large blocks of habitat.

***Habitat Objective 3***

Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving agricultural practices, fire management, weed control, livestock grazing practices, and road management on existing shrubsteppe.

Strategies

- Implement habitat stewardship projects with private landowners.
- Develop fire management protocols (protection and prescribed burning) to produce desired shrubsteppe habitat conditions.
- Wenatchee National Forest plan, Chelan County Watershed Mgt Plan, North Cascades National Park General Management Plan, WDFW Wildlife Area Management Plan, Colville Tribes Integrated Resource Management Plan.
- Develop and implement a coordinated, cross-jurisdictional comprehensive weed control management plan.
- Develop and implement a coordinated, cross-jurisdictional road management plan.

***Biological Objective 1***

Determine population status of Brewer's sparrow by 2008.

Strategies

- Select survey protocol and measure abundance of focal species.
- Select survey protocol and measure diversity and richness of species assemblages within shrubsteppe.

***Biological Objective 2***

Within the framework of the Brewer's sparrow population status determination, inventory other shrubsteppe obligate populations to test assumption of the umbrella species concept for conservation of other shrubsteppe obligates.

Strategy

- Implement federal, state, tribal management and recovery plans.

***Biological Objective 3***

Maintain and enhance mule deer populations consistent with state/tribal herd management objectives.

Strategies

- Implement state and tribal management plans.
- Ensure mule deer habitat needs are met on federal, state, and tribal managed lands during land use planning.
- Maintain mule deer populations within private landowner tolerances.

### 8.2.3 Ponderosa Pine

**Goal**

Provide sufficient quantity and quality ponderosa pine habitats to support the diversity of wildlife as represented by sustainable focal species populations. Emphasis should be placed on managing ponderosa pine toward conditions 1a, 1b, 2 and 3 identified in 3.1.7.1.3 (Inventory and Assessment).

***Habitat Objective 1***

Determine the necessary amount, quality, and juxtaposition of ponderosa pine habitats by the year 2008.

Strategy

- Select and implement methodology, alternative to IBIS or GAP, to accurately characterize ponderosa pine habitat in the Lake Chelan subbasin.

***Habitat Objective 2***

Based on findings of Objective 1, provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Strategies

- Utilize federal, state, tribal, and local government programs to conserve ponderosa pine habitat.
- Achieve permanent protection of ponderosa pine through acquisition, conservation easement, cooperative agreements, etc.
- Emphasize conservation of large blocks and connectivity of high quality ponderosa pine habitat.
- Promote local planning and zoning to maintain or enhance large blocks of habitat.

***Habitat Objective 3***

Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving silvicultural practices, fire management, weed control, livestock grazing practices, and road management in existing and restored ponderosa pine habitat.

Strategies

- Implement habitat stewardship projects with private landowners.
- Develop fire management protocols (protection and prescribed burning) to produce desired ponderosa pine habitat conditions.
- Wenatchee National Forest plan, Chelan County Watershed Mgt Plan, North Cascades National Park General Management Plan, WDFW Wildlife Area Management Plan, Colville Tribes Integrated Resource Management Plan.
- Develop and implement a coordinated, cross-jurisdictional comprehensive weed control management plan.
- Develop and implement a coordinated, cross-jurisdictional road management plan.

***Biological Objective 1***

Determine population status of white-headed woodpecker, flammulated owl, and pygmy nuthatch by 2008.

Strategies

- Select survey protocol and measure abundance of focal species.
- Select survey protocol and measure diversity and richness of species assemblages within ponderosa pine.

***Biological Objective 2***

Within the framework of the focal species population status determinations, inventory other ponderosa pine obligate populations to test assumption of the umbrella species concept for conservation of other ponderosa pine obligates.

Strategy

- Implement federal, state, tribal management and recovery plans.

### 8.2.4 Riparian Wetlands

**Goal**

Provide sufficient quantity and quality riparian wetlands to support the diversity of wildlife as represented by sustainable focal species populations. Emphasis should be placed on managing riparian wetland habitats toward conditions 1a, 1b, and 2 identified in 3.1.7.3.3 (Inventory and Assessment).

***Habitat Objective 1***

Determine the necessary amount, quality, and connectivity of riparian wetlands by the year 2008.

Strategy

- Select and implement methodology, alternative to IBIS or GAP, to accurately characterize riparian wetlands habitats in the Lake Chelan subbasin.

***Habitat Objective 2***

Based on findings of Habitat Objective 1, provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Strategies

- Utilize federal, state, tribal, and local government programs, to conserve riparian wetlands habitat.
- Achieve permanent protection of riparian wetlands through acquisition, conservation easement, cooperative agreements, etc.
- Emphasize conservation connectivity of high quality riparian wetlands habitat.
- Promote local planning and zoning to maintain or enhance riparian wetlands habitat.

***Habitat Objective 3***

Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving silviculture, agricultural practices, fire management, weed control, livestock grazing practices, and road construction and maintenance on and adjacent to existing riparian wetlands.

Strategies

- Implement habitat stewardship projects with private landowners.
- Develop fire management protocols (protection and prescribed burning) to produce desired riparian wetlands habitat conditions.
- Wenatchee National Forest plan, Chelan County Watershed Mgt Plan, North Cascades National Park General Management Plan, WDFW Wildlife Area Management Plan, Colville Tribes Integrated Resource Management Plan.
- Develop and implement a coordinated, cross-jurisdictional comprehensive weed control management plan.
- Develop and implement a coordinated, cross-jurisdictional road management plan.

***Biological Objective 1***

Determine population status of beaver and red-eyed vireo chat by 2008.

Strategies

- Select survey protocol and measure abundance of focal species.

- Select survey protocol and measure diversity and richness of species assemblages within riparian wetland habitats.

***Biological Objective 2***

Within the framework of the focal species population status determinations, inventory other riparian wetlands obligate populations to test assumption of the umbrella species concept for conservation of other riparian wetlands obligates.

Strategy

- Implement federal, state, tribal management and recovery plans.

***Biological Objective 3***

Based on findings of Biological Objective 1 and Habitat Objective 2, maintain and enhance beaver populations where appropriate and consistent with state/tribal management objectives.

Strategies

- Protect, and where necessary restore, habitat to support beaver.
- Reintroduce beaver into suitable habitat where natural recolonization may not occur.
- Through state harvest restrictions, protect beaver populations at a level sufficient to allow natural and reintroduced beaver populations to perpetuate at levels that will meet Habitat Objective 2.

## 8.3 Research, Monitoring and Evaluation Plan

### Introduction

The Research, Monitoring, and Evaluation (RME) plan for the subbasin is intended as a tool that will allow managers to evaluate the efficacy of employed strategies in achieving corresponding focal habitat objectives for the subbasin. If implemented, elements of the plan will also facilitate coordination and tracking of management activities within the subbasin, periodic review of progress, and a basis for recommended adjustments to management direction over time (adaptive management).

The RME plan, as presented, consists of a variety of quantitative elements, ranging from scientific wildlife and vegetation surveys, spatial analyses of project location and acreage, to simple enumeration of land use projects/regulations commented upon by cooperating agencies.

Organization of the RME plan is as follows:

***Research***

- Research needs, with justification, are also listed. Detailed research project design is not presented, however, being beyond the scope of the current planning effort
- Existing Data Gaps, as identified through the subbasin planning process, are listed in this section, because many will require effort above routine monitoring and evaluation to address

***Monitoring and Evaluation***

- Focal habitat monitoring methodology, and Management Plan strategies addressed
- Focal species monitoring methodology, and Management Plan strategies addressed

### 8.3.1 Existing Data Gaps and Research Needs

In the course of subbasin plan development, a number of data gaps were identified. Some of these gaps will be filled as data is collected via the monitoring and evaluation process as the plan is implemented. Others will require formal research efforts to address. Data gaps and research needs identified during development of the subbasin plan are listed in the tables below.

As part of the adaptive management philosophy of subbasin planning, managers believe that additional research needs not yet identified will become apparent over time. These needs should be addressed in future subbasin plan iterations.

**Table 33.** General Lake Chelan subbasin data gaps and research needs

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| **General** | | |
| Testing of assumption that focal habitats are functional if a focal species assemblage's recommended management conditions are achieved | | Coordinated government & NGO effort |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| Testing of assumption that selected species assemblages adequately represent focal habitats | | Coordinated government & NGO effort |
| Current, broad-scale habitat data | Spatial data collection and GIS analysis | Coordinated government & NGO effort |

### 8.3.2 Riparian Wetland

**Table 34.** Riparian wetland data gaps and research needs

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| **Riparian Wetlands** | | |
| **Recommended Priority Order of Research Needs** | | |
| Refinement of recommended management conditions for Riparian Wetlands | Research need; use for update to future subbasin plan iterations | Coordinated government & NGO effort. |
| Data are needed on all aspects of red-eyed vireo and beaver ecology in the subbasin. | | Coordinated government & NGO effort |
| **Data Gaps** | | |
| Accurate habitat type maps are needed to improve assessment quality and support management strategies and actions, including, updated and fine resolution historic/current riparian wetland data and GIS products e.g., structural conditions and KEC ground-truthed maps | Coordinated, standardized monitoring efforts;<br>Spatial data collection and GIS analysis | Subbasin managers |
| Riparian habitat quality data. Assessment data do not address habitat quality. | Monitoring activities | Subbasin managers |
| Refined habitat type maps | Spatial data collection and GIS | Subbasin managers |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| | analysis | |
| GIS soils products including wetland delineations | Spatial data collection and GIS analysis | Subbasin managers |
| Local population/distribution data for red-eyed vireo, , and beaver | Species Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |

### 8.3.3 Ponderosa Pine

**Table 35.** Ponderosa pine data gaps and research needs

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| **Ponderosa Pine** | | |
| **Recommended Priority Order of Research Needs** | | |
| Data are needed on all aspects of white-headed woodpecker nesting ecology and habitat use within the Lake Chelan subbasin | | Coordinated government & NGO effort |
| Data are needed on all aspects of pygmy nuthatch nesting ecology and habitat use within the Lake Chelan subbasin | | Coordinated government & NGO effort |
| Data are needed on all aspects of flammulated owl nesting ecology and habitat use, specifically related to the size, configuration, and abundance of grassy openings for foraging and clumped thickets of sapling/pole trees for roosting | | Coordinated government & NGO effort |
| Research to determine if restored sites attract white-headed woodpeckers and provide viable habitat, to include recommendations on effective treatment conditions | | Coordinated government & NGO effort |
| Research to determine if restored sites attract pygmy nuthatches and provide viable habitat, to include | | Coordinated government & |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| recommendations on effective treatment conditions | | NGO effort |
| Research to determine whether an intensively harvested landscape that meets snag and large tree objectives support viable white-headed woodpecker populations | | Coordinated government & NGO effort |
| Research to determine whether a managed site attracts flammulated owls and provides viable habitat. Identification of the most effective treatment processes and conditions most effective. | | Coordinated government & NGO effort |
| **Data Gaps** | | |
| Refinement of recommended management conditions for Ponderosa pine: collect current ponderosa pine structural condition/habitat variable data | Management Objective for Ponderosa pine | Subbasin managers |
| Accurate habitat type maps are needed to improve assessment quality and support management strategies and actions, including, updated and fine resolution historic/current ponderosa pine data and GIS products e.g., structural conditions and KEC ground-truthed maps | Coordinated, standardized monitoring efforts;<br>Spatial data collection and GIS analysis | Subbasin managers |
| Habitat quality data. Assessment data do not address habitat quality. | Coordinated, standardized monitoring efforts);<br>Spatial data collection and GIS analysis | Subbasin managers |
| Finer resolution GIS habitat type maps that include structural component and KEC data. | Coordinated, standardized monitoring efforts);<br>Spatial data collection and GIS analysis | Subbasin managers |
| GIS soils products | Spatial data collection and GIS | Subbasin |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| | analysis | managers |
| Identify current distribution and population levels of white-headed woodpeckers, pygmy nuthatches and flammulated owls | Species Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |
| Identify current and potential areas of high quality flammulated owl habitat (short-term strategy i.e., <2 years). | Habitat Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |
| Monitor white-headed woodpecker, pygmy nuthatch and flammulated owl distributions within the Lake Chelan subbasin, to determine current distributions, population levels and population trends | Species Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |

### 8.3.4 Shrubsteppe

**Table 36.** Shrubsteppe data gaps and research needs

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| **Shrubsteppe** | | |
| **Recommended Priority Order of Research Needs** | | |
| | | |
| Data are needed on all aspects of Brewer's sparrow nesting ecology, especially area requirements to maintain populations | | WDFW, Subbasin managers |
| Data are needed on all aspects of Brewer's sparrow nesting ecology, particularly relationship to livestock grazing and pesticide use | | WDFW, Subbasin managers |
| An assessment of the viability of small populations of Brewer's sparrow in fragments of habitat versus those in large contiguous blocks | | WDFW, Subbasin managers |
| **Data Gaps** | | |
| Accurate habitat type maps are needed to improve | Coordinated, | Subbasin |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| assessment quality and support management strategies and actions, including, updated and fine resolution historic/current shrubsteppe data and GIS products e.g., structural conditions and KEC ground-truthed maps | standardized monitoring efforts;<br>Spatial data collection and GIS analysis | managers |
| Habitat quality data. Assessment data bases do not address habitat quality | Coordinated, standardized monitoring efforts;<br>Spatial data collection and GIS analysis | Subbasin managers |
| Refined habitat type maps | Coordinated, standardized monitoring efforts;<br>Spatial data collection and GIS analysis | Subbasin managers |
| GIS soils products, including wetland delineations | Spatial data collection and GIS analysis | Subbasin managers |
| Local population/distribution distribution for Brewer's sparrow | Species Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |
| Monitor Brewer's sparrow distribution within the Lake Chelan subbasin, to determine current distribution, population level and population trends | Species Monitoring, Spatial data collection, and GIS analysis | WDFW, Subbasin managers |
| Evaluate the role of fire, mowing, and other management treatments to maintain/improve shrupsteppe habitat quality | Coordinated, standardized monitoring | Subbasin managers |

| Research Needs And Data Gaps | Strategy To Address | Agency/ Personnel |
|---|---|---|
| | efforts | |

### 8.3.5 Focal Habitat and Species Monitoring Methodology

Recommended monitoring and evaluation strategies contained below for each focal habitat type, including sampling and data analysis and storage, are derived from national standards established by Partners in Flight for avian species (Ralph et al, 1993, 1995) and habitat monitoring (Nott et al, 2003). Deer sampling methodology follow standard protocols established by the Washington Department of Fish and Wildlife. In addition, protocols for specific vegetation monitoring/sampling methodologies are drawn from USDA Habitat Evaluation Procedure standards (USFWS 1980a and 1980b). A common thread in the monitoring strategies which follow is the establishment of permanent census stations to monitor bird population and habitat changes.

Wildlife managers will include statically rigorous sampling methods to establish links between habitat enhancement prescriptions, changes in habitat conditions and target wildlife population responses.

Specific methodology for selection of Monitoring and Evaluation sites within all focal habitat types follows a probabilistic (statistical) sampling procedure, allowing for statistical inferences to be made within the area of interest. The following protocols describe how M&E sites will be selected (from WDFW response to ISRP available: http://www.cbfwa.org/files/province/cascade/projects/199609400resp.pdf):

- Vegetation/HEP monitoring and evaluation sites are selected by combining stratified random sampling elements with systematic sampling. Project sites are stratified by cover types (strata) to provide homogeneity within strata, which tends to reduce the standard error, allows for use of different sampling techniques between strata, improves precision, and allows for optimal allocation of sampling effort resulting in possible cost savings (Block et al. 2001). Macro cover types such as shrubsteppe and forest are further sub-cover typed based on dominant vegetation features i.e.,% shrub cover,% tree cover, and/or deciduous versus evergreen shrubs and conifer versus deciduous forest. Cover type designations and maps are validated prior to conducting surveys in order to reduce sampling inaccuracies.

