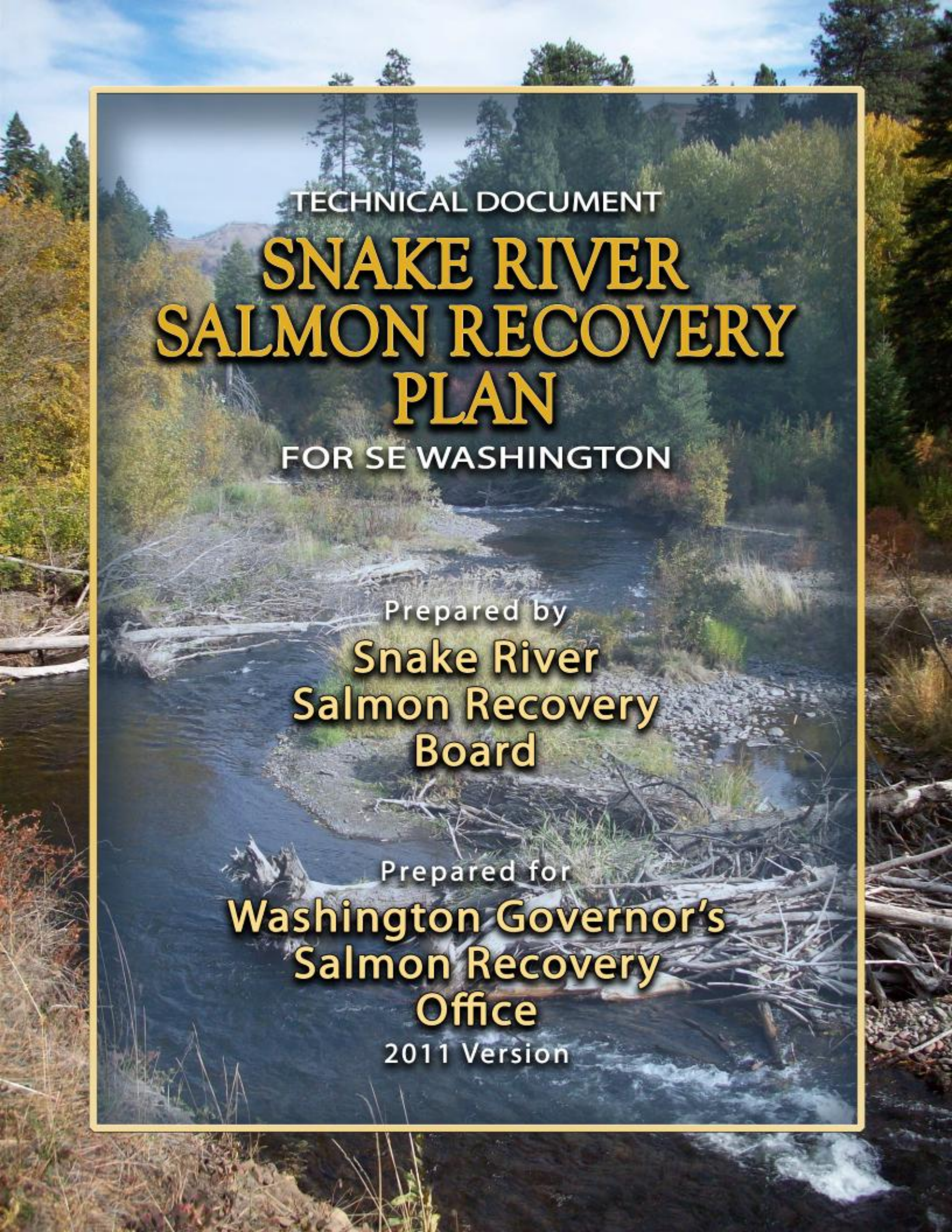


TECHNICAL DOCUMENT

SNAKE RIVER SALMON RECOVERY PLAN

FOR SE WASHINGTON

Prepared by

Snake River Salmon Recovery Board

Prepared for

Washington Governor's Salmon Recovery Office

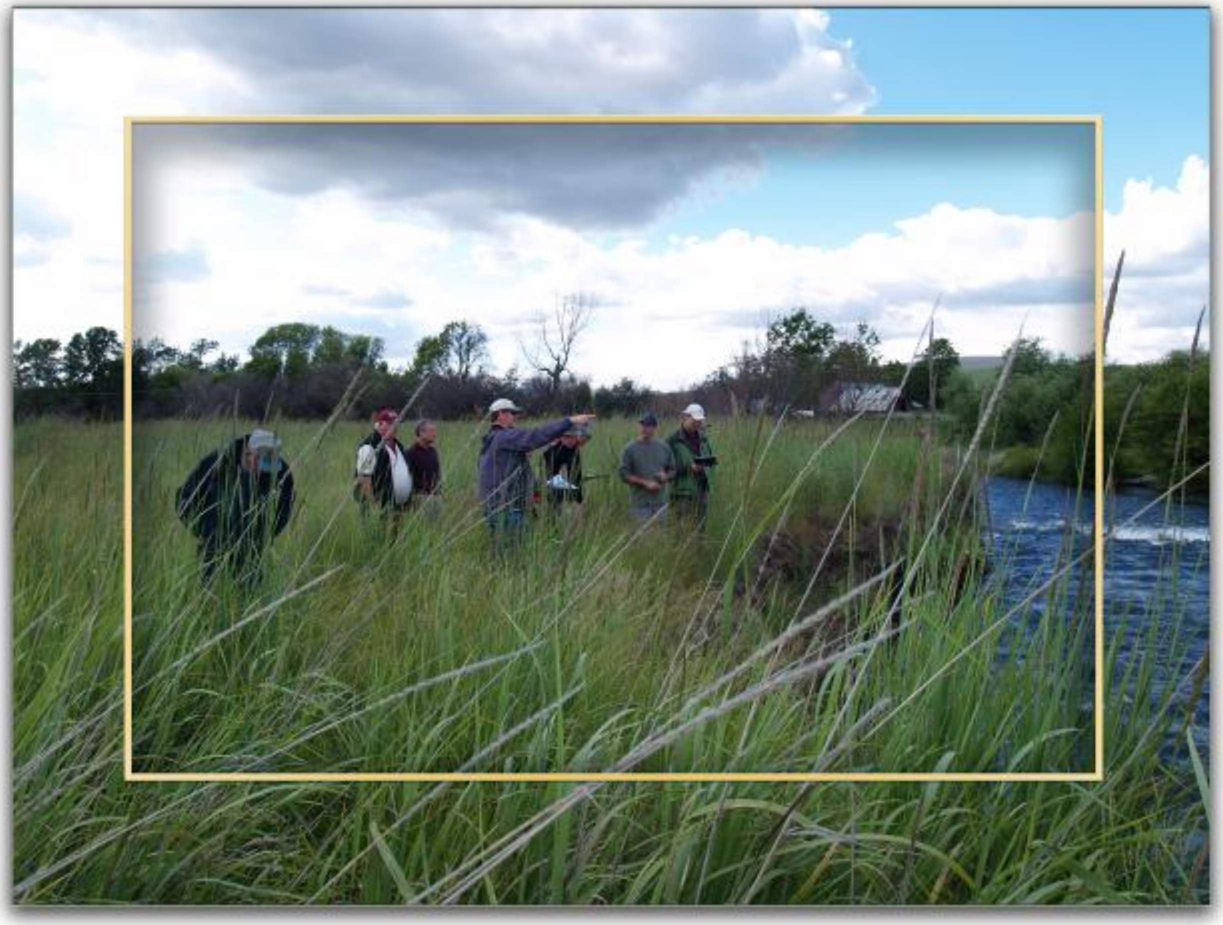
2011 Version

Table of Contents

Table of Figures

List of Tables

1 INTRODUCTION



Salmon, steelhead, and bull trout populations within the Columbia River Basin have suffered declines due to a variety of causes. Government agencies, tribal governments, environmental organizations, fishing interests, local entities, and the public at large agree that halting the decline and, if possible, reversing it is important to the social, cultural, economic, and environmental well-being of the region. Recovery plans are a vital part of the effort to combat the decline of salmon; the goal of the plans is to produce a guide for the long-term implementation of actions designed to restore populations as closely as practicable to a healthy state.

The following is a revision and update to a plan that was originally written in 2005 and finalized in 2006. Many of the processes and associated information has been updated from the 2006 plan and the status of the species (Appendix B) has also been updated.

This recovery plan addresses the following salmon and trout populations in southeast Washington: bull trout, Asotin Creek summer steelhead, Asotin Creek spring/summer Chinook, Tucannon River summer steelhead, Tucannon River spring/summer Chinook, Wala Walla River summer steelhead, Touchet River summer steelhead, Joseph Creek summer steelhead, Lower Grande Ronde River summer steelhead, and Wenaha River spring/summer Chinook.

1.1 VISION STATEMENT

Defining recovery goals and planning targets begins with establishment of a vision statement for the recovery region. The vision statement provides the context within which recovery goals and planning targets are set and strategies and actions are identified. The following vision statement for this Plan is based largely on statements from the Tucannon River, Asotin Creek, Walla Walla River, Grande Ronde River, and Lower Snake Mainstem subbasin plans:

> *Develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.*

The vision statement includes: 1) meeting recovery goals established by NMFS for listed populations of anadromous fish species and by U.S. Fish and Wildlife Service for bull trout, 2) achieving healthy and harvestable populations of listed species in affected subbasins, and 3) realizing these objectives while recognizing that local culture and economies (agriculture, urban development, logging, power production, recreation, and other activities) are beneficial to the health of the human environment within the recovery region.

1.2 PURPOSE AND CONTEXT

Salmon and other salmonids are an important part of the life and economy of the Pacific Northwest. Since the 19th century, salmon populations have declined within the Columbia River Basin. Over-harvesting, as well as loss of habitat due to agricultural activities, logging, urbanization, and construction of dams, have reduced populations of salmonids to extremely low levels in some parts of Washington State, resulting in some populations being listed as threatened or endangered under the federal endangered species acts.