- Pilot studies are conducted to estimate the sample size needed for a 95% confidence level with a 10% tolerable error level (Avery 1975) and to determine the most appropriate sampling unit for the habitat variable of interest (BLM 1998). In addition, a power analysis is conducted on pilot study data (and periodically throughout data collection) to ensure that sample sizes are sufficient to identify a minimal detectable change of 20% in the variable of interest with a Type I error rate of not more than 0.10 and P = 0.9 (BLM 1998, Hintze 1999, Block et al. 2001). M&E includes habitat trend condition monitoring on the landscape scale (Tier 1-HEP) and plant community monitoring (Tier 2) i.e., measuring changes in vegetative communities on specific sites.

- For HEP surveys, specific transect locations within strata are determined by placing a Universal Transverse Mercator (UTM) grid over the study area (strata) and randomly

selecting “X” and “Y” coordinates to designate transect start points. Random transect azimuths are chosen from a computer generated random number program, or from a standard random number table. Data points and micro plots are systematically placed along the line intercept transect at assigned intervals as described in Part 2 – monitoring section of the proposal. Sample sizes for statistical inferences are determined by replication and systematic placement of lines of intercept within the strata with sufficient distance between the lines to assume independence and to provide uniform coverage over the study site.

- Permanent vegetation monitoring transect locations are determined by placing a UTM grid over the strata and randomly selecting “X” and “Y” coordinates to designate plot locations as described for HEP surveys. One hundred meter baseline transect azimuths are randomly selected from a random numbers table. Ten perpendicular 30 meter transects are established at 10 meter intervals along the baseline transect to form a 100m x 30m rectangle (sample unit). Micro plot and shrub intercept data are collected at systematic intervals on the perpendicular transects.

By systematically collecting and analyzing plant species frequency, abundance, density, height, and% cover data, vegetative trends through time can be described. Likewise, the effectiveness of exotic weed control methods can be evaluated and weed control plans can be adjusted accordingly.

Presence of all exotic weeds i.e., knapweeds, yellow starthistle, etc. will be mapped in GIS using Global Positioning System (GPS) equipment. This information will be used to develop an annual exotic vegetation control plan.

Causes of seeding or planting failure will be identified and planting methods/site preparation will be modified as necessary. Data will be collected and analyzed, and, where necessary, changes in the management plan (adaptive management) will be identified and implemented.

General and site specific M&E protocols, outlining monitoring goals and objectives and specific sampling designs are included in the following monitoring section.

In addition to defining habitat and species population trends, monitoring will also be used to determine if management actions have been carried out as planned (implementation monitoring). In addition to monitoring plan implementation, monitoring results will be evaluated to determine if management actions are achieving desired goals and objectives (effectiveness monitoring) and to provide evidence supporting the continuation of proposed management actions. Areas planted to native shrubs/trees and/or seeded to herbaceous cover will be monitored twice a year to determine shrub/seeding survival, and causes of shrub mortality and seeding failure i.e. depredation, climatic impacts, poor site conditions, poor seed/shrub sources.

Monitoring of habitat attributes and focal species in this manner will provide a standardized means of tracking progress towards conservation, not only within the Lake Chelan subbasin, but within a national context as well. Monitoring will provide essential feedback for demonstrating adequacy of conservation efforts on the ground, and guide the adaptive management component that is inherent in the subbasin planning process.

### 8.3.6 Riparian Wetlands

Focal Species: Red-eyed vireo (*Vireo olivaceous*) and American beaver (*Castor canadensis*)

**Overall Habitat and Species Monitoring Strategy**

- Establish monitoring program for protected and managed Riparian Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.
- Establish permanent censusing stations to monitor bird population and habitat changes.

**Focal Habitat Monitoring**

***Factors Affecting Habitat***

- Direct loss of riparian deciduous and shrub understory
- Fragmentation of wetland habitat
- Agricultural and suburban development and disturbance
- Reduction in water quality
- Organochlorines such as dieldrin or DDE may cause thinning in egg shells which results in reproductive failure (Graber et al. 1978; Ohlendorf et. al. 1980; Konermann et. al. 1978).

***Riparian Wetlands Working Hypothesis Statement***

The proximate or major factors affecting this focal habitat type are direct loss of habitat due primarily to urban/agricultural development, reduction of habitat diversity and function resulting from exotic vegetation, livestock overgrazing, fragmentation and recreational activities. The principal habitat diversity stressor is the spread and proliferation of invasive exotics. This coupled with poor habitat quality of existing vegetation have resulted in extirpation and or significant reductions in riparian habitat obligate wildlife species.

Recommended Range of Management Conditions

18. Well-distributed range of 20 to 100% tree canopy closure (cottonwood and other hardwood species), with a mature cottonwood component including trees at least 160 feet tall
19. Multi-structure/age tree canopy (includes trees less than 6 inches in diameter and mature/decadent trees)
20. Forty to 80% native shrub cover (greater than 50% comprised of hydrophytic shrubs), with scattered herbaceous openings
21. Multi-structured shrub canopy greater than 3 feet in height, at least 10% of which are comprised of young cottonwoods

Focal Habitat Monitoring Strategies

Establish an inventory and long-term monitoring program for protected and restored riparian wetlands to determine success of efforts.

22. Identify riparian wetland sites within the subbasin that support populations of focal species for this habitat.
23. Evaluate habitat site potential on existing public lands and adjacent private lands for protection. (short-term strategy i.e., < 2 years).
24. Enhance habitat on public lands and adjacent private lands.
25. Identify high quality/functional privately owned riparian wetlands sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
26. Establish permanent censusing stations to monitor bird population and habitat changes

### Sampling Design

HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type. (Riparian zone width within portions of the subbasin will require modification of this 100 foot buffer requirement.)

In addition, at any permanently established avian species monitoring site established within the Riparian Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

### Sampling Methods (USFWS 1980a and 1980b)

#### Herbaceous

Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrant is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

#### Shrub

Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible “hits” per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible “hits” per 100 ft segment).

Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

#### Tree

Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

**Other**

At any permanently established avian species monitoring site established within the Riverine Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003) (http://www.birdpop.org/DownloadDocuments/manual/HSAManual03.PDF).

Analysis

Transects are divided into 100 ft. segments, and total transect length is determined using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95% confidence interval with suitable degrees of freedom

s = standard deviation

E = desired level of precision, or bounds

**Focal Species Monitoring: American beaver and Red-eyed Vireo**

***Rationale***

Maintaining and enhancing beaver and red-eyed vireo populations within the subbasin will assure the maintenance and rehabilitation of riparian wetlands.

***Limiting Factors***

27. Loss of deciduous tree cover and sub-canopy/shrub habitat in riparian zones. 2.) Conversion of riparian habitat due to channelization, agriculture, and development, 3) flooding of habitat resulting from hydropower facilities, 4) habitat fragmentation, 5) degradation of existing habitats from overgrazing and introduced weedy vegetation, and 6) tree/shrub removal in riparian areas. Proximity to agriculture, suburban development creates a hostile landscape where a high density of nest parasites, such as, brown cowbird and predation by domestic cats may occur. Disturbance from agriculture, silviculture, road management and recreational activities can also cause nest abandonment.

***Assumptions***

28. Addressing factors that affect riparian wetlands, will also address red-eyed vireo, beaver and other wetland obligate species limiting factors. 2) If riparian wetland habitat is of sufficient quality, extent, and distribution to support viable red-eyed vireo and beaver populations, the needs of most other riparian wetland obligate species will also be addressed and habitat functionality could be inferred. 3) If habitat is present sufficient to support avian focal species, suitable habitat will be present to support beaver. 4) Beaver will persist in these habitats if appropriate protection measures to preclude overharvest are implemented.

***Sampling Strategy***

Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the

goal of being able to detect a 25% increase in abundance of yellow warbler with a power of 0.8 or greater. This protocol is based on the point count survey (Ralph et al. 1993, Ralph et al. 1995), with each survey station referred to as a "point count station." In addition to these bird survey data, information about the distance at which individual birds are detected will also be collected, allowing absolute density estimated to be made using distance-sampling methodology (e.g., the program DISTANCE).

### *Methods*

We will survey birds on randomly selected (stratified) points along the riparian corridor. Each site will have 4 100-m fixed-radius point counts (Ralph et al. 1993) established along a transect and spaced 200m apart (Fig 4). Each point will be marked with a permanent fiberglass stake (1m electric fence post) and colored flagging will be placed on shrubs at 50 and 100m from the point in each of the 4 cardinal directions to aid in determining distance. Counts at each point will be 5 minutes in duration during which all birds seen or heard will be noted, along with their sex (if known), distance from the point (within 50m, >50 but <100m, or beyond 100m), and behavior (singing, calling, silent, or flying over the site). Surveys will be conducted once each in May and June and within prescribed weather parameters (e.g., no rain and low wind).

### *Analysis*

Analysis is described by Nur et al. (1999). Absolute density estimation (see Buckland et al. 1993) can be estimated using the program DISTANCE, a free program

available on the World-Wide Web (http://www.ruwpa.st-and.ac.uk/distance ); an example is given in Nur et al. (1997). In brief: for species richness and species diversity, these can be analyzed as total species richness or as species richness for a subset of species; the same is true for species diversity. Species diversity can be measured using the Shannon index (Nur et al. 1999), also called the Shannon-Weiner or Shannon-Weaver index. Statistical analysis can be carried out using linear models (regression, ANOVA, etc.), after appropriate transformations (examples in Nur et al. 1999).

### 8.3.7 Ponderosa Pine

Focal Species: Flammulated owl *(Otus flammeolus)*, white-headed woodpecker (*Picoides albolarvatus),* pygmy nuthatch (*Sitta pygmaea*)

**Overall Habitat and Species Monitoring Strategy**

Establish monitoring program for protected and managed Ponderosa pine sites to monitor focal species population and habitat changes and evaluate success of efforts.

**Focal Habitat Monitoring**

***Factors affecting habitat***

- Direct loss old growth forest and associated large diameter trees and snags
- Fragmentation of remaining Ponderosa pine habitat
- Agricultural and sub-urban development and disturbance
- Hostile landscapes which may have high densities of nest parasites, exotic nest competitors, and domestic predators
- Fire suppression/wildfire
- Overgrazing
- Noxious weeds
- Silvicultural practices
- Insecticide use.

***Ponderosa Pine Working Hypothesis Statement***

The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to timber harvesting, fire reduction/wildfires, mixed forest encroachment, development, recreational activities, reduction of habitat diversity and function resulting from invasion by exotic species and vegetation and overgrazing. The principal habitat diversity stressors are the spread and proliferation of mixed forest conifer species within ponderosa pine communities due primarily to fire reduction and intense, stand-replacing wildfires, and invasive exotic weeds. Habitat loss and fragmentation (including fragmentation resulting from extensive areas of undesirable vegetation) coupled with poor habitat quality of existing vegetation (i.e., lack of old growth forest and associated large diameter trees and snags) have resulted in significant reductions in ponderosa pine habitat obligate wildlife species.

Recommended Range of Management Conditions

Recognizing that extant ponderosa pine habitat within the subbasin currently covers a wide range of seral conditions, wildlife habitat managers have identified three general ecological / management conditions that, if met, will provide suitable habitat for multiple wildlife species at the subbasin scale within the ponderosa pine habitat type. These ecological conditions correspond to life requisites represented by a species' assemblage that includes white-headed

woodpecker (Picoides albolarvatus), flammulated owl (Otus flammeolus), and pygmy nuthatch (Sitta pygmaea)

Mature ponderosa pine forest: The white-headed woodpecker represents species that require/prefer large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50% and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags greater than 31 inches DBH).

Multiple canopy ponderosa pine mosaic: Flammulated owls represent wildlife species that occupy ponderosa pine sites that are comprised of multiple canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner et al. 1990), two layered canopies, tree density of 508 trees/acre (9 foot spacing), basal area of 250 feet2/acre (McCallum 1994b), and snags greater than 20 inches DBH 3-39 feet tall (Zeiner et al. 1990). Food requirements are met by the presence of at least one snag greater than 12 inches DBH/10 acres and 8 trees/acre greater than 21 inches DBH.

3. Heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age: pygmy nuthatches represent those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 inches DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

### Focal Habitat Monitoring Strategies

Establish an inventory and long-term monitoring program for protected and managed Ponderosa pine habitats to determine success of efforts. Subbasin managers recognize that restoration of late-successional forest is a long-term process, but these short-term (i.e., up to 15 years) strategies reflect the commitment and initiation of the process of management.

29. Identify Ponderosa pine habitat sites within the subbasin that support populations of focal species for this habitat.

30. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of focal species habitat (short-term strategy i.e., < 2 years).

31. Enhance habitat on public lands and adjacent private lands (intermediate strategy 2 to 10 years)

32. Identify high quality/functional privately owned Ponderosa pine sites that are not adjacent to public lands (long-term strategy 2 to 15 years).

33. Establish permanent censusing stations to monitor bird population and habitat changes.

### Sampling Design

Permanent survey transects will be located within Ponderosa pine habitats using HEP protocols. HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP

transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type.

In addition, at any permanently established avian species monitoring site established within the Riverine Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

Sampling Methods (USFWS 1980a and 1980b)

**Herbaceous**

Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrant is a rectangular 0.5m2 microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

**Shrub**

Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

**Tree**

Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

***Measurement of Attributes (Habitat Conditions)***

>10 snags/40 ha (>30cm DBH and 1.8m tall)

Method: A direct count in the 1/10 acre circle plot at the end of each 100 ft segment of the transect. DBH (measured with a loggers tape) and condition is noted for each snag. Snag condition scale follows Parks et al. (1997).

>20 trees /ha (>21" DBH)

Method: A direct count in the 1/10 acre circle plot. DBH measured with a logger's tape.

Ponderosa Pine – old growth: >10 trees/ac (>21" DBH w/ >2 trees >31" DBH)

Method: A direct count in the 1/10 acre circle plot. DBH measured with a logger's tape.

10-50% canopy closure

Method: A line intercept 'hit' or 'miss' measurement. Ten direct measurements along each 100 foot section of the transect (one every 10 feet) taken with a moosehorn densitometer.

> 1.4 snags/ac (>8" DBH w/ >50% >25")

Method: A direct count in the 1/10 acre circle plot at the end of each 100 ft segment of the transect. DBH (measured with a loggers tape) and condition is noted for each snag. Snag condition scale follows Parks et al. (1997).

**Other**

At any permanently established avian species monitoring site established within the ponderosa pine habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

Analysis

Transects are divided into 100 ft. segments, and total transect length is determined using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95% confidence interval with suitable degrees of freedom

s = standard deviation

E = desired level of precision, or bounds

**Focal Species Monitoring: Flammulated Owl**

***Rationale***

The Flammulated owl is listed as candidates for inclusion on the WDFW endangered species list and is considered a species-at-risk by the Washington GAP Analysis and Audubon-Washington. Flammulated owls are highly structurally dependent on the Ponderosa Pine habitat. Therefore, it is important to maintain and enhance the structure and function of ponderosa pine habitats for flammulated owls.