Recovery planning for salmon in Washington State is defined by the Salmon Recovery Act of 1998 (RCW 77.85) as "a state plan developed in response to a proposed or actual listing under the federal endangered species act that addresses limiting factors including, but not limited to harvest, hatchery, hydropower, habitat, and other factors of decline." In addition to aiding in the recovery of salmon populations within the state, Washington's goal in embarking upon the recovery planning effort was to retain responsibility for managing the state's resources rather than relying on the federal government to do so. The recovery planning process is designed to provide an opportunity to incorporate best available scientific information with local enhancement efforts. The objective in adopting this approach is a plan, capable of being implemented, that can be used to remove currently listed species from the threatened or endangered species designation and maintain healthy, viable, sustainable, and harvestable populations of those species.

In 1999, the document "Extinction is Not an Option—a Statewide Strategy to Recover Salmon" was released by the Washington Governor's Salmon Recovery Office. This document provides overall guidance for addressing the myriad aspects of salmonid recovery including agriculture, forestry, land use, water quality and quantity, fish passage, harvest, artificial production (hatcheries), and hydroelectric dams. It "stresses the importance of a strong scientific foundation, a collaborative and open process, and a long-term adaptive management strategy based on a comprehensive monitoring of salmon recovery and watershed health."

To guide regional groups entering into salmonid recovery planning, "An Outline for Salmon Recovery Plans" was developed by the State of Washington, National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), the Northwest Power and Conservation Council (NWPCC), and other local and regional organizations. This document is based on the earlier strategy document and presents more details on what should be included in a recovery plan. It was endorsed by the Governor's Office of the State of Washington and approved by NMFS in December 2003.

The outline establishes the approach to salmon recovery planning and identifies the important components of a plan. Specifically, the plan must include:

- Scientific assessments of the status of species and their habitats.

- Factors for decline, threats to viability, and/or factors limiting recovery of the species, and factors supporting current populations.

- Measurable goals that describe recovery for the listed species against which the success of actions will be measured.

- Actions and commitments for habitat, harvest, hatcheries, and hydropower necessary to reduce or eliminate the limiting factors and recover fish populations.

- Implementation components such as time lines, funding, identification of responsible parties and authorities, research needs, monitoring plans, and methods of evaluating actions and adapting the plan.

In the Pacific Northwest, NMFS has identified four recovery domains: Puget Sound; Willamette/Lower Columbia, which has two sub-domains of Willamette and Lower Columbia; Oregon Coast; and Interior Columbia, which has three sub-domains of Middle Columbia, Snake and Upper Columbia (Figure 1-1). These are geographically-based areas for preparing multi-species recovery plans for anadromous salmonids in the states of Washington, Oregon, and Idaho.

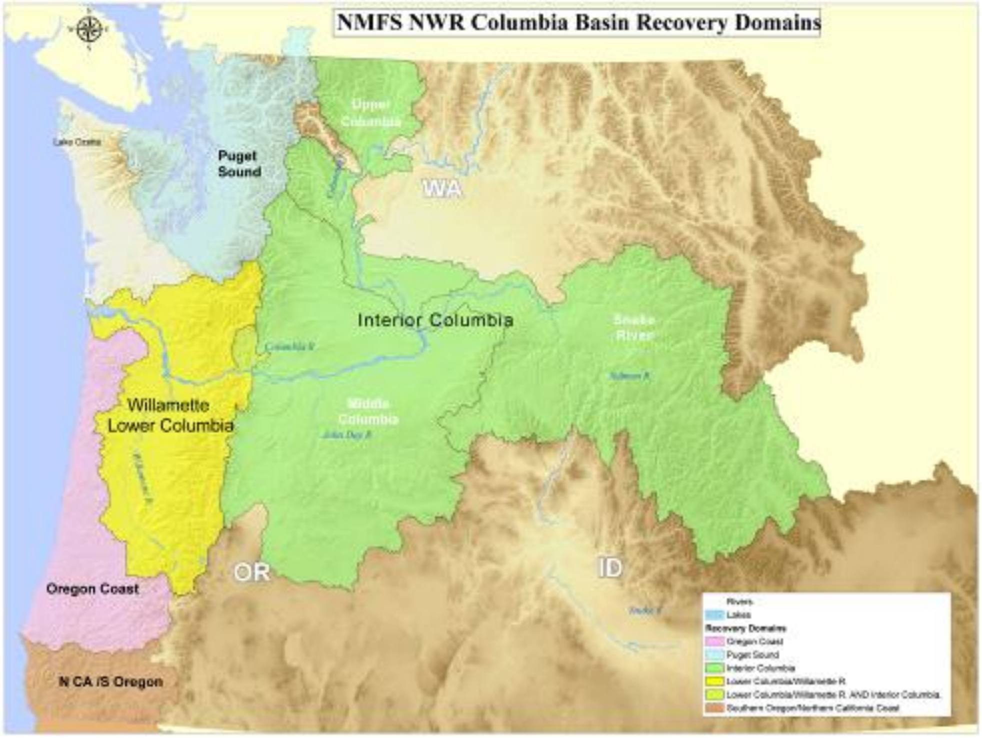


Figure 1-1. Columbia Basin Recovery Domains for NMFS Northwest Region

Because most state and local boundaries are not drawn on the basis of watersheds or ecosystems, the various groups and organizations that formed for recovery planning in these subregions do not necessarily correspond to salmon evolutionarily significant unit (ESU) and steelhead distinct population segment (DPS) areas. So to develop ESU-wide recovery plans that are built from local recovery efforts, NMFS defined "management units" that roughly follow jurisdictional boundaries but, taken together, encompass the geography of entire ESUs/DPSs.

Two of the Interior Columbia sub-domains, the Middle Columbia and Snake, have multiple management units. For the Middle Columbia, there are four management units: Oregon, Yakima, Columbia Gorge (Klickitat/Rock Creek/White Salmon), and Southeast Washington (Walla Walla and Touchet). The Snake sub-domain has three management units: Idaho, Oregon and Southeast Washington.

This plan provides recovery planning for the Southeast Washington Management Unit (SEWMU), which is part of the Snake River Recovery sub-domain (Figure 1-2, 1-3).

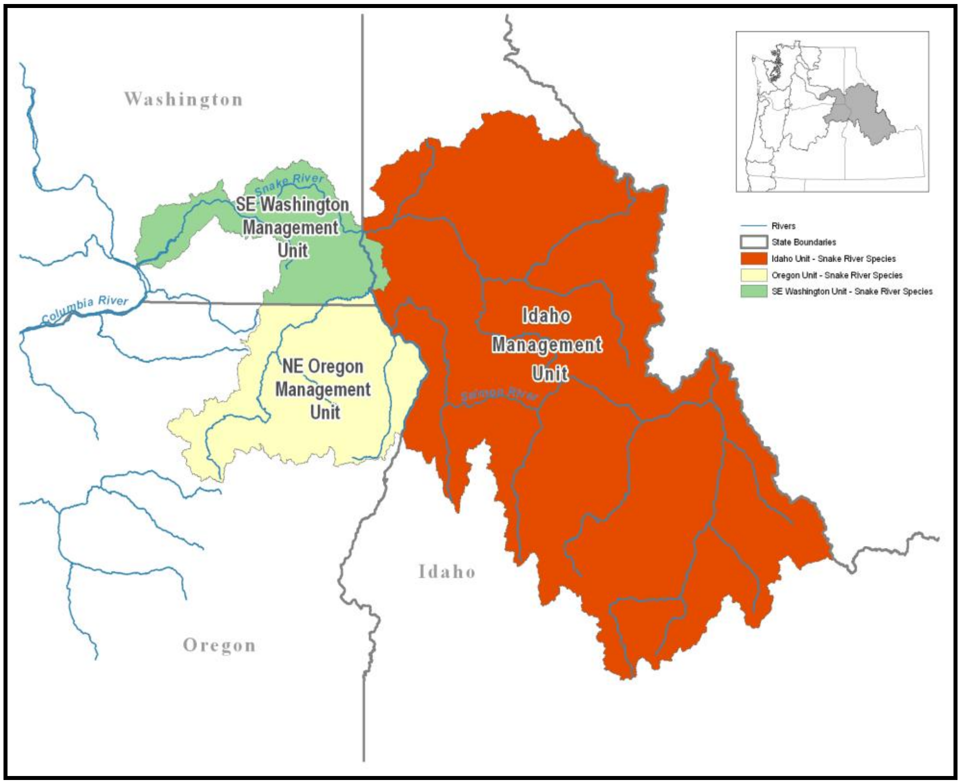


Figure 1-2. Snake River Basin Recovery Sub-Domain displaying the Idaho, Northeast Oregon, and Southeast Washington Management Units. (note that the Walla Walla subbasin is absent from the SEWMU in the figure, but is considered by NMFS, the Washington Governor's Office of Salmon Recovery and the SRSRB to part of the management unit).

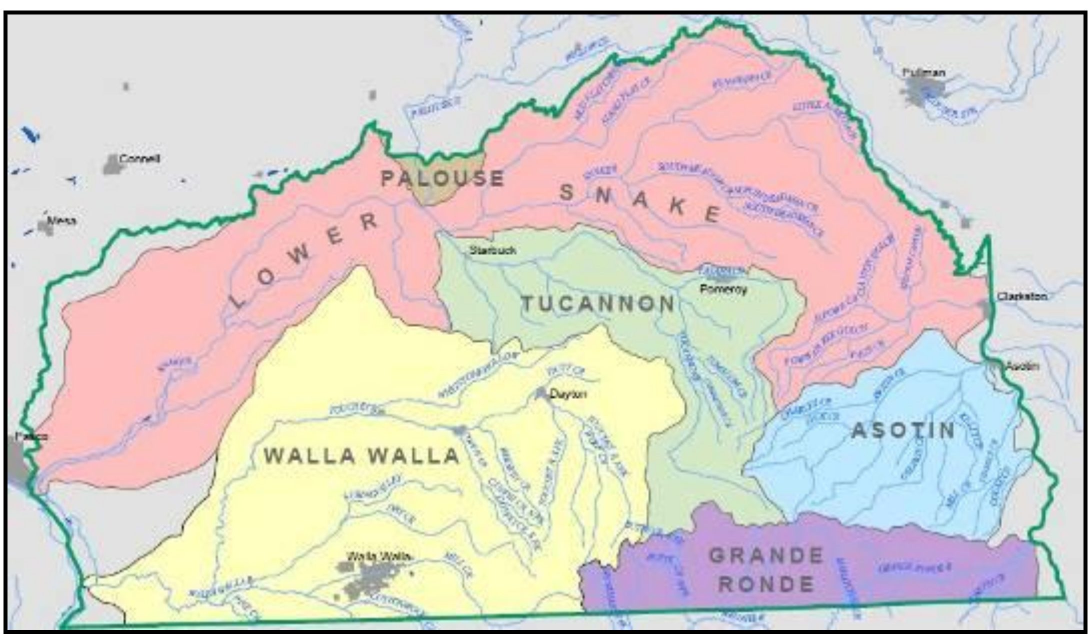


Figure 1-3. Southeast Washington Management Unit.

NMFS has the ultimate responsibility to decide if actions implemented by the salmon recovery domains have successfully restored salmon and steelhead populations to the point where they can be de-listed. NMFS appointed technical recovery teams (TRTs) for each domain to identify independent salmon populations within each ESU, recommend viability criteria, and analyze factors that limit species survival. The TRTs provide the technical basis for recovery plans and advise NMFS and other recovery planners.

For bull trout, the USFWS has the ultimate responsibility to determine when this species has been successfully restored to the point where they can be delisted.

This Plan will be one part of a comprehensive Snake River Basin Sub-Domain Salmon and Steelhead Recovery Plan, coordinated and developed by NMFS and other local stakeholders.

The primary purpose of this recovery plan is to present implementable actions that can lead to the de-listing of populations of salmon, steelhead and bull trout within the SEWMU.

1.3 USE OF THIS PLAN

This plan is to be used to guide federal agencies charged with species recovery. In and of itself, this plan is a non-regulatory document. As such, it is not intended to be nor may it serve as a regulatory document forcing landowner action. Any such regulatory actions deemed necessary as a result of this document must be accompanied by a clear legislative mandate to that end.

The plan may be used to inform state and local agency planning and land use actions, but it may not be deemed to place requirements on such entities. The goal of this plan is to offer options for future actions that strive to secure the survival of species. No mandate on state or local agencies may be construed from this plan, and the plan may not be cited as creating a need for new regulatory actions at the state or local level unless clear legislative authority is first adopted.

1.4 LEAD ENTITY AND PARTICIPANTS

1.4.1 Snake River Salmon Recovery Board

To aid in salmon recovery planning, the state was divided into regions: Snake River, Northeast Washington, Upper Columbia Basin, Middle Columbia Basin, Lower Columbia River, Puget Sound, and the Washington Coast (Figure 1-4). The planning effort in each region is funded by Washington’s Salmon Recovery Funding Board (SRFB) established by the Salmon Recovery Act. Lead Entities were organized as precursors to regional recovery organizations and were locally based committees reliant upon citizen volunteers to provide a framework for restoration of salmon habitat.

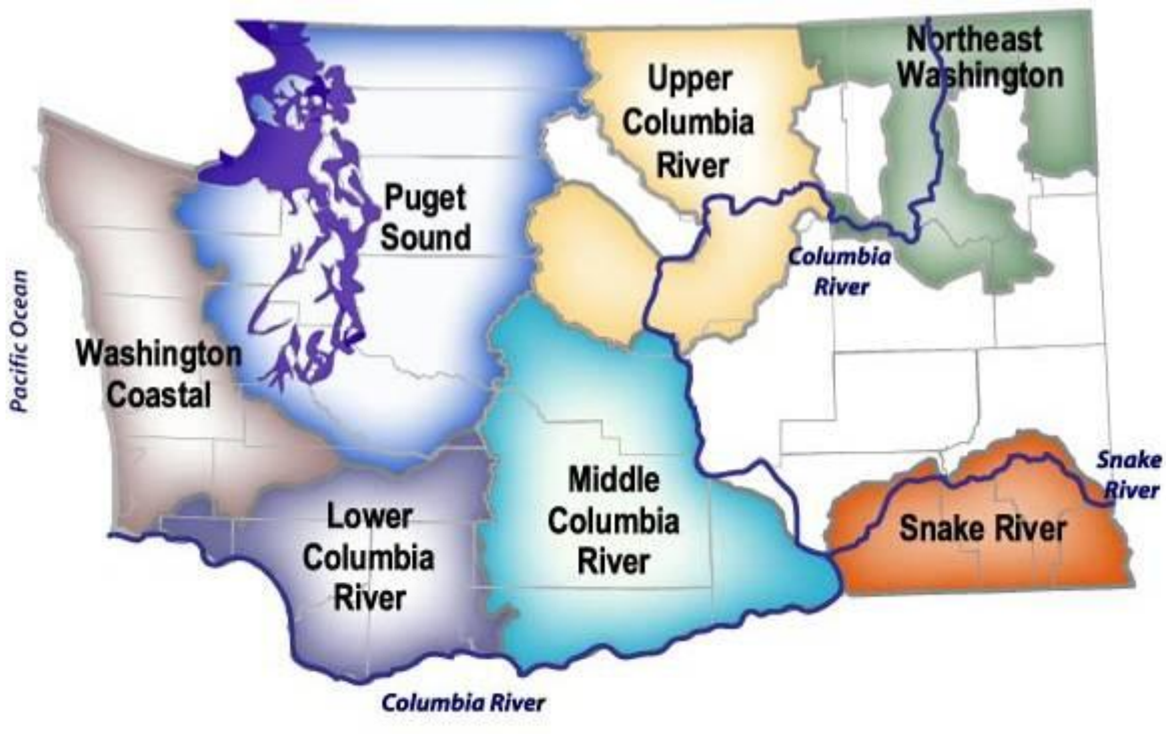


Figure 1-4 State of Washington Salmon SEWMUs

For the Washington State Snake River region (SEWMU), the Lead Entity is the Snake River Salmon Recovery Board (SRSRB). The SRSRB comprises government and tribal representatives, landowners, and private citizens. Table 1-1 shows the list of voting SRSRB members.

Table 1-1 Snake River Salmon Recovery Board

Affiliation	Constituency
Garfield County	Landowner
	Citizen
	County Commisioner
Columbia County	Landowner
	Citizen
	County Commissioner
Asotin County	Landowner
	Citizen
	County Commisioner
CTUIR	Tribal Representative
	Tribal Representative
	Tribal Representative
Whitman County	Landowner
	Citizen
	County Commissioner
Walla Walla County	Landowner
	Irrigation District

Affiliation	Constituency
	County Commissioner

The SRSRB was formed in 2002 after invitations were submitted to more than 150 individuals, organizations, tribes, and government bodies. The invitation was followed by presentations by the state Recovery Planning project manager to better acquaint potential members with the responsibilities and goals of salmon recovery planning.

The Snake River Salmon Recovery Board makes decisions using a consensus-driven process and is committed to implementing a recovery plan that is supported by science and the community.

The Snake River Salmon Recovery Board defined its mission as protection and restoration of salmon habitat, consistent with the recovery plan, for current and future generations. The following recovery priorities were established by the SRSRB.

- Habitat Protection: protect existing high-quality salmonid habitat
    - Recognize and support cooperative, voluntary habitat protection activities and projects
    - Protect key habitat via public education, outreach, and voluntary activities
    - Protect key habitat via market-oriented conservation easements, banking, and/or lease
    - Protect key habitat via purchase by government entities or non-profit land trusts
- Habitat Restoration: restore degraded salmon habitat
    - Continue promoting cooperative, voluntary landowner involvement in habitat restoration activities
    - Restore important habitat consistent with, but not limited to, recommendations in the SRSRB’s Recovery Strategy, Washington Conservation Commission Limiting Factors Analysis, Guidance on Watershed Assessment for Salmon, and Subbasin Summaries
    - Restore important habitat via public education and involvement activities
    - Encourage restoration of important habitat via cost-share funded restoration project
- Public Support/Involvement: Facilitate widespread support for salmonid habitat protection and restoration activities among taxpayers, landowners, civic groups, and businesses
    - Create general public awareness that public funds are being spent effectively and strategically
    - Create interest in public and private habitat protection and restoration assistance from owners of important habitat
    - Create interest among civic groups and businesses to be involved with protection and restoration efforts

In addition, all SRSRB actions “occur with an emphasis on (1) being proactive rather than reactive, (2) providing strategic leadership, (3) looking to the future rather than the past, (4) encouraging diversity in viewpoints, and (5) making collective rather than individual decisions” (Parametrix 2003).

The priorities will guide the development of the SEWMU Recovery Plan. The plan will become the implementing mechanism for salmon, steelhead, and bull trout recovery efforts in the region following its submittal and funding by the Salmon Recovery Funding Board.

1.4.2 Committees and Subcommittees

The SRSRB operates through several committees including the Lead Entity Project Review and Ranking Committee. In addition, the SRSRB has appointed a Regional Technical Team (RTT) to review and provide input to the recovery effort from the technical and scientific standpoints. Figure 1-5 shows the relationship of the SRSRB and various committees. The Executive Committee is responsible for developing broad policy recommendations, guidance, and budgets. These recommendations are referred to the full SRSRB for consideration.