***Limiting Factors***

1) Silvicultural practices that reduce habitat quality 2) pesticide use 3) predation/competitors 4) exotics.

***Assumptions***

1) Addressing factors that affect ponderosa pine, will also address flammulated owl and other ponderosa pine obligate species limiting factors. 2) If ponderosa pine habitat is of sufficient quality, extent, and distribution to support viable flammulated owl and white-headed woodpecker populations, the needs of most other ponderosa pine obligate species will also be addressed and ponderosa pine functionality could be inferred.

### *Sampling Strategy*

The following methods are designed to, 1.) facilitate delineation of current distribution and population levels of flammulated owls, and 2) identify current and potential areas of high quality flammulated owl habitat (short-term strategy i.e., <2 years).

### *Methods*

Nighttime surveys will be conducted throughout potentially suitable Flammulated Owl breeding habitat, which will be determined according to habitat use reported in the literature, other reports, GIS habitat mapping, and other reported sightings the species.

Routes will be randomly selected from within the potential habitat area using a stratified sampling scheme. Each route should have between 10-12 stations, distributed along the route at equal intervals of .5 km, a standard methodology based on the distance owls can be heard on a calm night (at least 1.0 km) and the average size of territories (<500 m across) (Reynolds and Linkhart 1984, Howle and Ritchie 1987, Van Woudenberg and Christie 1997). The location of the starting point of the route, and of each station along the route, should be recorded as precisely as possible using a GPS (Global Positioning System). Each route should be surveyed three times per year during May-July – the time of year when vocal activity of the majority of species is greatest. Conduct surveys between 2200 and 0100 hours (Howle and Ritcey 1987, Groves et al. 1997). An attempt should be made to conduct the survey at the same time of night each year. At the beginning of the breeding season the greatest calling intensity for the Flammulated Owl is during much of the evening, and then after nestling hatching singing is "later at night" (Reynolds and Linkhart 1987).

Surveys should only be conducted under favorable conditions: wind speeds <20 km per hour, a wind speed of Beaufort 3 or less and no precipitation (including rain and/or snow). Temperatures should be close to the average for the season and efforts should be made to avoid extremely cold temperatures because of evidence that owls may be less vocal in very cold weather (Takats 1998a).

Surveys will consist of visiting a point for two minutes to listen for Flammulated Owls calling, and if no owls are heard then a male territorial call will be imitated or played from tape for one minute. After listening for an additional two minutes, the observer will then walk to the next point while still listening for calling owls. (Two minutes appears to be adequate for most spontaneously calling owls to be detected, at least during the period of peak calling activity. In Alberta, relatively few additional owls were detected during a third minute of listening (Takats, pers. comm.). In Ontario, more than 70% of 5 species of owls that were detected over a 5 minute period (included playback) were detected in the first two minutes (Takats 1997, 1998b)

Playback recordings should be as clear and loud as possible without distortion. Digital technology is recommended (CD-ROM, solid state, or digital tape) as the sound quality can be better controlled and is less likely to deteriorate over time. The audio equipment should be of sufficient quality that it will not distort the sound at loud volumes. We suggest the volume be such that the recording can be heard at 400m, but not at 800m (to minimize bias at the next survey station due to owls hearing the recording from the previous station). If possible, the volume should be measured at a standard distance (e.g., 1m from the speakers) using a decibel meter.

The recording should include both the silent listening periods as well as the playback sequence time period. A soft 'beep' or other sound can be used to indicate the start of the first silent listening period, and another beep to indicate the end of the final listening period. This will ensure that the time is fully standardized at each station, and reduce the need for participants to keep checking their watches.

Surveyors should be asked to estimate the approximate direction and distance to the first position where they detect each owl and plot location on a map. This data can help to determine whether the same owls are being detected at different stations along the route, to adjust for some of the variation in detection rates, and to aid in daytime nest searches.

Male presence is not adequate to determine habitat suitability as many males may remain unmated (Reynolds and Linkart 1987a, McCallum 1994a). The nests should be monitored so that success can be determined. Parallel transects 50 m apart through areas where owls were detected were surveyed in June and early July to try and find nest site locations. Since most of the calls heard in the field are from territorial reproductive males, nests can be located by systematic nest searches during the day (Bull et al. 1990). Once territory boundaries are delineated, all suitable nesting cavities (tree cavities with entrance diameters >4 cm) within territories will be checked for nesting owls (Linkart and Reynolds 1997).

Nest sites will be searched for using a pinhole camera system attached to a telescoping pole that reaches approximately 11 m high (Proudfoot 1996). This is an effective nest finding technique, but is limited to cavities within reach. Tree scratching (with a stick) can also used, which imitates a predator climbing the nest tree and often stimulates incubating or brooding females to look out of the nest cavity entrance (Bull et al. 1990). Observation of a female Flammulated Owl at a cavity entrance will document a nest site.

### *Analysis*

Data from the surveys described here are similar to those of the Breeding Bird Survey, though some modifications may be required in the future. A wide variety of methods have been developed for analysis of BBS data (James et al. 1996, Link and Sauer 1994, 1998), but there is still some disagreement as to which methods are best (James et al. 1996, Link and Sauer 1994a, Link and Sauer 1994b, Thomas 1996). There are two main methods currently being used by the coordinators of the BBS. One involves route regression using estimating equations (Link and Sauer 1994), which assumes that trends may differ among routes, and calculates a weighted mean of the trends within routes. The selection of weighting factors is strongly dependent upon the sampling scheme used to select routes. An alternate approach involves a generalized linear model assuming over-dispersed Poisson residuals and a log-link function (Link and Sauer 1998). This approach assumes that trends are similar within a broader region, and allows more robust modeling of nonlinear population changes (e.g., year to year fluctuations). A simplified version of this latter approach has been used for analysis of population trends in Ontario (Lepage et al 1999, Francis and Whittam 2000), but it is not yet known whether this is the most appropriate analysis method.

The power of the survey technique will be investigated after its first three years in its present design to determine the actual variance. This will allow us to determine the number of routes required to detect our objective of a 35% change by 2020.

Finally, we recommend that relevant data be made publicly available, preferably over the Internet. This will encourage further research into analysis methods, thus ensuring that maximum use is made of the data for conservation purposes. However, care should be taken to protect sensitive information, such as precise nesting locations of rare species.

## Focal Species Monitoring: White-headed Woodpecker

### *Rationale*

Suitable white-headed woodpecker habitat includes large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50% and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags greater than 31 inches DBH). Maintaining white-headed woodpecker populations will require that this mature/old growth component of ponderosa pine habitat is maintained or enhanced within the subbasin.

### *Limiting Factors*

34. 1) Silvicultural practices that reduce habitat quality 2) pesticide use 3) predation/competitors 4) exotics.

### *Assumptions*

If ponderosa pine habitat is of sufficient quality, extent, and distribution to support viable white-headed woodpecker populations, the needs of most other ponderosa pine obligate species will also be addressed and ponderosa pine functionality could be inferred.

### *Sampling Strategy*

Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 25% increase in abundance of white-headed woodpecker with a power of 0.8 or greater.

### *Methods*

The method used, point counts, is derived from Dixon (1998)

#### Point counts

Each observer will conduct one transect per day individually. Survey low-elevation transects first to assure accessibility. The protocol for point counts will follow standardized methods for variable circular plots (Reynolds et al. 1980, Ralph et al.1995, Hutto and Hoffland 1996), but modified to better census white-headed woodpeckers.

#### When to survey

Point counts should be conducted between April 1 and May 15 when the detectability of White-headed Woodpeckers is highest and most stable. After this period the woodpeckers typically excavate from within the nest cavity and become less visible and less vocal. Counts should begin at official sunrise and end no later than 1030 and 1100. Each transect will be visited once.

#### Point count timing

Counts will begin as soon as the observer arrives at the station and will be comprised of a 5-minute listening period without the use of tape playbacks followed by a 6-minute sequence of tape playbacks of White-headed Woodpecker calls and drums for a total count of 11 minutes. Data from the two types of counts will be recorded separately-with a code-on a the bird data sheet.

#### Tape playback procedure

Tape playback procedures will essentially follow the Payette National Forest Protocol for Broadcast Vocalizations (Payette National Forest 1993). The tape playback sequence should begin immediately after the 5-min unsolicited point count-be ready to start the tape at exactly 5 min. A total of four 30-second tape-playbacks of White-headed Woodpecker drums and calls will be projected at 1-min intervals (e.g. using a Johnny Stewart™ game caller); that is, begin the first sequence of vocalizations to the north. During the one minute pause after the first sequence, rotate 90° for the second sequence, pause, then rotate another 90° for the third sequence of vocalizations after the second one minute break. When the third sequence is complete, rotate 90° for the fourth and final sequence for a total of 6 minutes of tape-playbacks.

#### When not to survey

Surveys will not be conducted during heavy rain, fog, or when wind interferes with an observer's ability to detect calls (greater than 20 mph). If the weather appears prohibitive, wait 1 to 1.5 hours, or until you cannot reasonably complete the transect by 1100 hours. If the weather puts you in danger, STOP-your safety comes first.

#### What to record

Record all species detected, visual or auditory. At the bottom of the data sheet, record any birds you might have detected either before or after a point count, or between stations.

### Focal Species: Pygmy Nuthatch

#### *Rationale*

Suitable pygmy nuthatch habitat contains heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age. Pygmy nuthatch represents those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 inches DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

#### *Limiting Factors*

35. Silvicultural practices that reduce habitat quality; 2) fragmentation; 3) predation/competitors; 4) exotics.

#### *Assumptions*

If ponderosa pine habitat is of sufficient quality, extent, and distribution to support viable pygmy nuthatch populations, the needs of most other ponderosa pine obligate species will also be addressed and ponderosa pine functionality could be inferred.

### *Sampling Strategy*

This is a survey development need.

## 8.3.8 Shrubsteppe

Focal Species: Brewer's sparrow (*Spizella breweri*), mule deer (*Odocoileus hemionus hemionus*)

**Overall Habitat and Species Monitoring Strategy**

Establish monitoring program for protected and managed shrubsteppe sites to monitor focal species population and habitat changes and evaluate success of efforts.

**Focal Habitat Monitoring**

***Factors Affecting Habitat***

- Direct loss shrubsteppe due to conversion to agriculture, residential, urban and recreation developments
- Fragmentation of remaining shrubsteppe habitat, with resultant increase in nest parasites
- Fire Management, either suppression or over-use, and wildfires
- Invasion of exotic vegetation
- Habitat degradation due to overgrazing, and invasion of exotic plant species
- Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.

***Shrubsteppe Working Hypothesis Statement***

The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to conversion to agriculture, reduction of habitat diversity and function resulting from invasion of exotic vegetation and wildfires, and livestock grazing. The principal habitat diversity stressor is the spread and proliferation of annual grasses and noxious weeds such as cheatgrass and knapweeds that either supplant and/or radically alter entire native bunchgrass communities significantly reducing wildlife habitat quality. Habitat loss and fragmentation (including fragmentation resulting from extensive areas of undesirable vegetation) coupled with poor habitat quality of extant vegetation have resulted in extirpation and/or significant reductions in shrubsteppe obligate wildlife species.

Recommended Range of Management Conditions

Condition 1: Sagebrush dominated shrubsteppe: The Brewer's sparrow was selected to represent wildlife species that require sagebrush dominated sites, but prefer a patchy distribution of sagebrush clumps 10-30% cover, lower sagebrush height (between 20 and 28 inches), native grass cover 10 to 20% (Dobler 1994), non-native herbaceous cover less than 10% , and bare ground greater than 20% (Altman and Holmes 2000).

Condition 2 - Diverse shrubsteppe habitat: Mule deer were selected to represent species that require/prefer diverse, dense (30 to 60% shrub cover less than 5 feet tall) shrubsteppe habitats comprised of bitterbrush, big sagebrush, rabbitbrush, and other shrub species (Leckenby 1969; Kufeld et al. 1973; Sheehy 1975; Jackson 1990; Ashley et al. 1999) with a palatable herbaceous understory exceeding 30% cover (Ashley et al. 1999).

### Focal Habitat Monitoring Strategies

Establish an inventory and long-term monitoring program for protected and managed shrubsteppe habitats to determine success of management strategies. Subbasin managers recognize that restoration of shrubsteppe is still very much a fledgling field, and complete restoration of degraded or converted shrubsteppe may not be feasible. These monitoring strategies reflect the commitment to and initiation of the process of longterm management.

36. Identify shrubsteppe habitat sites within the subbasin that support populations of Brewer's sparrow
37. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of focal species habitat (short-term strategy i.e., < 2 years).
38. Enhance habitat on public lands and adjacent private lands (intermediate strategy; 2 to 10 years)
39. Identify high quality/functional privately owned shrubsteppe sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
40. Establish permanent censusing stations to monitor bird population and habitat changes.

### Sampling Design

Permanent survey transects will be located within shrubsteppe habitats using HEP protocols. HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type.

### Sampling Methods (USFWS 1980a and 1980b)

#### Bare ground or cryptogram crust

Measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrant is a rectangular 0.5m2 microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

The% age of the microplot consisting of either bare ground or cryptogram crust is estimated via ocular estimate.

#### Herbaceous

Measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrant is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

Herbaceous cover% age is measured via an ocular estimate of the% age of the microplot shaded by any grass or forb species.

#### Shrub

Canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

Shrub canopy cover is measured on a line intercept 'hit' or 'miss'. Measurements are taken every 2 or 5 feet, depending upon shrub density.

Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

#### Tree

Canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

#### Other

At any permanently established avian species monitoring site established within the shrubsteppe habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

##### Analysis

Transects are divided into 100 ft. segments, and total transect length is determined using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95% confidence interval with suitable degrees of freedom

s = standard deviation

E = desired level of precision, or bounds

### Focal Species Monitoring: Brewer's Sparrow

#### *Rationale*

The main premise for focal species selection is that the requirements of a demanding species assemblage such as Brewer's sparrow encapsulate those of many co-occurring less demanding species. By directing management efforts toward the requirements of the most exigent species, the requirements of many cohabitants that use the same habitat type are met. Therefore, managing habitat conditions for a species assemblage comprised of these three species should provide life requisite needs for most other shrubsteppe obligate species.

***Limiting Factors***

41. Conversion of native shrubsteppe habitat for agricultural purposes, 2) habitat fragmentation; 3) degradation of existing habitats from overgrazing and introduced weedy vegetation, 4) brush removal, 5.) wildfire

***Assumptions***

42. Addressing factors that affect shrubsteppe habitat will address Brewer's sparrow; 2) If shrubsteppe habitat is of sufficient quality, extent, and distribution to support Brewer's sparrow populations, the needs of most other shrubsteppe obligate species will also be addressed and shrubsteppe functionality could be inferred.

***Sampling Strategy***

Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 35% increase in abundance of key species with a power of 0.8 or greater.

***Methods***

We will survey birds on 64 sites in different vegetation types and levels of fragmentation. Each site will have 4 100-m fixed-radius point counts (Ralph et al. 1993) established along a transect and spaced 200m apart (Fig 4). The outer points of the point-count circles will describe a rectangular plot of 16ha that will be the focus of all survey work in Objectives 2-4. Each point will be marked with a permanent fiberglass stake (1m electric fence post) and colored flagging will be placed on shrubs at 50 and 100m from the point in each of the 4 cardinal directions to aid in determining distance. Counts at each point will be 5 minutes in duration during which all birds seen or heard will be noted, along with their sex (if known), distance from the point (within 50m, >50 but <100m, or beyond 100m), and behavior (singing, calling, silent, or flying over the site). Surveys will be conducted once each in May and June and within prescribed weather parameters (e.g., no rain and low wind).