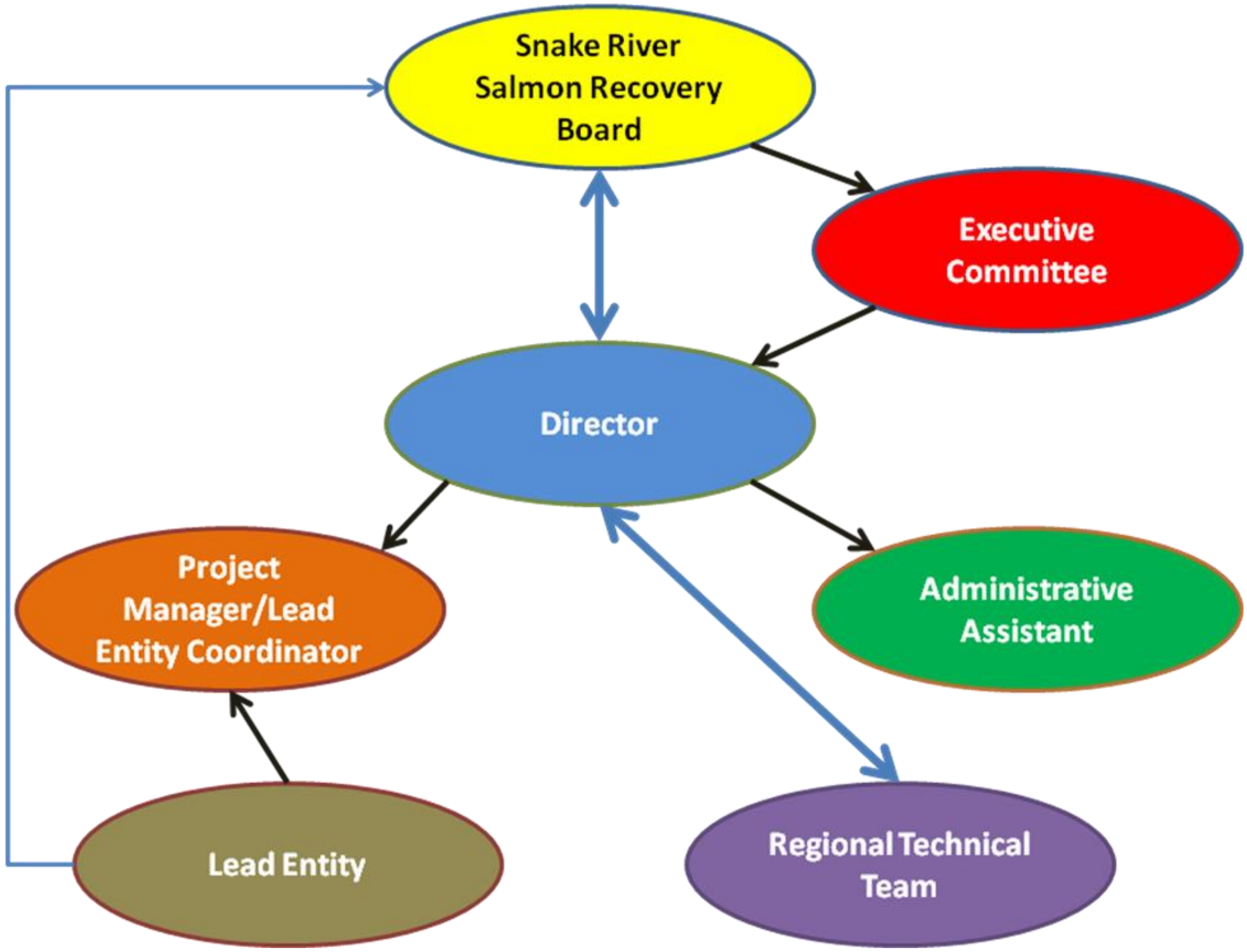


Figure 1-5 Organizational Chart for the Snake River Salmon Recovery Board and Committees

The Lead Entity Project Review and Ranking Committee is responsible for developing a ranked habitat project list for the SRSRB to use in requesting funding from the state-level Salmon Recovery Funding Board. This committee is managed by the Habitat Project Manager and has citizen members and members from the Technical Advisory Committee. The committee's organizational members are Washington Department of Fish and Wildlife, U.S. Forest Service (Pomeroy Ranger District), Washington Department of Ecology, Natural Resources Conservation Service, and the Confederated Tribes of the Umatilla Indian Reservation.

1.4.2.1 Technical Recovery Team

For each domain, NMFS appointed a team of scientists to provide a scientific foundation for recovery plans. The charge of each Technical Recovery Team (TRT) included defining ESU/DPS population structures; characterizing habitat and fish productivity relationships; identifying factors for decline and limiting factors; identifying early factors for recovery; and describing research, monitoring, and evaluation needs. For this plan, the regional TRT is the Interior Columbia TRT (ICTRT), which includes biologists from NMFS, states, tribes, and academic institutions.

1.4.2.2 Regional Technical Team

The SRSRB has appointed a Regional Technical Team (RTT) to review and provide input to the recovery effort from the technical and scientific standpoints. The RTT has reviewed information leading to creation of the plan including the methods and strategies that lead to formulation of salmonid restoration actions. The RTT worked with the SRSRB to ensure that policies and the recovery plan's implementation strategies are based on best available science. Furthermore, it is intended that the RTT will be involved in implementation of the plan as well as monitoring and evaluation. Membership in the RTT consists of the following organizations: Confederated Tribes of the Umatilla Indian Reservation (CTUIR), GSRO, WDFW, U.S. Army Corps of Engineers (USACE), U.S. Forest Service (USFS), NRCS, and NMFS. Currently, the WDOE and NPT are not represented but are encouraged by the SRSRB to participate.

1.5 APPROACH AND COORDINATION WITH OTHER PLANNING PROCESSES

1.5.1 Coordination and Approach

Salmon recovery planning is part of a larger array of planning taking place within the region. Recovery planning must be cognizant of other plans which have been, or are being, formulated and must seek consistency with those plans to the extent possible. The Snake River Salmon Recovery Board considers that the recovery plan is based primarily on the subbasin plans developed by local entities in partial response to the Northwest Power and Conservation Council's Fish and Wildlife Program. Other plans which may affect or be affected by the recovery plan include Habitat Conservation Plans and other documents developed under the ESA, State of Washington habitat preservation programs, conservation reserve enhancement programs, watershed plans, and harvest management plans. Some of these plans are discussed further in Chapter 6. In addition, master plans and comprehensive plans developed by communities, as well as land and water use plans for communities and counties may affect the recovery plan by defining what can and cannot be done to lands and water within certain geographic areas.

Where possible, the recovery plan will coordinate with the goals of other applicable plans. The plan has sought to actively integrate the various planning projects to achieve consistency, to the extent possible, among the plans and to make use of data and information from the other plans. Many of the plans have similar broad goals and objectives, facilitating coordination and communication across planning efforts.

The Snake River Salmon Recovery Board recognizes the importance of a coordinated approach to salmon recovery within its region. To that end, the SRSRB developed an "interlocal" agreement between itself and the affected counties and the CTUIR. The purpose of the agreement is to achieve salmon, steelhead, and bull trout recovery, to the extent possible, through habitat restoration and protection. The SRSRB recognizes that it has no authority or jurisdiction over the land or water within the counties and cannot preempt any jurisdiction or treaty rights, but it intends to work with the counties, the tribes, the State of

Washington, NMFS, and the USFWS to achieve the recovery goals. The SRSRB will strive to ensure that the recovery plan is consistent with local watershed plans, the subbasin plans, and the Environmental Protection Agency's Total Maximum Daily Load criteria.

The SRSRB's primary approach to salmon, steelhead, and bull trout recovery is through habitat restoration and protection through collaboration and coordination of the various interest groups and stakeholders in the SEWMU. The SRSRB believes that hydropower operations, hatchery management, and harvest issues are being addressed in other forums, and while integral for the recovery of SEWMU salmonids, they are outside the purview of the SRSRB. The SRSRB will maintain familairatiy with these processes and forums, and may offer recommendations or persepctives for consideration.

The SRSRB through the RTT prioritized streams for preservation and restoration within the SEWMU and assessed the reasons for salmonid decline within the prioritized streams on a stream-by-stream basis. Projects and programs designed to aid in salmonid recovery will be prioritized on the basis of a project's benefit for salmon recovery and its ability to protect, restore, or enhance treaty reserved resources of the affected Indian tribes and to benefit the citizens of Washington. Economic impact will be considered in designing the prioritization criteria.

1.6 PUBLIC INVOLVEMENT

1.6.1 2004-2006

The public involvement strategy, which was conducted in three phases, resulted in hundreds of agency and public comments. The purpose of Phase 1 was to inform the public about the planning process and to receive public input on the first two plan elements: existing conditions and salmonid assessment (chapters 1.0 and 2.0). This phase took place between May 2004 and September 2004. Phase 2 began in October 2004 and extended through June 2005. Its purpose was to report to the public on the planning process and to receive public comment on the Draft Snake River Salmon Recovery Plan and Draft Public Summary. Phase three or the "transition phase" occurred between July 2005 and October 2005. During the transition period, additional agency and public comment was procured and incorporated into the June 2005 version of the plan. The October 2005 version of the plan received additional agency and public comments and the updated versionwas completed in December 2006.

The website, www.snakeriverboard.org, includes information about the planning process and schedule and outlines ways in which the public can be involved in the process. It also provides specific information about the planning elements and related planning processes. SRSRB meeting times and locations, SRSRB meeting minutes, drafts of plan elements, and planning updates were posted on the site.

Paid advertisements ran in several area newspapers at various times throughout the initial planning process during development of the 2005 Plan: *Walla Walla Union Bulletin*, *Waitsburg Times*, *Dayton Chronicle*, *The East Washingtonian*, *Lewiston Tribune*, *Whitman County Gazette*, *The Daily Bulletin*, and the *Moscow-Pullman Daily News*. The advertisements gave an overview of the planning process and informed the public that portions of the plan were available for review. Press releases aimed at advertising the public workshops were also sent to the newspapers, 19 radio stations, and four television stations in the area.

In August and September 2004, public displays were set up at the Columbia and Walla Walla county fairs. The displays provided recovery planning information and information about public workshops related to early stages of the planning process. In addition, brochures about recovery planning were made available to those who passed by the display booths.

SRSRB meetings are held in Dayton, Washington, and are open to the public. The meetings are advertised on the website and approved minutes are posted to the website.

In Phase 1, four public workshops were held in September 2004 in Clarkston, Pomeroy, Walla Walla, and Dayton, Washington. All the workshops were held in the evening with a staffed "open house" followed by a short Power Point presentation and comment period. These workshops were held to provide general information on the plan and the planning process and to provide the public with an opportunity to ask questions and provide input. Workshops were held in April 2005 in Clarkston, Walla Walla, and Dayton during Phase 2. Specific information was provided about each chapter of the draft plan and the public was given an opportunity to comment.

In addition to the workshops, a regional salmon summit was held in March 2005 in Dayton. The purpose of the summit was to update regional stakeholders on the salmon recovery planning process, generate discussion on the draft recovery plan, and provide other entities involved in salmon recovery activities within the region the opportunity to share the results of their efforts.

A "speakers' bureau" was offered by the SRSRB staff. The staff contacted groups within the SEWMU which were considered to have a particular interest in the salmon recovery plan. Several of these requested presentations by the SRSRB staff during the early portions of the planning process.