**Focal Species Monitoring: Mule Deer**

***Rationale***

Mule deer inhabit all habitats within the subbasin. The largest concentration of mule deer is found on the north shore of Lake Chelan during winter. Shrubsteppe habitat quality determines the size and persistence of mule deer populations within the subbasin, as they are both critical winter habitat and the limiting factor for this species in the subbasin. Mule deer have been selected as a focal species due to the significant economic, recreational, and cultural values this species provides.

***Limiting Factors***

43. flooding of habitat resulting from hydropower facilities, 2) loss of habitat due to urban and suburban development, 3) road and highway construction, 4) degradation of existing habitats from overgrazing and introduced weedy vegetation, 5) alteration of historic fire regimes, 6) past silvicultural practices, 7) deer control efforts necessitated by agricultural damage, 8) natural predation and over-harvest by hunters, 9) disease and parasites

### *Assumptions*

Addressing factors that affect shrubsteppe habitats, will also address mule deer and other shrubsteppe obligate species limiting factors.

### *Management Objective*

The population management objective for mule deer will be to increase or maintain populations within the limitations of available mule deer habitat and landowner tolerance (agricultural damage). Population monitoring variables and objectives are established in the Washington Department of Fish and Wildlife Game Management Plan (WDFW 2003). A valuable tool unique in this subbasin are the 12, annual winter wildlife surveys conducted by Chelan PUD as a condition of the Lake Chelan hydroelectric project operating license. In areas with periodically high mule deer populations and significant agricultural damage complaints, WDFW will regulate populations as appropriate through hunter harvest.

### *Monitoring Methods*

Mule deer populations will be monitored using a combination of post hunting surveys, winter surveys and harvest data. Current surveys allow the monitoring of age/sex ratios to determine if management objectives established in the Game Management Plan (WDFW 2003) are being met for post-season buck survival (> 15 bucks/100 does) and fawn production and recruitment. Harvest data is used as an indicator of population trend.

### *Evaluation Strategies*

44. Use winter aerial, boat and ground surveys to classify mule deer to determine post-hunt buck/fawn to doe ratios and population size trends.

45. Monitor harvest level of bucks and antlerless deer using mandatory hunter report system.

46. Model the Chelan and Methow PMU mule deer populations (Lake Chelan divides two population management units, both of which extend beyond the subbasin border).

## 8.4 Aquatic

## 8.5 Westslope Cutthroat Trout

### 8.5.1 Biological Objectives

47. Make historic spawning grounds available to westslope cutthroat trout (WSCT) earlier by removal of tributary barriers or lake level management by 2008 (assuming new license is issued to Chelan PUD)

48. Eliminate the introductions of non-native species that have negative impacts on WSCT by 2010.

49. Decrease the abundance or remove key exogenous species by 2015.

50. Reduce direct harvest impacts on naturally produced WSCT by 2010.

### 8.5.2 Strategies

51. Mechanically remove barriers to WSCT spawning streams

52. Produce a comprehensive fish stocking plan for all species of interest that have potential to negatively affect WSCT.

53. Increase harvest on chinook salmon and lake trout.

54. Remove harvest limit on brook trout and rainbow trout.

55. Determine early life history requirements of WSCT

56. Assess whether kokanee spawning disrupts WSCT fry emergence

57. Delay opening of fishing near tributary mouths until after the spawning season

### 8.5.3 Consistency with ESA and CWA Requirements

***ESA consistency***

Bull trout are currently the only focal species that are listed under the ESA. In the Chelan Basin, bull trout have not been sited since the 1950s. Therefore, any actions taken to increase WSCT will consider potential interactions with bull trout if they are found within the Chelan Basin.

***Clean Water Act compliance***

Lake Chelan is considered ultra oligotrophic and in excellent condition. However, Railroad Creek still suffers from mining activities from the 1930s to 1950s. Current plans call for the clean up of the mine tailings which have been identified as the major source of contaminants.

A consortium of local agencies and the Washington State Department of Ecology have formed the Lake Chelan Water Quality Committee. This Committee was formed to provide a framework within which to monitor the water quality characteristics of Lake Chelan.

### 8.5.4 Research, Monitoring and Evaluation

Research, monitoring and evaluation are linked to each hypothesis and its biological objectives and strategies and conclude each hypothesis table.

**Table 37.** WSCT working hypothesis 1, objectives, strategies, and research

**Working hypothesis WSCT 1 for Lake and Tributary Assessment Units**:

*Interactions with exogenous species have negatively affected WSCT spawning and rearing.*

**Key findings supporting hypothesis**:

- WSCT compete with suckers and rainbow trout during spawning
- Rainbow trout interbreed with WSCT where they occur together
- Brook trout and rainbow trout compete for food in natal streams with juvenile WSCT
- Juvenile kokanee and chinook salmon all compete for limited zooplankton in Lake Chelan
- Adult kokanee spawn during observed fry emergence

**Biological objectives:**

- Eliminate the introductions of non-native species that have negative impacts on WSCT by 2010.
- Decrease the abundance or remove key exogenous species by 2015.

**Strategies**:

1. Produce a comprehensive fish stocking plan for all species of interest that have potential to negatively affect WSCT.

   Removing known species from plantings (e.g., rainbow trout) will reduce the impact on spawning and rearing.

   Because populations of species such as kokanee salmon, brook and rainbow trout are already established, eliminating more plantings will help other efforts aimed at reducing their impacts on WSCT.

2. Remove harvest limit on brook trout and possibly rainbow trout

   Removing the harvest limits on brook trout, and potentially rainbow trout will reduce their abundance and decrease the likelihood that these species can negatively impact WSCT on the spawning grounds or rearing areas.

3. Assess whether kokanee spawning disrupts WSCT fry emergence

   Adult kokanee have been observed spawning during fry emergence on Company Creek. Kokanee may be dislodging pre-emergent fry at times that may not be beneficial to fry

survival

4. Determine early life history requirements of WSCT

Understanding early life history requirements of WSCT will increase our understanding of potential interactions with other species.

The priorities of the strategies are: 1, 2, 4, 3 based on the potential impacts and feasibility of implementing programs that would occur under these strategies.

**Research**

Hypothesis: *Interactions with exogenous species have negatively affected WSCT spawning and rearing.*

To determine the potential negative interactions, the following information would be needed to test the hypothesis:

**I. Tributaries Assessment Units**

*Current information:*

- Brook trout and rainbow trout are established within most, if not all assessment units
- Spawning habitat is limited in the smaller tributaries to Lake Chelan
- Kokanee salmon spawn in most streams that WSCT are found

*Additional informational needs:*

- Intensive spawning ground investigations of WSCT to determine if suckers and rainbow trout are displacing WSCT and whether rainbow are interbreeding with WSCT

  By intensively monitoring spawning areas during migration and spawning, interactions between WSCT and rainbow and suckers could be systematically recorded. Other species that interact with WSCT should be recorded too.

  Currently, known areas of spawning of WSCT are: 25-Mile, Safety Harbor, Railroad, Prince, Fish, Four-mile creeks, and the Stehekin River drainage. Representative areas within these a subsample of these streams would be surveyed at least once per week from May through July.

- Juvenile life history information, so we understand what factors may be limiting production (and when juveniles enter the lake for adfluvial ecotypes).

  Understanding WSCT early life history will enable researchers to determine negative interactions between WSCT and other species, and will assist in developing management actions to reduce the negative impacts.

*Anticipated results/interpretations:*

- Interactions between rainbow trout and suckers limit spawning success of WSCT

It is anticipated that other interactions (e.g., competition for food) will be observed between WSCT and other species. However, it is important that researchers understand that not all interactions are negative. It will be important to clearly define which interactions could be interpreted as negative prior to the study.

- Interactions will be identified that limit WSCT survival

  It is anticipated that interactions will be identified that potentially limit production. It is important that is also determined if any interactions with other species are shown to potentially increase production.

- Early life history needs, including habitat preferences, species interactions, and lake entry (for adfluvial ecotypes).

  By "following" juvenile WSCT early rearing, including emergence timing, interactions with kokanee spawners, rainbow and sucker fry (and potentially Chinook and kokanee salmon fry in the lake (if it is shown that fry emigrate to the lake).

  Some species interaction may displace WSCT into Lake Chelan.

  By either trapping or observing, it is anticipated that lake entry will also be determined. This will increase our understanding of WSCT life history needs and potential other impacts within Lake Chelan (see below).

*Potential management applications*

- Remove non-native species that negatively affect WSCT by traps, increased catch limits, and other physical means.
- Decrease negative interactions with native species by making spawning habitat more available earlier for some populations.
- Increase spawning habitat

*Approach (general experimental design)*

- Snorkeling surveys to:
  1. observe WSCT spawning, and interactions with other species;
  2. determine early life history needs and interactions with other species;
  3. observe whether kokanee are disrupting emergence timing of WSCT.
- Electrofish:
  1. to determine numbers and diversity of fish within a sample reach
- Determine fry emergence timing, based on temperature and observed spawning within a sample reach;
- Remove exogenous species from a sample reach and compare to a "control" reach

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Snorkeling will be conducted in four streams, representing the diversity of WSCT spawning habitat. These streams will be located near the lower limit of their range in the lake (e.g., 25-Mile Creek), towards the middle (e.g., Prince Creek), near the upper (e.g., Fish Creek), and in the Stehekin drainage (e.g., Company Creek).

*Temporal scale*

- It is suggested that this study take place over two generations of WSCT (6-10 years).
- Observations would be taken during three main time periods:
    1. pre-spawning
    2. during spawning
    3. during emergence
- Further definition on whether there could be a randomized design where not every stream was looked at each year will be further investigated since this would decrease the budget.

*Application*

- The results of this research would apply to WSCT and the species that are shown to negatively interact with it.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, USFS, and NPS

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.

- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public

**II. Lake Chelan Assessment Unit**

*Current information:*

- Mysids, brook trout, rainbow trout, lake trout, Chinook and kokanee salmon are established within the lake
- Lake trout and chinook salmon are large enough to prey on juvenile or adult WSCT
- Lake Chelan does not produce large quantities of zooplankton

*Informational needs:*

- Species interactions within the lake.

  Understanding species interactions within the lake will enable managers to make informed decisions on which management strategies to follow.

- WSCT movement within the lake

  Understanding WSCT movement within the lake will increase our understanding of potential interactions with predators and competitors

*Anticipated results/interpretations:*

- Stomach analysis will determine that lake trout and Chinook salmon are preying on WSCT.
- WSCT stomach analysis will show which plankton and other invertebrates they are keying on.

  Species interactions may be difficult to determine within the lake because of logistical problems with sampling. However, indirect information from stomach analyses, plankton tows, etc., will enable researchers to make inferences on these potential interactions.

*Potential management applications*

- Reduce abundance of lake trout and Chinook salmon.
- Immediately stop planting both species into the lake

*Approach (general experimental design)*

- Detailed stomach analysis of lake trout and Chinook salmon caught at different times of the year and in different locations
- Detailed stomach analysis of WSCT, rainbow trout, and other species
- Active tag tracking of WSCT, and potentially other competitors or predators

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- WSCT will be tagged at various life stages at various locations around the lake and within tributaries

*Temporal scale*

- It is suggested that this study take place over two years
- Further definition on whether there could be a randomized design where not every stream was looked at each year will be further investigated since this would decrease the budget.

*Application*

- The results of this research would apply to WSCT and the species that are shown to negatively interact with it.

*Budget (concurrent with tributary work)*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, WDFW, USFS, and NPS

*Deliverable (concurrent with tributary work)*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data (concurrent with tributary work)*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.

All data will be available upon request to other agencies or the public

**Table 38.** WSCT working hypothesis 2, objectives, strategies, and research

**Working hypothesis WSCT 2**:

- *Development of barriers at tributary mouths has negatively affected spawning and subsequent fry survival of WSCT.*

**Key findings supporting hypothesis**:

- With the exception of 25-Mile Creek, First Creek, and the Stehekin River, barriers (velocity, deposition, and depth) have formed at spawning tributary mouths. Most other habitat features remain (except for LWD in the lake which is removed for navigation purposes).

**Biological objectives:**

- Make historic spawning grounds available to WSCT earlier by removal of tributary barriers or lake level management by 2008 (assuming new license is issued to Chelan PUD)

**Strategies**:

1. Mechanically remove barriers to WSCT spawning streams

   Studies conducted in 1999 and 2000 showed that WSCT were spawning one- two months later than in the late 1970s-early 1980s.

   By a combination of lowering the lake slightly earlier in the fall (freshets may help flush physical barriers out at mouth tributaries), mechanically removing (when needed), and filling the lake slightly earlier in the spring (inundating barriers), barriers at tributary mouths will not impede WSCT passage into spawning areas.

Data Gaps and additional informational needs:

- Determine after barriers are removed whether spawning time has changed.

**Research**

Hypothesis: *Modifications in lake levels have negatively affected spawning and subsequent fry survival of WSCT.*

To determine whether removing barriers at the mouth of WSCT spawning streams has reduced WSCT production, the following information would be needed to test the hypothesis:

**Tributaries Assessment Units**

*Current information:*

- Most spawning streams (excluding First, Twenty-five Mile Creek and the Stehekin River) are currently difficult to reach at historic spawning times because of the barriers that have

been created at their mouths.

*Additional informational needs:*

- Precise spawning time of WSCT in sample tributaries that have shown to have barrier problems before and after barrier removal

  By understanding spawning time prior to barrier removal, it will us understand the effects of removal

- Fry emergence and early life history needs within sample streams before and after barrier removal

  Understanding WSCT early life history will enable researchers to determine the effects of barrier removal.

*Anticipated results/interpretations:*

- WSCT will reach historic spawning areas earlier than they do presently.

  By removing physical barriers, WSCT will be able to reach their spawning areas closer to historic times, which may reduce competition with other species, e.g., suckers.

- Fry will emerge sooner, better able to synchronize with food production, and potential negative impacts from kokanee spawners

  It is anticipated that if WSCT spawn sooner, fry will emerge sooner and will better able to survive.

*Potential management applications*

- Remove barriers.
- Increase spawning habitat

*Approach (general experimental design)*

- Pre barrier removal:
  1. Obtain precise spawning dates in sample streams.
  2. Determine fry emergence in sample streams.
- Post barrier removal:
  1. Obtain precise spawning dates in sample streams.
  2. Determine fry emergence in sample streams.
- Determine fry emergence timing, based on temperature and observed spawning within a sample reach;

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical

methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Two streams will be chosen that are currently known to have barriers at their mouths.

*Temporal scale*

- It is suggested that this study take place over three years.
- Year one would be pre-barrier removal. Years two and three would be post barrier removal.

*Application*

- The results of this research would apply to WSCT and possibly rainbow trout.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: Chelan PUD, USFWS, USFS, and WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public

**Table 39.** WSCT working hypothesis 3, objectives, strategies, and research

| **Working hypothesis WSCT 3**: |
|---|
| *Harvest regulations and hatchery practices have reduced adult abundance.* |
| **Key findings supporting hypothesis**: |
| ➢ Based on anecdotal information on early catch rates of WSCT in newspapers and other sources, the current population of WSCT appears to be much reduced from historic times. |

High catch rates in the 19th century and historic and current hatchery practices in have all lead to their decline.