1.6.2 2006-Present

The SRSRB has met in open public meetings monthly since 2005 and notification of those open public meeting are provided in newspapers, announced in partner newsletters and correspondances (Conservation Districts, WDFW, Watershed Planning Units, regional fisheries enhancement group, etc) to engage the public in the process and decisions of the SRSRB. The Director and Project Manager participate in myriad public meetings and informal meetings with the Boards of County Commissioners, CTUIR, Watershd Planing Units, RFEG, cattleman's ssociation, wheat growers, Kiwanis, Rotary, Exchange Club and other organizaitons to ensure community understanding of the Salmon Recovery Plan. Outreach to state and federal agencies through meetings with policy leads and collaboration in local work groups on pertinent topics has and continues to occur on a frequent basis.

2 DESCRIPTION OF SOUTHEAST WASHINGTON MANAGEMENT UNIT

Chapter 2.0 contains a brief overview of the physical, environmental, and human aspects of the SEWMU so that planning for salmon recovery can be understood within the broad context of the region's economy, environment, and culture.

2.1 HISTORY, CULTURE, AND ECONOMY

Prior to contact with European settlers, the area was inhabited by various native peoples, including the Nez Perce (Nimi'ipuu), Cayuse, Yakama, Umatilla, and Walla Walla tribes (Nez Perce Tribe 2002; Confederated Tribes of the Umatilla Indian Reservation 2004). The native people harvested fish from the Snake and Columbia rivers and their tributaries, and hunted elk, deer, bear, and waterfowl. The lower Snake, Asotin, Walla Walla, Grande Ronde, and Tucannon rivers are still of particular historic and cultural importance to the native people of the area.

The Lewis and Clark expedition (1803-1805) traveled through this area and opened the door to an influx of settlers from the United States (Asotin County 1997; Dayton, Washington 2004; Pasco, Washington

2003). Marcus and Narcissa Whitman came to the Walla Walla Valley in 1836 to minister to the Cayuse and Nez Perce people (Walla Walla Valley Chamber of Commerce 2002). By the 1840s, the Oregon Trail was established; by 1860, settlers had arrived in the Pacific Northwest in great numbers. Some were lured by gold, but many stayed in the southeast area of Washington to take advantage of its agricultural opportunities (Walla Walla Valley Chamber of Commerce 2002). Wheat was an important crop throughout the Pacific Northwest, with much of the grain going via river and ocean to the rapidly growing settlements in California as well as to Asia (Robbins 1997). The Snake and Columbia rivers became important transportation corridors from southeast Washington to the Pacific Ocean.

Today, the economy of the SEWMU is still primarily dependent upon agriculture (Asotin County 1997; Dayton, Washington 2004; Pasco, Washington 2003; Walla Walla County 2004; Walla Walla Valley Chamber of Commerce 2002; Whitman County 2003). The primary agricultural products in the Walla Walla subbasin portion of the SEWMU are spring wheat, winter wheat, and barley. Peas and lentils are grown as well as apples, cherries, asparagus, potatoes, onions, alfalfa, and wine grapes. Walla Walla sweet onions, developed in this area, are internationally known. Walla Walla and Columbia counties support a significant number of cattle. In addition, Walla Walla County boasts two of the world's largest farms: Snake River Vineyard is the world's largest Concord grape vineyard and Broetje Orchards is the world's largest apple orchard (Walla Walla Valley Chamber of Commerce 2002). Agricultural products, particularly wheat, are still transported by barge down the Snake and Columbia rivers to Portland, Oregon where they are exported to international markets.

Other economic factors include industry (primarily related to agriculture), education, recreation and tourism, and government. Whitman College and Walla Walla College are located in Walla Walla and College Place, respectively (Walla Walla County 2004) and Walla Walla Community College has facilities in Walla Walla and Clarkston. Washington State University is located in Pullman (Pullman, Washington 2003). In many communities, the largest employers are the school districts and various government entities (State of Washington 2004).

Tourism is centered on the region's natural and historical attributes. Sites of historic interest are found throughout the SEWMU. For example, the Whitman Mission National Historical Site and Fort Walla Walla are located near Walla Walla (Walla Walla Valley Chamber of Commerce 2002). Dayton boasts 117 buildings listed on the National Historic Register (Dayton, Washington 2004). The Lewis and Clark expedition is commemorated throughout the region; a number of parks and memorials are found along their original route (Dayton, Washington 2004; Pasco, Washington 2003).

Boating on the rivers and reservoirs is an important recreational activity and skiing and snowmobiling in the Blue Mountains are attractions for winter visitors (Dayton, Washington 2004; Pullman, Washington 2003). Touring wineries is an important draw in Walla Walla County as are local festivals including automobile shows, horse races and rodeos, and hot air balloon events (Dayton, Washington 2004; Walla Walla Valley Chamber of Commerce 2002; Walla Walla County 2003).

Hunting and sport fishing also bring visitors to the area. Deer, elk, and upland game birds are important species to hunters. The Snake River reservoirs are the most popular fishing areas and support a major year-round fishery. Hatchery-reared steelhead and salmon are released into the Snake River and tributaries and have made the "Snake one of the best steelhead rivers in the state" (WDFW 2003). In a recent assessment conducted by WDFW, it is estimated that the steelhead fishery generates $50 million annually on the Snake River and when spring Chinook salmon fisheries occur, another $5 million is generagted withing the SEWMU. Expanded fisheries are anticipated with the re-introduction of spring Chinook salmon in the Walla Walla River and as the abundance of wild salmon increases, we anticipate increased fishing opportunity. Recreational fisheries are an economic driver in the SEWMU area. Warm water species, including smallmouth bass, channel catfish, and some sturgeon, are caught in the sloughs and backwaters of the Snake River. The Grande Ronde River in Asotin County provides hatchery steelhead as well as smallmouth bass and channel catfish. Fishing for stocked rainbow trout takes place at various ponds throughout the SEWMU. Closures and gear restrictions are in place on most of the major rivers and streams to protect native populations of steelhead and salmon.

2.2 GEOGRAPHY

The SEWMU is located in the southeast corner of the State of Washington (Figure 1-3). The region is generally bounded by the Washington/Oregon state line on the south, the Columbia River (to the confluence with the Snake River) on the west, the Snake River (includes southern flowing tributaries, including the Palouse River (downstream of the falls), Alkali Flats Creek, Penawawa Creek, and Almota Creek) on the north, and the Snake River on the east (Figure 1-3).

The region is generally characterized by rolling, semi-arid lands flanked by the forested Blue Mountains in the south. The major rivers draining the area are the Snake, the Grande Ronde, and the Tucannon, the Walla Walla, and Asotin Creek. Elevations at the Snake River range from approximately 400 to 500 feet near its confluence with the Columbia River to around 750 feet near Clarkston on the east side of the SEWMU. Peaks reaching above 6,000 feet in elevation are found in the Blue Mountains.

Many of the cities and towns of the SEWMU are located along or near rivers and streams. Clarkston, on the eastern boundary, is near the confluence of the Snake and Clearwater rivers. Pasco and Burbank, which lie just outside the SEWMU’s western boundary, is on the bank of the Columbia River near its confluence with the Snake. The Cities of Walla Walla and College Place occupy the fertile valley of the Walla Walla River. The town of Touchet is along the Touchet River near its mouth. Waitsburg is at the confluence of the Touchet and Coppei creeks, Pomeroy is located on Pataha Creek, and the City of Dayton is near the confluence of the South and East forks of the Touchet River. Clarkston is located on the mainstem Snake River opposite of the confluence of the Clearwater and Snake rivers. Asotin is located 3 miles south of Clarkston on the west bank of the Snake River. The Snake River provides transportation for many of the region’s products which are barged downstream to the lower Columbia River ports for transshipment to national and international destinations. In addition, the region is connected internally and externally by an extensive system of highways and railroads.

2.3 CLIMATE

The region’s climate is influenced by the Cascade Mountains, the Pacific Ocean, and the prevailing westerly winds. The Cascades intercept the maritime air masses as they move eastward, creating a rain shadow effect that reaches as far as the Blue Mountains. The results are warm and semi-arid conditions in the lower elevations of the SEWMU to cool and relatively wet in the higher elevations. In the semi-arid portions of the SEWMU, the annual precipitation is less than 15 inches per year while some areas in the eastern portion of the region receive as little as 5 inches of rain per year. Rainfall in the Blue Mountains can be 45 inches or more (Whiteman et al. 1994). Ninety percent of the precipitation occurs between September and May with 30 percent of winter precipitation falling as snow. Snowfall at elevations less than 1,500 feet seldom lingers beyond three or four weeks, occasionally melting quickly enough to produce severe erosion. Temperatures can range from -20°F in the winter to 105°F in the summer. The growing season in the SEWMU is 115 to 155 days.

2.4 GEOLOGY

The SEWMU is located within the Columbia River Plateau and is underlain by thick layers of basalt of the Columbia River Basalts Group (Drost and Whiteman 1990). The topography of this area is largely defined by structures which have resulted from faulting, folding, and erosion of the basalts. The SEWMU is dissected by several rivers, including the Snake River, which is a major tributary to the Columbia River, and tributaries to the Snake River.

Basalts are rocks that usually originate as lava flows. The Columbia River Basalts erupted from volcanoes between 6 million and 17 million years ago. The resulting basalt layers have a combined thickness of many thousands of feet and form many of the topographic features of the Pacific Northwest, including the rimrock along Hells Canyon and the cliffs of the Columbia River Gorge (Bishop 2003). The Blue Mountains were island arcs which arose, sank, and reappeared over geologic time. At times in their history, the Blue Mountains rotated as much as 170 degrees from their original position; these movements resulted in the basalt layers being compressed and twisted. Combined with erosion from the catastrophic floods which spread across the area at the end of the Pleistocene era (10,000 to 20,000 years ago), the movement of the rock layers formed many of the landscape features that exist today in southeastern Washington.

Sediments (sands, gravels, silts, and clays) deposited by rivers, streams, and volcanoes lie on top of the Columbia River Basalts. The thickest sediment layers (hundreds of feet) are found where material was deposited in the low-lying portions of folded basalts (Drost and Whiteman 1990). More localized deposits occur along rivers and streams.

The SEWMU lies within three physiographic provinces defined by their geologic structures: the Yakima Fold Belt, Blue Mountains, and Palouse provinces (Drost and Whiteman 1990). The Yakima Fold Belt includes the southwest corner of the SEWMU and is characterized by a series of east-west trending ridges and basins. The Walla Walla subbasin is situated in a down-warped fold within this province.

The south-central portion of the region lies within the Blue Mountain province. The Blue Mountains are formed by a broad northeast-trending up-folded arch, reaching elevations over 6,000 feet. Within the SEWMU, the basalts slope from the crest of the Blue Mountains to the north and northwest. Uplift of the basalts in this area has resulted in high plateaus deeply dissected by narrow V-shaped streams. Streams and rivers originating in the Blue Mountains include Asotin Creek, Tucannon River, Walla Walla River, and Touchet River.

The northern and extreme southeastern portions of the SEWMU lie within the Palouse province, which is characterized by gently southwest-sloping basalt flows covered with a veneer of loess (silty soils deposited by wind). This area, which is drained by the Palouse River, is part of the channeled scablands that were scoured by massive floods of water released during multiple ice dam ruptures of great glacial lakes (the Missoula Floods) which occurred at the end of the Ice Age. The loess deposits, which are over 100 feet thick in places, were formed when wind redistributed the silt derived from the floods into a mantle of soil over the basalts.

2.5 HYDROLOGY

2.5.1 Surface Water

The Snake River originates in Idaho and Wyoming, enters Washington at the far southeast corner of the state and forms the border with Idaho. It then turns west and flows over 100 miles until it joins the Columbia River near Pasco, Washington. Figure 2-1 shows hydrologic features in the SEWMU, including the Snake River and its tributaries and reservoirs formed by the Snake River dams.

2.5.2 Rivers and Streams

Major tributaries to the Snake River in Washington include Asotin Creek and the Tucannon, Grande Ronde, and Palouse rivers. The Walla Walla River flows directly into the Columbia River just downstream of the Snake River. The SEWMU covers approximately 4,300 square miles and is divided into the following Water Resource Inventory Areas - WRIAs.

- Lower Snake River Watershed (WRIA 33)
- Middle Snake River Watershed, including the lower six miles of the Palouse River (WRIA 35)
- Walla Walla River Watershed (WRIA 32)

The area of each WRIA is given in Table 2-1; details of each are described below.

Table 2-1 Area of Drainage Basins within the SEWMU

Watershed	WRIA #	Drainage Area within Washington State
Walla Walla	32	1,283 square miles
Lower Snake	33	722 square miles
Middle Snake (including Palouse below Palouse Falls)	35, 34	2,250 square miles

Source: Kuttel, Jr. 2001, 2002.

2.5.2.1 Walla Walla River Watershed:

The Walla Walla River originates in the Blue Mountains at an elevation of approximately 6,250 feet. It flows north from the Blue Mountains and enters Washington State just north of Milton-Freewater, Oregon. Primary tributaries to the Walla Walla River include the Touchet River and Mill, Birch, Cottonwood, Mud, Russell, Yellowhawk, and Dry creeks. The Touchet River drains a majority of the northern portion of the Walla Walla watershed. Mill Creek and its primary tributary, Blue Creek, drain a significant area in the southern and southeastern portions of the watershed. Mill Creek begins in the forested uplands, dips south into Oregon, and returns to Washington where it passes through the City of Walla Walla. The total drainage area of the Walla Walla River near the Touchet is 1,657 square miles and the average annual runoff is 462,000 acre-feet/year (Saul et al. 2001). The amount and timing of precipitation in the Washington portion of the Walla Walla watershed varies. When temperatures warm in the spring, rain and snow melt supplement the dwindling precipitation to maintain high flows and occasional flooding. Most flooding results from rain-on-snow events in the late winter and early spring. As precipitation wanes in early summer, large intermittent streams dry up, reducing the drainage network to the streams flowing out of the Blue Mountains. Low flows are due to both natural variability and human water use.

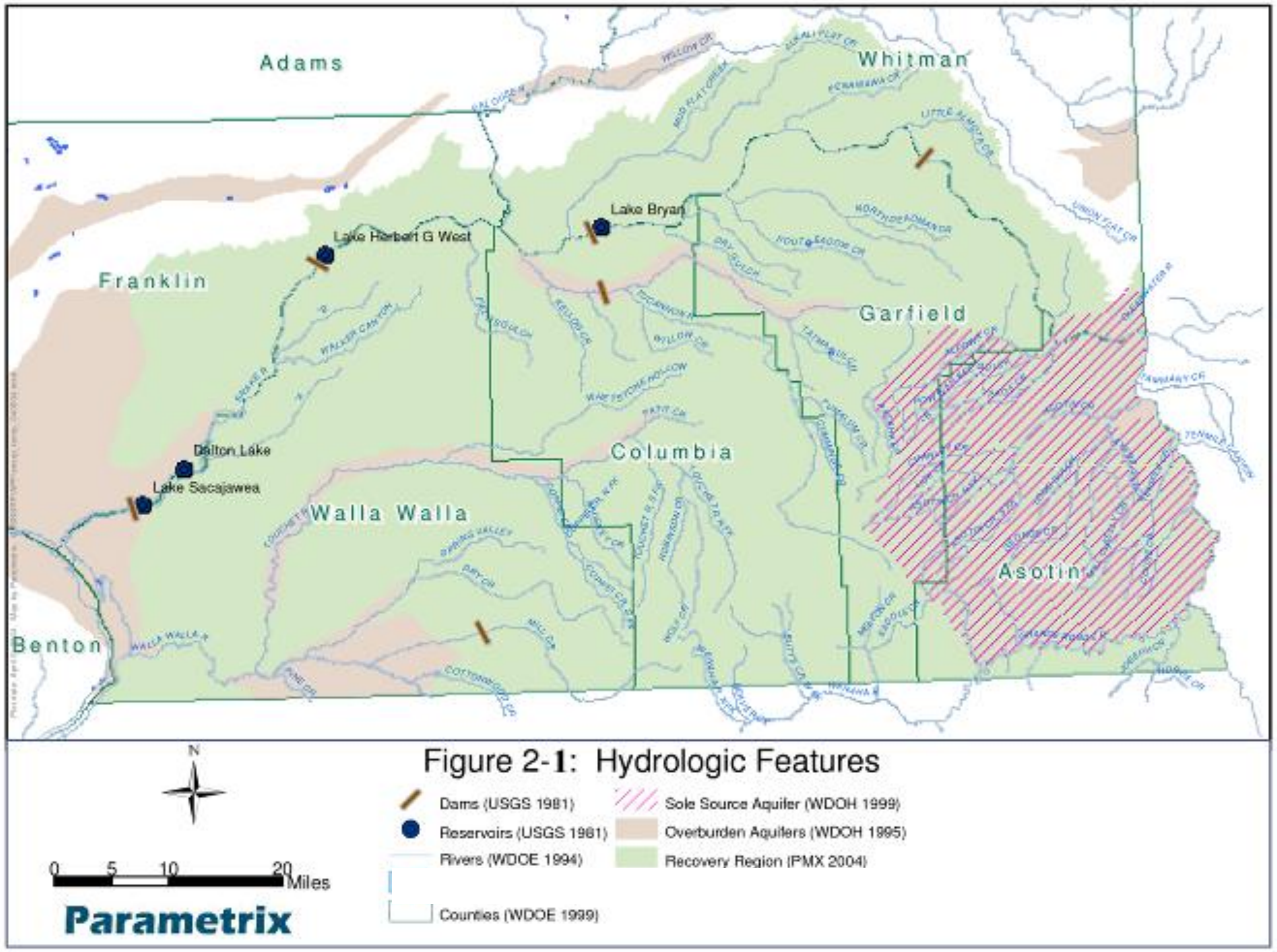


Figure 2-1 Hydrologic Features within the Southeast Washington Recovery Management Unit.

2.5.2.2 Lower Snake River Watershed:

The Lower Snake River watershed begins at the confluence of the Palouse and Snake rivers, extending downstream to the mouth of the Snake River at the Columbia River. The basin covers approximately 722 square miles (Kuttel, Jr. 2002) and encompasses portions of Columbia, Franklin, and Walla Walla counties. There are no perennial tributaries in the Lower Snake River Watershed.

2.5.2.3 Middle Snake Watershed including the Palouse River below Palouse Falls:

The Middle Snake watershed encompasses the entire Snake River mainstem from the Oregon-Washington border downstream to the Palouse River, an area of approximately 2,250 square miles (Kuttel, Jr. 2002). The Middle Snake subbasin includes several streams: Grande Ronde River, Tenmile-Couse Creek, Asotin Creek, Tucannon River, and the lower six miles of the Palouse River. As in the Lower Snake Basin, intermittent and/or ephemeral streams are present throughout the watershed, and these streams flowing down steep canyons can carry large debris loads during storm events.

Tributaries to the Snake River that have perennial flow include streams draining the north side (Alkali Flat, Penawawa, Almota, Wawawai, and Steptoe Canyon creeks), and streams draining the south side (Alpowa, Deadman, and Meadow creeks). These streams generally drain an arid landscape. The Deadman watershed encompasses the watersheds of Alpowa, Deadman, and Meadow creeks (approximately 336 square miles) (Kuttel, Jr. 2002). Alpowa Creek originates from springs at the northeast terminus of the Blue Mountains at an elevation of 3,280 feet and terminates at the Snake River at RM 131 at about 740 feet in elevation. Deadman and Meadow creeks flow from springs in the Palouse hills south of the Snake River and north of US Highway 12. Both enter the Snake River at RM 83 near State Route 127. The topography of this watershed is characterized by deep v-shaped valleys in headwater areas, gradually widening into relatively broad valley bottoms on the mainstem of each stream. Intermittent and/or ephemeral streams are typically present throughout the watershed. These streams flow down very steep canyons and, under typical conditions, do not convey much water; however, during thunderstorms or rain-on-snow events they are capable of carrying large volumes of water and debris. The sediment-moving capacity of these small streams is easily seen in the extensive alluvial fans deposited at their mouths. Maximum stream flow occurs in the spring during snowmelt and minimum stream flow occurs during summer and early fall. Summer base flow is contributed by springs.

The Tenmile-Couse drainage encompasses Tenmile (approximately 42 square miles) and Couse (approximately 26 square miles) creeks and all tributaries. These creeks originate in the foothills of the northeast portion of the Blue Mountains. Tenmile and Couse creeks enter the Snake River at RM 150 (1,100 feet elevation) and RM 158 (1,200 feet elevation), respectively.