**Biological objectives:**

- Eliminate the introductions of non-native species that have negative impacts on WSCT by 2010.
- Decrease the abundance or remove key exogenous species by 2015.
- Reduce direct harvest impacts on WSCT by 2010.

**Strategies**:

1. Produce a comprehensive fish stocking plan for all species of interest

   A comprehensive fish stocking plan will consider all impacts of introduced fish, and will determine the types of fish introduced, best release locations and timing.

   In the past, many management decisions on Lake Chelan have not been well coordinated, or were made based on false information (e.g., Mysids, which were introduced into Lake Chelan to increase the size of kokanee, but ended up being competitors for the same resource). By having a coordinated plan, all species that are impacted will be regarded prior to fish releases.

2. Increase harvest on Chinook salmon and lake trout

   Increasing harvest on Chinook salmon and lake trout will have a direct effect on the number of WSCT spawners. Spawning WSCT will increase and productivity will increase.

3. Remove harvest limit on brook trout and rainbow trout

   Reducing the numbers of brook and rainbow trout will reduce competition for spawning and rearing habitat in the tributaries. Reducing competition for spawning and rearing habitat will increase survival of WSCT, and subsequent productivity.

4. Delay opening of fishing near tributary mouths until after the spawning season.

   By delaying the opening of fishing near tributary mouths, fishers will not be able to target WSCT when they are either staging for spawning, or post spawning return to Lake Chelan.

   Reducing direct harvest on vulnerable adults will increase the number of adult fish surviving, and since WSCT are iteroparous, more adults surviving after spawning means more adults will spawn again, thus increasing productivity.

The priorities of the strategies are: 1,4,3,2 based on the potential impacts and feasibility of implementing programs that would occur under these strategies.

Data Gaps and additional informational needs:

- Determine public acceptance of changed harvest regulations prior to initializing

  Estimates of adult abundance prior to and after regulations/hatchery practices are changed.

**Research**

Hypothesis: *Harvest regulations and hatchery practices have reduced adult abundance.*

To determine whether harvest regulations and current hatchery practices are reducing the numbers of adult WSCT, the following information would be needed to test the hypothesis:

**Tributary and Lake Assessment Units**

*Current information:*

- Current populations of WSCT are low based on creel and stream surveys.

*Additional informational needs:*

- Estimate of current population

  By understanding what the current population may be, researchers might be able to determine what effects changes in harvest regulations and hatchery practices may have.

- Species interactions within the lake.

  Understanding species interactions within the lake will enable managers to make informed decisions on which management strategies to follow.

*Anticipated results/interpretations:*

- The abundance of WSCT will be made, with low confidence because of the numerous assumptions that will be necessary to generate this estimate..

  Since current inference suggests that abundance is low, many assumptions will have to be made to estimate the WSCT abundance in the lake. Statistical confidence will most likely be low, with a wide range in the estimate.

- Stomach analysis will determine that lake trout and Chinook salmon are preying on WSCT.

- WSCT stomach analysis will show which plankton and other invertebrates they are keying on.

  Species interactions may be difficult to determine within the lake because of logistical problems with sampling. However, indirect information from stomach analyses, plankton tows, etc., will enable researchers to make inferences on these potential interactions.

*Potential management applications*

- Increase harvest on lake trout and Chinook salmon.

- Stop stocking Chinook salmon and rainbow trout
- Removal of other exotic species from the lake (e.g., mysids)

*Approach (general experimental design)*

- Estimate total abundance:
    1. Based on extensive spawner survey;
    2. Based on total current habitat use
- Detailed stomach analysis of lake trout and Chinook salmon caught at different times of the year and in different locations
- Detailed stomach analysis of WSCT, rainbow trout, and other species
- Observation near spawning tributary mouths when adfluvial trout are staging and returning to the lake

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Four sites within Lake Chelan will be randomly picked after determining a larger number of sites within the lake where useful data may be obtained..

*Temporal scale*

- It is suggested that this study take place over two years.

*Application*

- The results of this research would apply to WSCT, rainbow trout, Chinook salmon, lake trout, potentially brook trout.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: WDFW, USFWS, and USFS.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public

**Table 40.** Relationship of WSCT hypotheses, objectives, and strategies

| **Summary of relationship between hypotheses, biological objectives, and strategies** | | | |
|---|---|---|---|
| | **Hypothesis WSCT 1** | **Hypothesis WSCT 2** | **Hypothesis WSCT 3** |
| | *Interactions with non-native species have negatively affected WSCT in the Chelan Basin* | *Development of barriers at tributary mouths have negatively affected spawning and subsequent fry survival of WSCT* | *Harvest regulations and hatchery practices have reduced adult abundance* |
| **Biological Objectives** | | | |
| *Make historic spawning grounds available to WSCT earlier by removal of tributary barriers and lake level management by 2008 (assuming new license is issued to Chelan PUD)* | | X | |
| *Eliminate the introductions of non-native species that have negative impacts on WSCT by 2010* | X | | X |
| *Decrease the abundance or remove key exogenous species by 2015* | X | | X |
| *Reduce direct harvest impacts on WSCT by 2006* | X | | X |
| | | | |
| **Strategies** | | | |
| *Mechanically remove barriers to WSCT spawning streams* | | X | |
| *Produce a comprehensive fish stocking* | X | | X |

| | | | |
|---|---|---|---|
| *plan for all species of interest* | | | |
| *Increase harvest limit on Chinook salmon and lake trout* | X | | X |
| *Remove harvest limit on brook trout and possibly rainbow trout.* | X | | X |
| *Delay opening of fishing near tributary mouths until after the spawning season* | | | X |
| *Determine early life history requirements of WSCT* | X | X | |
| *Assess whether kokanee spawning disrupts fry emergence* | X | | |

**Table 41.** WSCT monitoring and evaluation indicators

| **Indicators that will be monitored and evaluated** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **General characteristics** | **Specific indicators** | **Strategies** | | | | | | |
| **Biological** | | *Mechanically remove barriers to WSCT spawning streams* | *Produce a comprehensive fish stocking plan for all species of interest* | *Increase harvest limit on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout and possibly rainbow trout.* | *Delay opening of fishing near tributary mouths until after the spawning season* | *Determine early life history requirements of WSCT* | *Assess whether kokanee spawning disrupts fry emergence* |
| *Adults* | Escapement/ Number | X | X | X | X | X | | X |
| | Age structure | | X | X | | | | |
| | Size | | | X | | | | |
| | Sex ratio | | | X | | | | |
| | Run timing | X | | X | | | | X |
| | Origin (hatchery/ wild) | | X | | | | | |
| | Fecundity | | | | | | | |
| *Redds* | Number | X | | X | X | X | | |
| | Distribution | X | | | X | | | X |
| | Timing | X | | | X | | | X |
| *Parr/* | Abundance | X | X | X | X | | X | X |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Juveniles* | Distribution/ Habitat use | X | X | | X | X | X | |
| | Size | X | | | X | | X | X |
| *Interactions* | Predator/ prey | | X | X | X | | X | |
| | Displacement | X | X | | X | | X | X |
| | Interbreed | | X | | X | | | |
| **Habitat** | | | | | | | | |
| *Water Quality* | MWMT and MDMT | | | | | | | |
| | Turbidity | | | | | | | |
| | Conductivity | | | | | | | |
| | pH | | | | | | | |
| | Dissolved oxygen | | | | | | | |
| | Nitrogen | | | | | | | |
| | Phosphorus | | | | | | | |
| *Habitat Access* | Road crossings | | | | | | | |
| | Diversion dams | | | | | | | |
| | Timing | X | | | | | X | X |
| | Barriers | X | | | | | | |
| *Habitat Quality* | Dominant substrate | | | | | | X | |
| | Embeddedness | | | | | | X | |
| | Depth fines | | | | | | X | |
| | LWD (pieces/km) | | | | | | X | |
| | Pools (pools/km) | | | | | | X | |
| | Residual pool depth | | | | | | X | |
| | Fish cover | | | | | | X | |
| | Side channels and backwaters | | | | | | X | |
| *Channel condition* | Stream gradient | X | | | | | | |
| | Width/depth ratio | X | | | | | | |
| | Wetted width | | | | | | | |
| | Bankfull width | | | | | | | |
| | Bank stability | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Riparian Condition* | Riparian structure | | | | | | X | |
| | Riparian disturbance | | | | | | X | |
| | Canopy cover | | | | | | X | |
| *Flows and Hydrology* | Streamflow | X | | | | | X | |
| *Watershed Condition* | Watershed road density | | | | | | | |
| | Riparian-road index | | | | | | | |
| | Land ownership | | | | | | | |
| | Land use | | | | | | | |

**Table 42.** WSCT monitoring needs

| **Commonality between monitoring needs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Metric or method** | **Strategies** | | | | | | |
| | | *Mechanically remove barriers to WSCT spawning streams* | *Produce a comprehensive fish stocking plan for all species of interest* | *Increase harvest limit on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout and possibly rainbow trout.* | *Delay opening of fishing near tributary mouths until after the spawning season* | *Determine early life history requirements of WSCT* | *Assess whether kokanee spawning disrupts fry emergence* |
| *Adults* | Spawning ground surveys | X | | X | X | | | |
| | Estimate of abundance | | X | X | X | X | | |
| | Interactions with native species | X | X | | | X | | |
| | Interaction with exogenous species | X | X | X | X | X | | |
| | Stomach analysis | | | X | | | | |
| | Movement | X | | X | | X | | |
| | Run timing | X | X | X | X | X | | |
| *Juveniles* | Emergence timing | X | | | X | | X | X |
| | Distribution | | | | X | | X | X |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Interactions with native species | X | X | X | | | X | |
| | Interaction with exogenous species | X | X | X | X | | X | X |
| | Abundance | | X | | X | | X | X |
| *Methods* | Snorkel | X | | | X | | X | X |
| | Electro-fish | X | | | X | | X | X |
| | Active tag & track | | | X | | | | |
| | Hook & line | | | X | X | | | |
| | Creel survey | | | X | X | X | | |
| | Stomach analysis | | X | X | | | | |
| *Scale* | Spatial | 2 streams | 2 streams Through-out lake | Through- out lake | 2 streams | 4 streams | 4 streams | 2 streams |
| | Temporal | 3 years | 2 years | 6-10 years | 6-10 years | 3 years | 3 years | 3 years |

**Table 43.** WSCT planning and design of strategy implementation

| **Planning, design and standards** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Metric/ responsibility** | **Strategies** | | | | | | |
| | | *Mechanically remove barriers to WSCT spawning streams* | *Produce a comprehensive fish stocking plan for all species of interest* | *Increase harvest limit on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout and possibly rainbow trout.* | *Delay opening of fishing near tributary mouths until after the spawning season* | *Determine early life history requirements of WSCT* | *Assess whether kokanee spawning disrupts fry emergence* |
| *Evaluation planning* | Evaluation responsibility | Chelan PUD | PUD, WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | PUD, WDFW, USFWS, USFS, NPS |
| | Decision responsibility | PUD, WDFW, USFWS, USFS, NPS | WDFW/ USFWS | WDFW | WDFW | WDFW | USFWS | USFWS |
| | Public feedback | 2 x/yr | 3 x/yr | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr |
| | Potential cost share (mostly personnel) | PUD | PUD, WDFW, USFWS, USFS, NPS | WDFW | WDFW | WDFW | WDFW, USFWS, USFS, NPS | PUD, WDFW, USFWS, USFS, NPS |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Sampling design** | Monitoring | E | S/T | E | E | E | S/T | E |
| | Frequency | 1 x/yr (2 mo.) | 3 x/yr | 3 x/yr | 3 x/yr | 1 x/yr | 3 x/yr | 1 x/yr |
| | Methods | Snorkel | Creel survey, hook & line | Creel survey, hook & line | Creel survey, hook & line | Creel survey, hook & line | Snorkel | Snorkel |
| *Statistical Considerations* | Significance level | α =0.10 | n/a | n/a | n/a | n/a | n/a | n/a |
| | Hypothesis | WSCT 2 | WSCT 1, 3 | WSCT 3 | WSCT 1, 3 | WSCT 3 | WSCT 1, 3 | WSCT 1 |
| *Performance standards* | Reference | Current spawn timing | Current abund. | Current abund. | Current abund. | Current abund. | Current emergence timing, lake entry | Current emergence |
| | Desired effect | Earlier spawn timing | Higher abund. | Higher abund. | Higher abund. | Higher abund. | Earlier emergence and longer stream life | Earlier emergence |

E = effectiveness; S/T = status/trend monitoring

**Table 44.** WSCT data management

| **Data information and archive** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Strategies** | | | | | | |
| | | *Mechanically remove barriers to WSCT spawning streams* | *Produce a comprehensive fish stocking plan for all species of interest* | *Increase harvest limit on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout and possibly rainbow trout.* | *Delay opening of fishing near tributary mouths until after the spawning season* | *Determine early life history requirements of WSCT* | *Assess whether kokanee spawning disrupts fry emergence* |
| *Quality Assurance/ control* | Agency responsible for developing QA/QC | Chelan PUD | PUD, WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | WDFW, USFWS, USFS, NPS | PUD, WDFW, USFWS, USFS, NPS |
| *Data management* | Format | PDA in field | Document/ matrices | PDA in field | PDA in field | PDA in field | PDA in field | PDA in field |
| | Stored | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU |
| | Updated | 6 mo. | 2 mo. | yearly | yearly | yearly | 6 mo. | 6 mo. |
| | Access | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Report preparation* | Format | Formal | Formal | Tech. memo | Tech. memo | Tech. memo | Formal | Formal |
| | Presentation | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final |
| | Incorporation of comments | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, | After sent to manage-ment agencies, | After sent to manage-ment agencies, | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, then public |

**Table 45.** WSCT evaluation

| **Evaluation** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Strategies** | | | | | | |
| | | *Mechanically remove barriers to WSCT spawning streams* | *Produce a comprehensive fish stocking plan for all species of interest* | *Increase harvest limit on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout and possibly rainbow trout.* | *Delay opening of fishing near tributary mouths until after the spawning season* | *Determine early life history requirements of WSCT* | *Assess whether kokanee spawning disrupts fry emergence* |
| *Scientific* | strengths | -already have base-line info.;<br>-observation relatively simple; | -coordinated plan will incorporate competing interests;<br>-better ability to recover or restore native species | -reduces one limiting factor | -reduces one limiting factor<br>-can test empirically (remove from one stream section) | -reduces one limiting factor | -data can be empirically gathered<br>-will foundation for other management actions | -data can be empirically gathered |
| | weaknesses | -time of year could render obs. diff. (high run-off);<br>-not enough WSCT to detect difference in some streams | -unavail-ability of eggs, or proper genetic stock;<br>-unintended species interactions | -response of WSCT will be complicated by other factors | -observation of interactions may be difficult to determine | -may be difficult to observe response | -observation of interactions may be difficult to determine | -observation of interactions may be difficult to determine |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Decision-making* | Determine if alternatives should be needed | If data suggests barriers are not problem and WSCT are still not reaching spawning grnds at appr. time | Alternatives to this point have not been coordinated and current negative species interactions are thought to be deleterious to native species | Determine public opposition to plan before implement-ting. | Pursue other options if the study is inconclusive. | Pursue other options if the study is inconclusive. | Other approaches may be necessary, but will not be known until after information is collected. | Pursue other options if the study is inconclusive. |
| | Management response to changes in indicators | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches |
| *Public* | Review format | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation |
| | Comment format | Written, verbal @ presentation | Written, verbal @ presentation | Written, verbal @ presentati on | Written, verbal @ presentation | Written, verbal @ presentati on | Written, verbal @ presentation | Written, verbal @ presentation |
| | Incorporation of comments | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency |

## 8.6 Bull Trout

### 8.6.1 Biological Objectives

58. Determine if bull trout exist in the basin by 2008.

59. If bull trout are found, attain self sustaining non-migratory populations of bull trout (if feasible) by 2025.

60. Reduce abundance of exogenous stocks that may hinder reintroduction by 2010.

61. Ensure historic habitat remains in tact by 2008

### 8.6.2 Strategies

62. Explore likely places that may hold reserves of non-migratory bull trout

63. Reintroduce bull trout into historic habitat, if feasible

64. Determine predator-prey relationships in Lake Chelan.

65. Determine potential interactions with established populations prior to introduction.

66. Increase harvest on Chinook salmon and lake trout.

67. Remove harvest limit on brook trout.

68. Preserve (or restore) geo-fluvial processes in all tributaries

### 8.6.3 Consistency with ESA and CWA Requirements

***ESA Consistency***

Bull trout are currently the only focal species that are listed under the ESA. In the Chelan Basin, bull trout have not been observed since the 1950s. One of the suggested approaches within this management plan is to increase investigations to confirm whether any non-migratory ecotypes may still exist in remote headwater sections of some streams. If bull trout are not found (or potentially if they are and introduced in other segregated areas), additional efforts may attempt to reintroduce them to increase the abundance of the Columbia River Distinct Population Segment, although this population, under section 10(j) of the ESA would be "experimental" would not be subject to the same level of limitations and requirements that accompany ESA status generally.