The Asotin subbasin encompasses Asotin Creek in its entirety and all tributaries (approximately 326 square miles). Asotin Creek originates high in the northeast portion of the Blue Mountains at an elevation of 6,200 feet and terminates at RM 145 of the Snake River, about 800 feet in elevation. It has two major drainages: the mainstem and George Creek. Much of Asotin Creek has been straightened, diked, or channelized (Asotin County Conservation District 2001). Efforts are underway to work with local landowners to restore sinuosity to portions of the creek.

The Tucannon subbasin encompasses the entire Tucannon River and all tributaries (approximately 502 square miles). The stream system originates high in the northeast portion of the Blue Mountains at an elevation of 6,234 feet and terminates at RM 62 on the Snake River, at about 540 feet in elevation.

Tributaries to the Tucannon include Bear Creek, Sheep Creek, Cold Creek, Panjab Creek, Turkey Creek, Meadow Creek, Little Tucannon River, Hixon Creek, Cummings Creek, Tumalum Creek, Pataha Creek, Kellogg Creek, and Smith Hollow Creek.

The Grande Ronde subbasin encompasses the Grande Ronde River and its tributaries (approximately 340 square miles). The subbasin contains perennial and intermittent and/or ephemeral streams. The Grande Ronde originates in the Blue Mountains at an elevation of 6,380 feet and terminates at the Snake River at RM 168.7 at about 1,400 feet elevation. The major tributary to the Grande Ronde is the Wenaha River.

The Palouse River below Palouse Falls flows through a deep canyon cut through the Columbia River Basalts during the torrential Spokane Floods that occurred during the Pleistocene time period. Palouse Falls are located six miles upstream from the river's mouth. The falls' 185-foot height presents an impassable barrier to salmon, preventing them from entering Cow Creek, Rock Creek, Rebel Flat Creek, and the South Fork of the Palouse River.

Reservoirs

The hydrology along the Snake River has been severely altered by the installation of hydroelectric dams. The dams operated by the USACE include Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams in Washington (Section 2.9). Several other dams are present in the SEWMU, including the Starbuck Dam along the Tucannon River, Hofer Dam in the lower Touchet, Dayton Dam in Dayton, City of Walla Walla intake dam in upper Mill Creek in Oregon, Headgate Dam in Asotin Creek, Burlingame Dam in the Walla Walla River near Walla Walla, and the Mill Creek Project (Bennington Dam) in Mill Creek upstream of the City of Walla Walla.

The dams on the Lower Snake River and McNary Dam downstream on the Columbia River impound the water of the Snake River in reservoirs. All the lower Snake River reservoirs share the same general shape; they are typically shallow with an average depth ranging from 48 to 57 feet deep. The reservoirs generally fill the width of the steep-sided canyons. The pooled reaches represent about 83 percent of the Snake River from the mouth upstream to the Washington-Idaho border (Kuttel, Jr. 2002).

Wetlands

The vast majority of wetlands in the SEWMU are associated with streams and rivers, although there are also a few isolated wetlands dispersed through the croplands. Areas with the fewest wetlands are the steep portions of the Blue Mountains and areas with few rivers and streams. Using the USFWS (Cowardin) vegetation-based classification system, the wetlands within the SEWMU primarily fall into three categories: riverine, palustrine, and lacustrine (USFWS no date). Riverine wetlands are found along rivers and streams while lacustrine wetlands are associated with lakes and reservoirs. Palustrine wetlands in this area include shrub-scrub and emergent vegetation types.

Wetland functions are often evaluated using the hydrogeomorphic (HGM) method. An HGM classification system has been developed for the Columbia River Basin within the SEWMU, excluding the Blue Mountains. Wetlands within the SEWMU fall into the HGM classifications of depressional, riverine, slope, and lacustrine fringe (Hruby et al. 2000).

Depressional wetlands occur in topographic depressions and may be isolated from other water bodies. Often there is no surface water inflow to the wetland or outflow from defined channels although this type of wetland may have intermittent surface water flows connecting to other surface waters. Many depressional wetlands gain water during the drier months through agricultural irrigation. The predominant source of water in the Columbia Basin for depressional wetlands is groundwater discharge. Freshwater and alkali depressional wetlands are both present in the Basin.

Riverine systems occur in topographic features such as canyons, floodplains, and riparian corridors associated with rivers and steams. This type of wetland is sustained primarily by direct inflow of surface water either in channels or as overflows from channels. Slope wetlands consist of sites with groundwater-dominated hydrologic regimes. Although the Columbia Basin does not contain many slope wetlands, there are likely some in the Blue Mountains. Lacustrine fringe wetlands are found along the margins of lakes and reservoirs. The water tables of lacustrine sites are maintained primarily by the water elevation of the adjoining lake.

Natural wetlands within the SEWMU have been altered by human development activities such as agriculture, logging, and the spread of noxious weeds. Activities that have negatively impacted wetlands include livestock grazing, road building, and draining for agricultural development. Wetlands may also have been lost in areas where stream channelization has taken place. It has been estimated that as much as 98 percent of the natural wetlands in the Palouse subbasin have been drained or altered (Palouse-Rock Lake Conservation District 2001).

Water Availability

The Snake River supplies about 20 percent of the Columbia River flow. While Snake River flows are controlled by the hydropower system, smaller tributaries are highly variable with seasonal high flows coinciding with winter precipitation and spring snowmelt. Summer base flows in Snake River tributaries, e.g., Asotin Creek, Touchet River, and Tucannon River, average approximately 20 to 25 percent of peak winter/spring flows (Columbia Conservation District 2001; Economic & Engineering Services 2002). Many smaller salmonid-bearing streams, such as Patit Creek in Columbia County and Pataha Creek in Garfield County, can go dry in summer months in their lower reaches (Columbia Conservation District 2001; Asotin County Conservation District 2001; Economic and Engineering Services 2002).

In addition to hydropower installations, other activities, such as water withdrawal for irrigation, have had substantial impacts on the mainstem Snake River as well as some of its tributaries. Land has been developed for irrigated agriculture along the Snake, Walla Walla, Touchet and Tucannon rivers, Asotin Creek, and in the Lower Snake River basin (Bauer and Vaccaro 1990). Natural groundwater recharge and discharge patterns have been modified by groundwater pumpage and surface water diversion for irrigation. Most irrigation water withdrawals occur during the summer dry months when precipitation is lowest and demand for water is the greatest.

Irrigation withdrawals have reduced flows in the Walla Walla, Touchet, Grande Ronde, and to a much lesser extent, the Tucannon river, and Asotin Creek (Forks to mouth), Tucannon River tributaries of Pataha Creek, and the Snake River tributaries of Steptoe, Wawawai, Almota, Little Almota, Penawawa, and Alkali Flat creeks.

Many floodplains in the SEWMU have been altered by channelization to reduce flooding and by clearing to convert land to agricultural and residential uses. Flood control structures have been constructed on a number of streams and rivers, including the Touchet, Tucannon, and Walla Walla rivers and Asotin Creek. These have accelerated surface water runoff and decreased groundwater recharge, contributing to lower summer stream flows. Road construction, overgrazing, and removal of vegetation in floodplain areas have also caused bank erosion, resulting in wide channels that increase the severity of low summer flows.

Reports prepared during the WRIA planning process indicate that natural flow regimes appear to be present on some streams. In WRIAs 33, 34, and 35, these include Couse Creek, North Fork Asotin Creek, North and South Forks of Asotin, Charley Creek, George Creek, Pintler Creek, Pataha Creek (Kuttel, Jr. 2002). The natural flow regime seems to be present also within these Grande Ronde River fish-bearing tributaries in Washington: Joseph, Schumaker, Deer, Buford, Rattlesnake, Cottonwood, Bear, Cougar, Menatchee, Grouse, Crooked, Butte, and Beaver creeks, and the North Fork Wenaha River. In WRIA 32, natural flow regimes appear to be present in the North Fork Touchet River above Lewis Creek, and the upper portion of Mill Creek (Kuttel, Jr. 2001). The upper portion of Mill Creek is protected by the Mill Creek watershed and has been closed to public entry since 1954.

Table 2-2 lists the factors that influence water availability for streams and rivers in the SEWMU whose flow regimes appear to have been altered.

Table 2-2 Current Flow Regimes within the Southeast Washington Recovery Management Unit

Watershed	Description of Flow Regime
Walla Walla River	Surface water from numerous streams in the Washington portion of the basin is over-appropriated. These streams have been closed to further consumptive appropriations since 1977. Many stream reaches have also been altered by diking, diversion, and/or channelization. A settlement between the irrigation districts and USFWS in 2000 has improved the flow conditions and progress to improve stream flows by implementing irrigation efficiencies (center pivots, piping ditches, etc) is being made.
Touchet River	The entire Touchet River has been closed to further consumptive appropriations of surface water between June 1 and October 1 since 1977. Low and/or subsurface summer flows have likely been affected by surface water diversions, land management practices (timber harvest, road construction) and floodplain development.
Grande Ronde River	Irrigation withdrawals in the Oregon portion of the Grande Ronde have substantially reduced flows downstream in Washington. Flows generally get very low during the summer and early fall, partly the result of natural climate and partly due to irrigation diversions in the upper watershed.
Joseph Creek	Joseph Creek (a 234 square mile watershed) yields significant higher streamflows than the other study streams, and irrigation withdrawals do not appear to exert an impact on the system. The headwaters are heavily forested.
Tenmile Creek	A constructed pond on upper Tenmile Creek may dampen flood peaks downstream and reduce sediment inputs. (Ullman & Barber 2009) Tenmile is a 42 square mile intermittent stream that is significantly water-limited but sustains a steelhead population. The headwaters are not wooded and this is an arid, low rainfall area with natural low summer flows.
Tucannon River	Irrigation has lowered stream flows and contributed to increased summer water temperatures in some areas, but not to the extent found in the Walla Walla watershed and most of the irrigation practices are highly efficient; more than 10 cfs has been trusted through the irrigation efficiency program.
Asotin Creek, forks to below the mouth of George Creek	A total of 5 cfs for irrigated agriculture water rights are diverted from this 201 square mile watershed (excludes George Creek). Not all senior water right holders are exercising their full water rights and natural low flows due to a low elevation, arid, and low rainfall conditions contribute more to summer low flows than the potential 5 cfs of irrigated ag in the lower 4 miles of the mainstem of Asotin Creek near the mouth with the Snake River.