***Clean Water Act Compliance***

Lake Chelan is considered ultra oligotrophic and in excellent condition. However, Railroad Creek still suffers from mining activities from the 1930s to 1950s. Current plans call for the clean up of the mine tailings which have been identified as the major source of contaminants.

A consortium of local agencies and the Washington State Department of Ecology have formed the Lake Chelan Water Quality Committee. This Committee was formed to provide a framework within which to monitor the water quality characteristics of Lake Chelan.

### 8.6.4 Research, Monitoring and Evaluation

Research, monitoring and evaluation are linked to each hypothesis and its biological objectives and strategies and conclude each hypothesis table.

**Table 46.** Bull trout working hypothesis 1, objectives, strategies, and research

| |
|---|
| **Working hypothesis BT 1**:<br>*Bull trout are still present in smaller tributaries as non-migratory ecotypes.* |
| **Key findings supporting hypothesis**:<br>➢ Bull trout have not been documented within the Chelan Basin since the 1950s.<br>➢ It is not clear why they may be extinct, but potential reasons are: over harvest, loss of spawning grounds due to high floods in 1948 and 1949; or a catastrophic disease outbreak, or a combination of above factors. |
| **Biological objectives:**<br>1. Determine if bull trout exist in the Basin by 2008. |
| **Strategies**:<br>1. Explore likely places that may hold reserves of non-migratory bull trout |

If bull trout still remain within the Basin, the potential exists to use that stock for reintroduction in other areas within the basin.

Data Gaps and additional informational needs:

- Extensive surveys are needed to determine whether bull trout exist in areas that have not been surveyed to date.

**Research**

Hypothesis: *Bull trout are still present in smaller tributaries as non-migratory ecotypes.*

To determine whether bull trout still exist in the Chelan Basin, the following information would be needed to test the hypothesis:

**Tributaries Assessment Units**

*Current information:*

- Bull trout have not been documented within the Chelan Basin since the 1950s

*Additional informational needs:*

- Determine potential upper geographic limits of likely bull trout occurrence within selected streams

  By understanding what the upper limits of bull trout occurrence could be within a stream, researchers will be able to know how far upstream within the likely stream they should investigate.

- Determine which streams to investigate

  Based on historical information and current understandings of bull trout habitat needs, researchers will be able to focus their efforts.

*Anticipated results/interpretations:*

- Non-migratory ecotypes of bull trout may be found.

  Until a systematic investigation has occurred that all stakeholders collaboratively agree to, the question of whether bull trout still exist in the Chelan Basin will remain unanswered.

*Potential management applications*

- If found, protection of critical habitat.
- If found, use for potential reintroduction in other areas within the basin

*Approach (general experimental design)*

- Literature review of temperature related limit of bull trout occurrence in streams (e.g., work by Mullan et al. 1992 in the Methow).

- Determination of likely streams where bull trout may remain

  1. Review historic information of previously surveyed streams

  2. Review habitat characteristics in potential streams that either have not been previously surveyed, or have not been completely surveyed.

- Survey likely streams looking for redds, or by snorkeling (at night). Sampling will follow American Fisheries Society protocols for bull trout presence-absence surveys (Peterson et al. 2001).

*Statistical analyses*

- These approaches are generally assessments, so no formal analyses, other than descriptive statistics and graphing methods will be necessary.

*Spatial scale*

- The Stehekin Basin will be the area of focus.

*Temporal scale*

- It is suggested that this study take place over two years.

*Application*

- The results of this research would apply to bull trout and possibly WSCT.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, NPS, USFS, and potentially WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public

**Table 47.** Bull trout working hypothesis 2, objectives, strategies, and research

**Working hypothesis BT 2**:

*Spawning and early rearing habitat will not limit bull trout re-introduction*.

**Key findings supporting hypothesis**:

- Current spawning and rearing areas within the Stehekin, and other tributaries are functioning near pristine levels

**Biological objectives:**

- Ensure historic habitat remains in tact by 2008.

**Strategies**:

1. Preserve (or restore) geo-fluvial processes in all tributaries

   Preserving (or restoring) geo-fluvial processes within tributaries will aid in either increasing (restoring) or ensuring that spawning habitat remains functional. Natural geo-fluvial processes will also aid in ensuring that pool formation and associated cover are occurring, which will aid in tributary rearing of bull trout.

2. Reintroduce bull trout into historic habitat, if feasible

   Introduction of bull trout will depend on available broodstock, feasibility of using hatcheries, and whether there is a high likelihood that they can maintain a self-sustaining population.

Data Gaps and additional informational needs:

Spawning and early rearing habitat conditions.

**Research**

Hypothesis: *Spawning and early rearing habitat will not limit bull trout re-introduction.*

To determine whether current habitat conditions warrant potential reintroduction (or building if they are found) bull trout into the Chelan Basin, the following information would be needed to test the hypothesis:

**Tributaries Assessment Units**

*Current information:*

- Potential bull trout habitat exists within most historic habitat.
- Access to most habitat is not limited, except downstream of the Holden mine on Railroad Creek.

*Additional informational needs:*

- Determine whether potential historic habitat niches are filled with current, established populations of exogenous species

  To determine whether bull trout will have access to potential historic habitat, it is important to understand the current use of this habitat by other species

- Determine whether presumed historic habitat is accessible

  Based on historical information and current understanding of bull trout habitat needs, researchers will be able to focus their efforts.

*Anticipated results/interpretations:*

- Brook trout, and potentially rainbow trout fill available niches within presumed historic bull trout habitat.

  Brook trout are known to compete and breed with bull trout, reducing the likelihood of successful introduction and reducing genetic integrity. Rainbow trout aggression may displace bull trout within certain habitat types.

- Historic habitat is mostly in tact, and accessible, especially in the upper Stehekin Basin.

  Except for the lower basin, where some riparian and geo-fluvial processes have been disrupted, the Stehekin River Basin is largely in historical condition. Other potential bull trout tributaries have not been substantially altered, except perhaps 25-Mile Creek, from road and other development.

*Potential management applications*

- Elimination of brook trout.
- Preservation of existing quality habitat

*Approach (general experimental design)*

- Determine likely bull trout habitat by general stream surveys
- Compare those habitats to areas where extant populations of bull trout exist.
- Within those surveys, also assess access
- Determine whether exogenous species are occupying available "typical" bull trout habitat.

*Statistical analyses*

- These approaches are generally assessments, so no formal analyses, other than descriptive statistics and graphing methods will be necessary.

*Spatial scale*

- Sample streams where bull trout are thought to have occurred historically.

*Temporal scale*

- It is suggested that this study take place over two years.

*Application*

- The results of this research would apply to bull trout, brook trout, and potentially rainbow trout and WSCT.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, USFS, and WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**Table 48.** Bull trout working hypothesis 3, objectives, strategies, and research

**Working hypothesis BT 3**:

*Competition with exogenous species will reduce the success of bull trout re-introduction*.

**Key findings supporting hypothesis**:

- Introduced lake trout and brook trout (and kokanee salmon) may inhibit re-introduction of bull trout through competition during rearing, foraging, or spawning phases.
- Brook trout are known to reduce genetic integrity of bull trout when they interbreed (and are sterile).

**Biological objectives:**

1. Reduce abundance of exogenous stocks that may hinder reintroduction by 2010.

**Strategies**:

1. Increase harvest on Chinook salmon and lake trout

Reducing the abundance of Chinook salmon and lake trout will reduce the likelihood of

any negative impacts these species may have in competing with reintroduced bull trout.

2. Remove harvest limit on brook trout

Reducing the abundance of brook trout will increase the likelihood of successful reintroduction on bull trout. Brook trout are known to out-compete bull trout during juvenile rearing, decrease genetic integrity when interbreeding with bull trout, and may compete for limited spawning habitat in smaller tributaries.

3. Determine predator-prey relationships in Lake Chelan.

Understanding the complex interactions between predators and prey will increase our knowledge on whether adfluvial forms of bull trout can be successfully reintroduced.

4. Determine potential interactions with established populations prior to introduction.

Understanding all potential interactions between key species will increase our knowledge on whether bull trout can be reintroduced into the Chelan Basin (for all ecotypes).

These strategies could be carried out simultaneously.

Data Gaps and additional informational needs:

- Potential negative interactions between lake trout and Chinook salmon with bull trout.
- Predictions of reduced abundance of these species are needed *before* these strategies are in place.

**Research**

Hypothesis: *Competition with exogenous species will reduce the success of bull trout re-introduction*.

To determine whether competition with exogenous species will reduce the likelihood of bull trout reintroduction into the Chelan Basin, the following information would be needed to test the hypothesis:

**I. Tributaries Assessment Units**

*Current information:*

- Chinook salmon, lake trout, brook trout, and rainbow trout support self-sustaining populations within the Chelan Basin.
- Spawning habitat is limited within smaller tributaries.

*Additional informational needs:*

- Determine whether potential historic habitat niches are filled with current, established populations of exogenous species

To determine whether bull trout will have access to historic habitat, it is important to understand the potential use of this habitat by other species

*Anticipated results/interpretations:*

- Currently, brook trout will inhibit bull trout reintroduction into some streams.

  Brook trout are known to compete and breed with bull trout, reducing the likelihood of successful introduction and reducing genetic integrity

*Potential management applications*

- Reduction or elimination of brook trout, and reduction of rainbow trout.

*Approach (general experimental design)*

- Compare sections of streams with exogenous species and those without
- Remove brook and rainbow trout by hook and line, weirs, or electrofishing

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Sample streams where bull trout are thought to have occurred historically.

*Temporal scale*

- It is suggested that this study take place over two years.

*Application*

- The results of this research would apply to bull trout, Chinook salmon, brook trout, and potentially rainbow trout and WSCT.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, USFS, and WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed

to by the lead agencies.

- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**II. Lake Assessment Unit**

*Current information:*

- Chinook salmon and lake trout are established within Lake Chelan.

*Additional informational needs:*

- Determine predator-prey relationships within the lake.

  Understanding current predator-prey relationships will help determine potential success of reintroducing adfluvial bull trout.

*Anticipated results/interpretations:*

- Lake trout and Chinook salmon have replaced bull trout as the apex predators in Lake Chelan.

  Food is limited within Lake Chelan because it is oligotrophic. There may not be enough prey species for bull trout if Chinook salmon and lake trout already prey on available prey items

*Potential management applications*

- Reduction, or elimination of lake trout and Chinook salmon.

*Approach (general experimental design)*

- Increase harvest,
- Capture of adults on spawning grounds (primarily Chinook).
- Tag lake trout to determine spawning areas

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Sample locations within the lake, and potentially streams if spawning ground capture is desired.

*Temporal scale*

- It is suggested that this effort take place over five years.

*Application*

- The results of this research would apply to bull trout, Chinook salmon, lake trout, brook trout, and potentially rainbow trout and WSCT.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, USFS, and WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**Table 49.** Bull trout working hypothesis 4, objectives, strategies, and research

**Working hypothesis BT 4**:

*All life histories of bull trout can be successfully reintroduced into the Chelan Basin.*

**Key findings supporting hypothesis**:

- Introduced Chinook salmon, lake trout and brook trout (and kokanee salmon) may inhibit re-introduction of bull trout through competition during rearing, foraging, or spawning phases.

**Biological objectives:**

- If bull trout are not found, develop pilot reintroduction program for non-migratory populations by 2010.
- If bull trout are found, attain self sustaining non-migratory populations of bull trout (if feasible) by 2025

**Strategies**:

1. Reintroduce bull trout into historic habitat (if feasible)

   By reintroducing bull trout into historic habitat within the basin, a more native species assemblage will be in place (if successful).

   This will also aid in the recovery of bull trout in the Columbia Cascade Province by increasing (and restoring) additional habitat, thus overall production to the DPS.

Data Gaps and additional informational needs:

- Potential negative interactions between brook trout, lake trout and Chinook salmon with bull trout.
- Whether acceptable brood stock is available.
- Whether there is an acceptable (and accessible) hatchery site.
- Whether hatchery bull trout will successfully spawn in the wild.

**Research**

Hypothesis: *All life histories of bull trout can be successfully reintroduced into the Chelan Basin*.

To determine whether bull trout reintroduction into the Chelan Basin will succeed, the following information would be needed to test the hypothesis:

**I. Tributaries Assessment Units**

*Current information:*

- Bull trout have not been confirmed within the Basin since the 1950s.
- Brook trout, rainbow trout, Chinook salmon, and lake trout have self-sustaining populations within the basin.
- There currently are no bull trout hatcheries within the state of Washington.
- Potential brood stock has not been identified.

*Additional informational needs:*

- Determine whether a bull trout hatchery is feasible.

  If appropriate broodstock is not found within the Chelan Basin, it is important to determine the feasibility of a hatchery program.

- Identify appropriate broodstock and whether that population can withstand an experimental hatchery program (egg mining).

  Without an appropriate broodstock, a hatchery program cannot proceed. It is also important to understand *before* any gametes are taken from the donor population

whether it can withstand the removal of gametes for its own health.

*Anticipated results/interpretations:*

- Some type of hatchery site can be found within the Basin, probably in the Stehekin Valley.

  Depending on the needs (e.g., raceways run on surface water; concrete ponds run on ground water, etc.), a site can be found within the Stehekin Valley, or another tributary with access.

- Appropriate, broodstock, within the geographic area (CCP) will be found.

  Donor populations, like the Chiwawa River spawning population may be deemed appropriate for use in a hatchery program.

- Removing gametes will present a high risk to the donor population.

  Depending on the scale of the hatchery program, removing gametes from any extant population of bull trout may risk the health of that population.

*Potential management applications*

- Build bull trout hatchery.
- Capture broodstock from extant population.

*Approach (general experimental design)*

- Determine feasibility of hatchery program by surveying likely sites within areas that access will be approved.
- Examine likely donor populations, estimating total abundance.
- Develop experimental hatchery program in phases, beginning with low levels of production until agreed upon success criteria are met for "Phase I."

*Statistical analyses*

- Both descriptive statistics and graphing methods will be used to analyze data.

*Spatial scale*

- Examine likely areas within Chelan Basin, and move outside the Basin if necessary (within close proximity).

*Temporal scale*

- Feasibility of hatchery sites and donor population should take one year. If both are feasible, then experimental hatchery evaluation should take 10 years.

*Application*

- The results of this research would apply to bull trout.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: USFWS, NPS, USFS, and WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**Table 50.** Relationship of bull trout hypotheses, objectives, and strategies

| **Summary of bull trout hypotheses, objectives, and strategies** | | | | |
|---|---|---|---|---|
| | **Hypothesis BT 1** | **Hypothesis BT 2** | **Hypothesis BT 3** | **Hypothesis BT 4** |
| | *Bull trout are still present in smaller tributaries as non-migratory ecotypes* | *Spawning and early rearing habitat will not limit bull trout re-introduction* | *Competition with exogenous species will reduce the success of bull trout re-introduction* | *All life histories of bull trout can be successfully re-introduced into the Chelan Basin.* |
| **Biological Objectives** | | | | |
| *Determine if bull trout still exist in the Basin by 2008* | X | | | |
| *Attain self sustaining populations of bull trout (if feasible) by 2020* | | | | X |
| *Reduce abundance of exogenous species that may hinder reintroduction by* | | | X | |

| | | | | |
|---|---|---|---|---|
| *2010* | | | | |
| *Ensure historic habitat remains in tact by 2008* | | X | | |
| | | | | |
| **Strategies** | | | | |
| *Explore likely places that may hold reserves of non-migratory bull trout* | X | | | |
| *Reintroduce bull trout into historic habitat, if feasible* | | X | | X |
| *Determine predator-prey relationships in Lake Chelan* | | | X | |
| *Determine potential interactions with established populations prior to introduction.* | | | X | |
| *Increase harvest on Chinook salmon and lake trout.* | | | X | |
| *Remove harvest limit on brook trout* | | | X | |
| *Preserve (or restore) geo-fluvial processes in all tributaries* | | X | | |

**Table 51.** Bull trout monitoring and evaluation indications

| **Indicators that will be monitored and evaluated** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **General characteristics** | **Specific indicators** | **Strategies** | | | | | | |
| **Biological** | | *Explore likely places that may hold reserves of non-migratory bull trout* | *Reintroduce bull trout into historic habitat, if feasible* | *Determine predator-prey relationships in Lake Chelan.* | *Determine potential interactions with established populations prior to introduction* | *Increase harvest on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout* | *Preserve (or restore) geo-fluvial processes in all tributaries* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Adults* | Escapement/ Number | | X | | X | X | X | |
| | Age structure | | X | | X | X | X | |
| | Size | | X | | X | X | X | |
| | Sex ratio | | X | | | | | |
| | Run timing | X | X | | X | X | X | |
| | Origin (hatchery/ wild) | | X | | | | | |
| | Fecundity | | X | | | X | X | |
| *Redds* | Number | X | X | | X | X | | |
| | Distribution | X | X | | X | | | |
| | Timing | X | X | | X | | | |
| *Parr/ Juveniles* | Abundance | X | X | | X | | | |
| | Distribution/ Habitat use | X | X | | X | | | |
| | Size | X | X | | X | | | |
| *Interactions* | Predator/ prey | | X | X | X | X | X | |
| | Displacement | | X | X | X | X | X | |
| | Interbreed | | X | | X | | X | |
| **Habitat** | | | | | | | | |
| *Water Quality* | MWMT and MDMT | X | X | | | | | X |
| | Turbidity | | | | | | | X |
| | Conductivity | | | | | | | X |
| | pH | | | | | | | X |
| | Dissolved oxygen | X | | | | | | X |
| | Nitrogen | | | | | | | X |
| | Phosphorus | | | | | | | X |
| *Habitat Access* | Road crossings | X | X | | | | | X |
| | Diversion dams | | X | | | | | X |
| | Timing | X | X | | | | | |
| | Barriers | X | X | | | | | X |
| *Habitat Quality* | Dominant substrate | X | | | | | | X |
| | Embeddedness | | | | | | | X |
| | Depth fines | | | | | | | X |
| | LWD (pieces/km) | X | X | | | | | X |
| | Pools (pools/km) | X | X | | | | | X |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Residual pool depth | X | | | | | | X |
| | Fish cover | X | X | | | | | X |
| | Side channels and backwaters | | | | | | | X |
| *Channel condition* | Stream gradient | | | | | | | X |
| | Width/depth ratio | | | | | | | X |
| | Wetted width | | | | | | | X |
| | Bankfull width | | | | | | | X |
| | Bank stability | | | | | | | X |
| *Riparian Condition* | Riparian structure | X | | | | | | X |
| | Riparian disturbance | | | | | | | X |
| | Canopy cover | | | | | | | X |
| *Flows and Hydrology* | Streamflow | X | | | | | | X |
| *Watershed Condition* | Watershed road density | | | | | | | X |
| | Riparian-road index | | | | | | | X |
| | Land ownership | | | | | | | X |
| | Land use | | | | | | | X |

**Table 52.** Bull trout monitoring needs

| **Commonality between monitoring needs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Metric or method** | **Strategies** | | | | | | |
| | | *Explore likely places that may hold reserves of non-migratory bull trout* | *Reintroduce bull trout into historic habitat, if feasible* | *Determine predator-prey relationships in Lake Chelan.* | *Determine potential interactions with established populations prior to introduction* | *Increase harvest on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout* | *Preserve (or restore) geo-fluvial processes in all tributaries* |
| *Adults* | Spawning ground surveys | X | X | | X | X | X | |
| | Estimate of abundance | X | X | | | X | X | |
| | Interactions with native species | | X | X | X | | X | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Interaction with exogenous species | | X | X | X | | X | |
| | Stomach analysis | | X | X | | | X | |
| | Movement | X | X | X | X | | X | |
| | Run timing | X | X | X | X | X | X | |
| *Juveniles* | Emergence timing | | X | | X | | X | |
| | Distribution | X | X | | X | | X | |
| | Interactions with native species | | X | | X | | X | |
| | Interaction with exogenous species | | X | | X | | | |
| | Abundance | X | X | | | | X | |
| *Methods* | Snorkel | X | X | | X | | X | |
| | Electro-fish | X | X | | X | | X | |
| | Active tag & track | | X | | | X | X | |
| | Hook & line | | | X | | X | X | |
| | Creel survey | | X | X | | X | X | |
| | Stomach analysis | X | X | X | X | | X | |
| *Scale* | Spatial | Primarily Stehekin Basin | TBD | Throughout lake | 2 sample streams and 4 lake sites | Throughout lake, and two sample streams | 2 sample streams | 2 sample streams |
| | Temporal | 2 years | 10 years | 3 years | 3 years | 3 years | 3 years | 2 years |

**Table 53.** Bull trout planning and design of strategy implementation

| **Planning, design and standards** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Metric/ responsibility** | **Strategies** | | | | | | |
| | | *Explore likely places that may hold reserves of non-migratory bull trout* | *Reintroduce bull trout into historic habitat, if feasible* | *Determine predator-prey relationships in Lake Chelan.* | *Determine potential interactions with established populations prior to introduction.* | *Increase harvest on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout* | *Preserve (or restore) geo-fluvial processes in all tributaries* |
| *Evaluation planning* | Evaluation responsibility | USFWS | USFWS, NPS | WDFW, USFWS, NPS | USFWS, WDFW, USFS, NPS | WDFW, USFWS, NPS | WDFW, USFWS, NPS | USFWS, USFS, NPS |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Decision responsibility | USFWS, USFS, NPS | USFWS | WDFW | USFWS, WDFW, NPS | WDFW | USFWS, WDFW | USFS, NPS |
| | Public feedback | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr | 2 x/yr |
| | Potential cost share | USFWS, USFS, NPS | USFWS, WDFW, USFS, NPS | WDFW | USFWS, WDFW, USFS, NPS | WDFW | WDFW, USFWS, USFS, NPS | USFWS, USFS, NPS |
| *Sampling design** | Monitoring | S/T | S/T | E | E | E | E | S/T |
| | Frequency | 3 x/yr | 3 x/yr | 3 x/yr | 3 x/yr | 3 x/yr | 3 x/yr | 3 x/yr |
| | Methods | Snorkel, electro-fish | Snorkel, electro-fish creel survey | Creel survey, hook & line | Snorkel, electro-fish, creel survey, hook & line | Creel survey, hook & line | Creel survey, hook & line | Various monitoring methods |
| *Statistical Considerations* | Significance level | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | Hypothesis | BT 1 | BT 2, 4 | BT 3 | BT 3 | BT 3 | BT 3 | BT 2 |
| *Performance standards* | Reference | No observations | No observations | Presumed effects | Presumed effects | Presumed effects | Presumed effects | Current conditions |
| | Desired effect | Local populations | Local populations | Empirical observations or inferences | Empirical observations or inferences | Empirical observations or inferences | Empirical observations or inferences | Current or better conditions |

* E = effectiveness; S/T = status/trend monitoring

**Table 54.** Bull trout data management

| **Data information and archive** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Strategies** | | | | | | |
| | | *Explore likely places that may hold reserves of non-migratory bull trout* | *Reintroduce bull trout into historic habitat, if feasible* | *Determine predator-prey relationships in Lake Chelan.* | *Determine potential interactions with established populations prior to introduction.* | *Increase harvest on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout* | *Preserve (or restore) geo-fluvial processes in all tributaries* |
| *Quality Assurance/ control* | Agency responsible for developing QA/QC | USFWS | USFWS, NPS | WDFW, USFWS, NPS | USFWS, WDFW, USFS, NPS | WDFW, USFWS, NPS | WDFW, USFWS, NPS | USFWS, USFS, NPS |
| *Data management* | Format | PDA (with GPS coordination) in field | PDA in field | PDA in field | PDA in field | PDA in field | PDA in field | PDA in field |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Stored | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU | CD/CPU |
| | Updated | 2 mo. | 2 mo. | 6 mo. | 6 mo. | 6 mo. | 6 mo. | 6 mo. |
| | Access | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site |
| *Report preparation* | Format | Formal | Formal | Formal | Tech. memo | Tech. memo | Tech. memo | Formal |
| | Presentation | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final | Updates, final |
| | Incorporation of comments | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, | After sent to manage-ment agencies, | After sent to manage-ment agencies, | After sent to manage-ment agencies, then public | After sent to manage-ment agencies, then public |

**Table 55.** Bull trout evaluation

| **Evaluation** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Strategies** | | | | | | |
| | | *Explore likely places that may hold reserves of non-migratory bull trout* | *Reintroduce bull trout into historic habitat, if feasible* | *Determine predator-prey relationships in Lake Chelan.* | *Determine potential interactions with established populations prior to introduction.* | *Increase harvest on Chinook salmon and lake trout.* | *Remove harvest limit on brook trout* | *Preserve (or restore) geo-fluvial processes in all tributaries* |
| *Scientific* | strengths | -rigorous observations will enable managers to aid in bull trout recovery;<br>Agreed-to prior to study by all stakeholders | -increase range of threatened species (if feasible); | -may help define feasibility of reintroduce-tion of adfluvial populations | -will increase the knowledge needed to determine the feasibility of reintroduction | -reduces one limiting factor | -data can be empirically gathered<br>-may build foundation for other management actions | -data can be empirically gathered |
| | weaknesses | -limitation because of accessibility, run off, or other abiotic factors may make the results inconclusive | -unavail-ability of eggs, or proper genetic stock;<br>-unintended species interactions | -results will be difficult to obtain interpret | - results will be difficult to obtain interpret | -may be difficult to observe response | -observation of interactions may be difficult to determine | -many variables affect observations |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Decision-making* | Determine if alternatives should be needed | If data suggests that bull trout do not exist within basin | If this strategy is feasible, then it will take a number of years to determine success | Pursue other options if the study is inconclusive | Pursue other options if the study is inconclusive. | Determine public opposition to plan before implement-ting. | Other approaches may be necessary, but will not be known until after information is collected. | n/a |
| | Management response to changes in indicators | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches prior to determining if program is successful | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches |
| *Public* | Review format | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation |
| | Comment format | Written, verbal @ presentation | Written, verbal @ presentation | Written, verbal @ presentation | Written, verbal @ presentation | Written, verbal @ presentati on | Written, verbal @ presentation | Written, verbal @ presentation |
| | Incorporation of comments | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency | Lead agency |

## 8.7 Kokanee Salmon

### 8.7.1 Biological Objectives

69. Reduce negative interactions with mysids by 2015

70. Increase juvenile survival and increase abundance of adults in lake by 2010

71. Ensure self-sustaining populations by 2015.

### 8.7.2 Strategies

72. Reduce abundance of mysids

73. Increase harvest on Chinook salmon and lake trout.

74. Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.

### 8.7.3 Consistency with ESA and CWA Requirements

***ESA consistency***

Bull trout are currently the only focal species that are listed under the ESA. In the Chelan Basin, bull trout have not been sited since the 1950s.

***Clean Water Act compliance***

Lake Chelan is considered ultra oligotrophic and in excellent condition. However, Railroad Creek still suffers from mining activities in from the 1930s to 1950s. Current plans call for the clean up of the mine tailings which have been identified as the major source of contaminants.

A consortium of local agencies and the Washington State Department of Ecology have formed the Lake Chelan Water Quality Committee. This Committee was formed to provide a framework within which to monitor the water quality characteristics of Lake Chelan.

### 8.7.4 Research, Monitoring and Evaluation

Research, monitoring and evaluation are linked to each hypothesis and its biological objectives and strategies and conclude each hypothesis table.

**Table 56.** Kokanee hypothesis 1, objectives, strategies, and research

**Working hypothesis K 1**:

*Rearing in Lake Chelan is limited by lake productivity and competition with other species.*

**Key findings supporting hypothesis**:

- Kokanee populations have been volatile and could be related to predator abundance, competition with native and exotic species for forage, and general lake productivity.
- Spawning habitat is not limiting

**Biological objectives:**

- Reduce negative interactions with mysids by 2015.

**Strategies**:

1. Reduce abundance of mysids

   Mysids are known to compete with juvenile kokanee for the limited zooplankton base of Lake Chelan (even though they were put in there to increase their size). Reducing their abundance (a program is underway in the Canadian Okanogan Basin), juvenile kokanee will have more forage, and survival, and subsequent production will increase.

Data Gaps and additional informational needs:

- Time series of information on abundance of mysids
- Development of reduction program based on experience from Canadians

**Research**

Hypothesis: *Rearing in Lake Chelan is limited by lake productivity and negative interactions with other species*.

To determine whether kokanee rearing is limited in Lake Chelan, the following information would be needed to test the hypothesis:

**I. Lake Assessment Unit**

*Current information:*

- Lake Chelan is oligotrophic.
- Mysids have been established in the lake since the early 1970s.

*Additional informational needs:*

- Determine if additional productivity information is needed.

  Past efforts have collected lake information concerning general lake productivity. It needs to be determined if further information is needed.

- Current abundance of mysids.

  To understand kokanee-mysid interactions properly (see below), it is essential to estimate the total abundance of mysids.

- Better understanding of mysid-kokanee interactions.

  To understand whether the kokanee population is being impacted by mysids, it is important to better understand their interactions.

*Anticipated results/interpretations:*

- Additional productivity information will not be needed.

  Previous information will suffice in our understanding of lake productivity.

- Mysid abundance has remained relatively constant over time.

  Compared to historic abundance estimates, the mysid population has most likely remained at relatively stable levels.

- Mysids compete for the same food as kokanee during their lake residency.

  Mysids are known to compete for the same food items as kokanee where they have been introduced except in the West Arm of Kootenay Lake..

*Potential management applications*

- Begin mysid reduction program based on existing programs in Canada.

*Approach (general experimental design)*

- Literature search for Lake Chelan productivity.
- Mysid sampling.
- Kokanee stomach sampling.

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Four sampling sites will be chosen throughout the lake that past research has shown to contain both mysids and kokanee.

*Temporal scale*

- Two years.

*Application*

- The results of this research would apply to kokanee, mysids, and potential other predators of mysids.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: WDFW.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**Table 57.** Kokanee hypothesis 2, objectives, strategies, and research

**Working hypothesis K 2**: *Total adult abundance is impacted by predation by lake trout and chinook*

**Key findings supporting hypothesis**:

- Kokanee populations have been volatile and could be related to predator abundance, competition with native and exotic species for forage, and general lake productivity.

**Biological objectives:**

- Increase juvenile survival and increase abundance of adults in the lake by 2010.

**Strategies**:

1. Increase harvest on Chinook salmon and lake trout

   Increasing harvest on Chinook and lake trout will increase the abundance of adult kokanee making it back to spawning areas, and will increase the productivity of the total population

Data Gaps and additional informational needs:

- Development of a predator-prey relationship between kokanee and lake trout and Chinook salmon

**Research**

Hypothesis: *Total adult abundance is impacted by predation by lake trout and chinook.*

To determine whether kokanee abundance is limited in Lake Chelan by Chinook and lake trout, the following information would be needed to test the hypothesis:

**I. Lake Assessment Unit**

*Current information:*

- Chinook have been established in the lake since the 1970s
- Lake trout were established in the lake in the 1980s
- Both species have the ability (size) to prey on kokanee

*Additional informational needs:*

- Estimate Chinook salmon and lake trout abundance.

  To understand predator-prey interactions properly, it is essential to estimate the total abundance of each within the lake.

- Develop predator-prey model to help understand dynamics of predator-prey species interactions.

  The information needed within the model may need to be collected, or historical information may be available.

*Anticipated results/interpretations:*

- Chinook abundance levels will be medium to low, and Lake trout abundance will be low.

  These estimates will be difficult to obtain, but some information is needed to determine potential impacts to kokanee and potentially other species.

- Predator prey relationships exist for Chinook salmon and to a lower level for lake trout.

  Because lake trout generally inhabit deeper waters, it is likely that they encounter kokanee less often than Chinook salmon.

*Potential management applications*

- Increase harvest on lake trout and Chinook salmon.

*Approach (general experimental design)*

- Spawning ground counts for kokanee and Chinook salmon.
- Hook and line capture of Chinook salmon and lake trout in the lake.
- Stomach sampling.

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Four sampling sites will be chosen throughout the lake that past research has shown to contain both Chinook salmon and lake trout.

*Temporal scale*

- Two to three years (depending on sample sizes obtained).

*Application*

- The results of this research would apply kokanee, Chinook salmon, and lake trout (and potentially other species preyed upon by Chinook and lake trout).

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: WDFW, USFWS, USFS, and NPS.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place

- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.
- All data will be available upon request to other agencies or the public.

**Table 58.** Kokanee hypothesis 3, objectives, strategies, and research

**Working hypothesis K 3**: *Hatchery plantings increase the total abundance of kokanee available for spawning or harvest*

**Key findings supporting hypothesis**:

- Introductions of hatchery fish have not been shown to increase natural production or harvest rates

**Biological objectives:**

- Ensure self-sustaining populations by 2015.

**Strategies**:

1. Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate

   Past evaluations have not shown significant numbers of hatchery released fish in the spawning populations or sport harvest, regardless of how they were released. By reducing or eliminating hatchery plants (after rigorous monitoring and evaluation), natural production and satisfactory harvest rates may be maintained. Resources now spent on kokanee could then be applied to WSCT and bull trout.

Data Gaps and additional informational needs:

- Rigorous evaluation of the success of hatchery plantings in terms of contribution to spawning grounds and harvest rates.
- Development of a contingency plan if evaluation shows that hatchery plants are ineffective.
- Determination of whether kokanee need hatchery plantings to be self-sustaining

**Research**

Hypothesis: *Hatchery plantings increase the total abundance of kokanee available for spawning or harvest*.

To determine whether hatchery plants of kokanee will increase abundance in Lake Chelan, the following information would be needed to test the hypothesis:

**I. Lake Assessment Unit**

*Current information:*

- Kokanee have been planted into Lake Chelan since 1917.
- Currently, there is a self-sustaining population of kokanee.
- Past attempts to verify hatchery plants in the fishery or on the spawning grounds have not shown any significant contribution from these plants.

*Additional informational needs:*

- Continuing evaluation of positive or negative affects of hatchery plants to the self-sustaining populations.

  Without an evaluation plan, there is no way to determine whether this program is effective (i.e., meeting its goal).

- Determine whether the self-sustaining populations of kokanee could support a sport fishery without hatchery plants.

  This would enable managers to either; 1) confirm the need for the program, or 2) determine that the program is not necessary and use the current money and effort for other purposes (e.g., WSCT).

*Anticipated results/interpretations:*

- Hatchery plants of kokanee do not significantly increase catch rates or spawner abundance.
- Release of hatchery fish do not survive in great numbers post release
- Hatchery fish are not negatively impacting self-sustaining populations.
- Hatchery fish are not found on the spawning grounds in great numbers, or competing for food in great numbers within the lake.

*Potential management applications*

- Reduce or eliminate hatchery releases.
- Use money for kokanee program for other species.

*Approach (general experimental design)*

- Mark and recapture studies.
- Increase capture methods on spawning grounds and in creel/hook and line surveys.
- Stomach analysis from lake (determine competition between hatchery and naturally produced fish).
- Possibly modify release locations to increase fidelity for the purposes of the study.

*Statistical analyses*

- Both statistical and graphical methods will be used to analyze data. Statistical methods will include descriptive statistics, trend analysis (changes in trend before and after implementation of management actions), multiphase regression, and t-tests with before-after and before-after-control-impact designs. Depending on the characteristics of the data, nonparametric procedures like the randomization test, Wilcoxon rank sum test, or the Mann-Whitney test may be used.

*Spatial scale*

- Four sampling sites will be chosen throughout the lake that past research has shown to contain kokanee.
- Determine index areas within four spawning ground tributaries (e.g., within Company Creek, Blackberry Creek, 25-Mile Creek, and Safety Harbor Creek).

*Temporal scale*

- Ten years (this should encompass 2-3 life cycles).

*Application*

- The results of this research would apply kokanee.

*Budget*

- To be determined, although it is assumed that a consortium of agencies would take the lead in this effort: Chelan PUD, WDFW, USFWS, USFS, and NPS.

*Deliverable*

- Draft annual report due December 15 of the year the research takes place
- Final annual progress reports due March 1 of the year following the research
- Final report due by July 1 after the final year of research

*Data*

- Data will be collected and entered in either spreadsheet or data base format, as agreed to by the lead agencies.
- Data will be stored by the lead agency, unless other collaboratively agreed upon arrangements are made.

- All data will be available upon request to other agencies or the public.

**Table 59.** Relationship of kokanee hypotheses, objectives, and strategies

| Summary of relationship between kokanee hypotheses, objectives, and strategies | | | |
|---|---|---|---|
| | **Hypothesis K 1** | **Hypothesis K 2** | **Hypothesis K 3** |
| | *Rearing in Lake Chelan is limited by lake productivity and competition with other species* | *Total adult abundance is impacted by predation by lake trout and Chinook* | *Hatchery plantings increase the total abundance of kokanee* |
| **Biological Objectives** | | | |
| *Reduce negative interactions with mysids by 2015* | X | | |
| *Increase juvenile survival and increase abundance of adults in lake by 2010* | | X | |
| *Ensure populations are self-sustaining populations by 2015* | | | X |
| | | | |
| **Strategies** | | | |
| *Reduce abundance of mysids* | X | | |
| *Increase harvest limit on Chinook salmon and lake trout* | | X | |
| *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* | | | X |

**Table 60.** Kokanee monitoring and evaluation indicators

| Indicators that will be monitored and evaluated | | |
|---|---|---|
| **General characteristics** | **Specific indicators** | **Strategies** |

| **Biological** | | *Reduce abundance of mysids* | *Increase harvest limit on Chinook salmon and lake trout* | *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* |
|---|---|---|---|---|
| *Adults* | Escapement/ Number | | X | X |
| | Age structure | | X | X |
| | Size | | X | X |
| | Sex ratio | | X | X |
| | Run timing | | X | X |
| | Origin (hatchery/ wild) | | X | X |
| | Fecundity | | | X |
| *Redds* | Number | | X | X |
| | Distribution | | X | X |
| | Timing | | X | X |
| *Parr/ Juveniles* | Abundance | X | X | X |
| | Distribution/ Habitat use | X | X | X |
| | Size | X | X | X |
| *Interactions* | Predator/ prey | | X | X |
| | Displacement | | | X |
| | Interbreed | | | |
| **Habitat** | | | | |
| *Water Quality* | MWMT and MDMT | | | |
| | Turbidity | | | |
| | Conductivity | | | |
| | pH | | | |
| | Dissolved oxygen | | | |
| | Nitrogen | | | |
| | Phosphorus | | | |
| *Habitat Access* | Road crossings | | | |
| | Diversion dams | | | |
| | Timing | | | |
| | Barriers | | | |
| *Habitat Quality* | Dominant substrate | | | |
| | Embeddedness | | | |
| | Depth fines | | | |

| | | | | |
|---|---|---|---|---|
| | LWD (pieces/km) | | | |
| | Pools (pools/km) | | | |
| | Residual pool depth | | | |
| | Fish cover | | | |
| | Side channels and backwaters | | | |
| *Channel condition* | Stream gradient | | | |
| | Width/depth ratio | | | |
| | Wetted width | | | |
| | Bankfull width | | | |
| | Bank stability | | | |
| *Riparian Condition* | Riparian structure | | | |
| | Riparian disturbance | | | |
| | Canopy cover | | | |
| *Flows and Hydrology* | Streamflow | | | |
| *Watershed Condition* | Watershed road density | | | |
| | Riparian-road index | | | |
| | Land ownership | | | |
| | Land use | | | |

**Table 61.** Kokanee monitoring needs

| **Commonality between monitoring needs** | | | | |
|---|---|---|---|---|
| **Category** | **Metric or method** | **Strategies** | | |
| | | *Reduce abundance of mysids* | *Increase harvest limit on Chinook salmon and lake trout* | *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* |
| *Adults* | Spawning ground surveys | | X | X |
| | Estimate of abundance | | X | X |
| | Interactions with native species | | | X |
| | Interaction with exogenous species | | X | X |
| | Stomach analysis | | X | X |

| | | | | |
|---|---|---|---|---|
| | Movement | | X | X |
| | Run timing | | X | X |
| *Juveniles* | Emergence timing | | | X |
| | Distribution | | | X |
| | Interactions with native species | X | | X |
| | Interaction with exogenous species | X | X | X |
| | Abundance | X | X | X |
| *Methods* | Snorkel | | | X |
| | Electro-fish | | | X |
| | Active tag & track | | | X |
| | Trawl net | X | | X |
| | Hook & line | X | X | X |
| | Creel survey | X | X | X |
| | Stomach analysis | X | X | X |
| *Scale* | Spatial | 4 lake transects | 4 lake transects | 4 lake transects, 2 streams |
| | Temporal | 5 years | 5 years | 5 years |

**Table 62.** Kokanee planning, design, and standards

| **Planning, design and standards for implementation** | | | | |
|---|---|---|---|---|
| **Category** | **Metric/ responsibility** | **Strategies** | | |
| | | *Reduce abundance of mysids* | *Increase harvest limit on Chinook salmon and lake trout* | *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* |
| *Evaluation planning* | Evaluation responsibility | WDFW | WDFW, USFWS, NPS | WDFW, USFWS, USFS, NPS |
| | Decision responsibility | WDFW, USFWS, USFS, NPS | WDFW/ USFWS | WDFW |
| | Public feedback | 2 x/yr | 3 x/yr | 2 x/yr |
| | Potential cost share | PUD, WDFW, NPS | WDFW, USFWS, USFS, NPS, PUD, | WDFW, USFWS, USFS, NPS |
| *Sampling design** | Monitoring | E | S/T | E |
| | Frequency | 3 x/yr | 3 x/yr | 3 x/yr |
| | Methods | Zooplankton trawl | Creel survey, hook & line | Snorkeling, electro-fishing, creel survey, hook & line |

| | | | | |
|---|---|---|---|---|
| *Statistical Considerations* | Significance level | α =0.10 | n/a | n/a |
| | Hypothesis | K 1 | K 2 | K 3 |
| *Performance standards* | Reference | Current abundance | Current abundance | Current species assemblage |
| | Desired effect | Lower abundance | Lower abundance | Agreed to species assemblage |

* E = effectiveness; S/T = status/trend monitoring

**Table 63.** Kokanee data management

| **Data information and archive** | | | | |
|---|---|---|---|---|
| | | **Strategies** | | |
| | | *Reduce abundance of mysids* | *Increase harvest limit on Chinook salmon and lake trout* | *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* |
| *Quality Assurance/ control* | Agency responsible for developing QA/QC | WDFW | WDFW | WDFW, USFWS, USFS, NPS |
| *Data management* | Format | PDA in field | Document | PDA in field |
| | Stored | CD/CPU | CD/CPU | CD/CPU |
| | Updated | 6 mo. | 2 mo. | yearly |
| | Access | Updates/ Drafts- Web site | Updates/ Drafts- Web site | Updates/ Drafts- Web site |
| *Report preparation* | Format | Formal | Tech. memo | Formal |
| | Presentation | Updates, final | Updates, final | Updates, final |
| | Incorporation of comments | After sent to management agencies, then public | After sent to management agencies, then public | After sent to management agencies, |

**Table 64.** Kokanee evaluation

| **Evaluation** | | | | |
|---|---|---|---|---|
| | | **Strategies** | | |
| | | *Reduce abundance of mysids* | *Increase harvest limit on Chinook salmon and lake trout* | *Develop planting schedule of hatchery fish that meets native fish production goals and ensures satisfactory harvest rate.* |
| *Scientific* | strengths | -reduce impacts on numerous species | -reduces one limiting factor | -coordinated plan will incorporate competing interests;<br>-better ability to recover or restore native species |

| | | | | |
|---|---|---|---|---|
| | weaknesses | -program will be difficult to implement | -response of kokanee will be complicated by other factors | -unavailability of eggs, or proper genetic stock;<br>-unintended species interactions |
| *Decision-making* | Determine if alternatives should be needed | If program is not feasible | Determine public opposition to plan before implement-ting. | Alternatives to this point have not been coordinated and current negative species interactions are thought to be deleterious to native species |
| | Management response to changes in indicators | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches | Pursue comments, collaborate, and determine other approaches |
| *Public* | Review format | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation | Advertise web page where draft info is available, then presentation |
| | Comment format | Written, verbal @ presentation | Written, verbal @ presentation | Written, verbal @ presentation |
| | Incorporation of comments | Lead agency | Lead agency | Lead agency |