Watershed	Description of Flow Regime
George Creek	George Creek presents and excellent illustration of an intermittent stream being able to produce vibrant steelhead populations. The system is naturally water limited, with less than 2 acres of irrigation in the lower 1 mile of the mainstem. George Creek is a very steep V-shaped valley with an arid, low rainfall regime (less than 9 inches in more than ¾ of the watershed). The George Creek watershed is 124 square miles with forested headwaters.
Alpowa Creek	Alpowa Creek is somewhat unique in that the headwaters are not wooded like other streams in the SEWMU. The entire 107 square mile watershed is either grazed or farmed. The system has likely become more prone to flash floods due to these changes and to the use of irrigation in the lower Alpowa. Alpowa is mostly spring flow and maintains a continuous flow year-round (according to Ullman and Barber (2009)) and has the most uniform flows measured in their study.
Meadow, North and South Deadman creeks	Deadman Creek, (a 135 square mile watershed) has been significantly impacted by multiple stressors and a recent emphasis on conservation practices in the watershed is just starting to elicit a response. It remains unknown to what degree the flow regime has changed, but evidence indicates other factors likely played a larger role in the systemic degradation of the stream. Irrigation activities do not appear to exert a noticeable effect on streamflow, but the recent invasion of noxious weeds in the riparian zone has been implicated in altering stream hydrology.
Pataha Creek	Pataha Creek, (a 185 square mile watershed) has been significantly impacted by multiple stresssors including logging, grazing, agriculture and urbanization. It has been straightened which has reduced its length and encouraged incision. The floodplain is largely perched above the incised channel, making riparian restoration difficult. Sediment is a major limiting factor along with naturally low stream flows and lack of channel complexity. Only a limited number of surface water irrigation activiites (less than 200 acres) affect flow.
Snake River fish-bearing tributaries: Steptoe, Wawawai, Almota, Little Almota, Penawawa, and Alkali Flat creeks	Conversion of native prairie vegetation to largely agricultural production is suspected to have altered the flow regime, although the effect has not been quantified. All these stream systems are located in arid, low rainfall areas and their headwaters have no forested areas and are extremely steep V-shaped valleys. WDFW is in the process of documenting steelhead use.
Couse Creek	Couse Creek epitomizes the paradox found in the Middle Snake watershed, wherein sustained steelhead populations exist under flow regimes that typically are deemed unable to support salmonids. This is a severely natural water-limited system (there is no irrigated agriculture) that is a very steep V-shaped valley and is a 28 square mile watershed with limited forested headwaters.
Palouse River below Palouse Falls	The pool from Lower Monumental Dam has inundated the Palouse River to about River Mile 2.5.

Sources: Kuttel, Jr. 2001, 2002; EES, personal communication; USFWS 2001, Pacific Groundwater Group 1995; Saul et al. 2001, Brad Johnson, personal communication.

Planning for future water use requires an understanding of current water use as well as land use and project population growth. Table 2-3 presents water usage that was current in 2006, and projected water use (projected in 2005) to 2020 within the SEWMU. Data were gathered primarily from watershed plans for the Walla Walla and Middle Snake subbasins; no DOE watershed assessment (for WRIA) has been completed for the Lower Snake River area (WRIA 33). In general, commercial and industrial uses occurring in urban areas were included in the municipal (residential) demand projections. Data were based on information presented in the WRIA 32 Level I Assessment (Economic and Engineering Services 2002).

Until recently, agricultural irrigators have not been required to measure or record their annual water use. Changes in the Washington State Water Code require measurement of all water diversions. In addition, a compliance plan developed by WDOE calls for water users comprising the top 80 percent of total water use in 16 critical fish watersheds to measure and report water use. Funds have been allocated to assist in purchasing water measurement devices.

The Level I assessments for WRIAs 32 and 35 contain descriptions of water use estimation methods and estimates of agricultural water usage in the Walla Walla and Middle Snake River watersheds (**http://www.wallawallawatershed.org/files/wplan** and **http://www.ecy.wa.gov/programs/eap/wrias/Planning/35.html**).

Walla Walla Watershed Irrigation Usage

Within the Walla Walla watershed portion of the SEWMU, it is estimated that approximately 50 percent of irrigation needs are met with surface water; the remainder comes from ground water. If current annual irrigation usage is estimated using surface water rights, it is estimated that 220,593 acre-feet per year (afy) may be used for irrigation. Actual water usage is probably considerably less—closer to 93,000 afy (WRIA 32, 2002).

Middle Snake River Watershed Irrigation Usage

In the Middle Snake River watershed portion of the SEWMU, it is estimated that 30 percent of irrigation water comes from surface water and 70 percent comes from ground water. Based on surface water rights, it appears that 9,600 afy may be used for irrigation. Table 2-4 presents a summary of irrigation water usage for the Middle Snake Watershed.

Table 2-3 Current and Projected Residential, Commercial and Industrial Water Use within the Southeast Washington Management Unit (mgd)

	2000* / 2002**		2005		2010		2020	
Service Area	**Population**	**Mean Annual Use**	**Population**	**Mean Annual Use**	**Population**	**Mean Annual Use**	**Population**	**Mean Annual Use**
Walla Walla Water District**	38,629	13.20	39,841	14.24	41,862	14.97	46,628	16.41
Port of Walla Walla**	0	0.08	0	0.09	0	0.09	0	0.10
Walla Walla Housing Authority**	--	0.06	--	0.06	--	0.06	--	0.06
Walla Walla College**	875	0.07	875	0.07	875	0.07	875	0.07
College Place Water Dept.**	6,208	0.36	6,403	0.38	6,728	0.40	7,494	0.45
Artesian Water Dist. No. 8**	311	0.02	321	0.02	337	0.02	376	0.03
Consolidate Irrigation Dist. No. 14**	1,367	0.10	1,410	0.11	1,481	0.12	1,650	0.13
City of Prescott*	335	0.09	337	0.09	354	0.10	393	0.11
City of Waitsburg*	1,195	0.31	1,302	0.34	1,367	0.36	1,483	0.39
City of Dayton*	2,495	0.62	2,677	0.66	2,771	0.69	3,032	0.73
City of Asotin*	1,095	0.35	1,137	0.36	1,195	0.37	1,320	0.42
City of Clarkston (includes PUD service area too)*	18,661	4.10	19,629	4.10	20,597	4.20	22,643	4.50
City of Pomeroy*	1,517	0.38	1,536	0.41	1,591	0.42	1,706	0.44
City of Starbuck*	165	0.34	165	0.34	165	0.34	165	0.34
Totals	68,828	15.41	71,317	16.59	74,831	17.41	82,857	19.04

* Current data available for 2000.

** Current data available for 2002.

-- No data available.

Sources: EES 1994, 2004.

Table 2-4 Irrigation Summary for the Middle Snake Portion of the SEWMU

Irrigated Crop	Acreage	Estimated Annual Irrigation (afy)	Estimated MGD
Asotin Region			
Hay (Grass)	10	20	0.02
Hay (Alfalfa)	20	50	0.05
Orchard	10	28	0.03
Subtotal	*329*	*676*	*0.10*
Middle Snake Region			
Hay (Grass)	50	100	0.09
Hay (Alfalfa)	50	125	0.11
Grain	221	486	0.43
Orchard	70	196	0.18
Subtotal	*391*	*907*	*0.81*
Pataha Region			
Hay (Grass)	117	234	0.21
Hay (Alfalfa)	180	450	0.40
Subtotal	*297*	*684*	*0.61*
Tucannon Region			
Hay (Grass)	115	464.8	0.42
Hay (Alfalfa)	835	3,167.20	2.83
Pasture	378	1,521.90	1.36
Wheat	596	1,222.90	1.09
Fallow	17	35.5	0.03
Subtotal	*1941*	*6,412.30*	*5.72*
Total	**3,286.30**	**9,597.30**	**8.07**

Source: EES 2002, 2004.

Agricultural water usage is limited in the Asotin area. In 1997, 329 acres of irrigated land were documented in the subbasin (C. Sonnen, Asotin County Conservation District, personal communication). The majority of irrigation water is diverted from Asotin Creek between May and August. Water use is expected to remain fairly constant (M. Heitstuman, WSU Extension Service, personal communication).

A total of 391 acres of cropland are irrigated in the Middle Snake area (D. Bartels, Pomeroy Conservation District, personal communication). Diversions occur primarily between May and August from Alkali Flat Creek, Alpowa Creek and, to a lesser extent, Deadman, Almota, and Meadow creeks. Because suitable irrigated agricultural land is limited in this area, agricultural activity in the subbasin is not expected to increase in the future.

In the Pataha subbasin, a total of 625 acres are currently being irrigated with surface water (D. Bartels, Pomeroy Conservation District, personal communication). Water is primarily drawn from Pataha Creek between May and August. As with the Middle Snake subbasin, agricultural opportunities are limited and, therefore, agricultural activity will probably not increase in the future.

The Tucannon subbasin is the most heavily farmed area within the Middle Snake Watershed. Currently 1,941 acres of cropland are irrigated. Most water is obtained from surface sources and, like the other areas, diversions take place primarily between May and August.

Surface Water Source Limitations

Surface Water Source Limitations (SWSL) have been established by WDOE on waterbodies throughout the State of Washington. As a result, minimum flow requirements or closure periods to further water appropriations have been established for specific river reaches in the SEWMU. Table 2-5 lists the closure areas and periods. To date, low flow restrictions have been applicable only to surface waters, although WDOE may eventually require restrictions on placement of wells.

Table 2-5 Closures to Surface Water Appropriation in the Southeast Washington Recovery Management Unit

Stream Name	Affected Reach	Effective Date	Period of Closure	Limitation
Blue Creek	Mouth to Headwaters	Date of adoption	June 1 - Oct 31	--
Mill Creek	Mouth to Stateline	2/6/1957	May 1 - Oct 1	--
Walla Walla River	Mouth to Stateline	Date of adoption	May 1 - Nov 30	--
Dry Creek	Mouth to Headwaters	Date of adoption	April 15 - Nov 15 or whenever Walla Walla River at USGS Gauge 140185 falls below 91.0 cfs	--
Touchet River	Mouth to Headwaters	Date of adoption	June 1 - Oct 31	--
Coppei Creek	Mouth to Headwaters	Date of adoption	April 1 - Nov 10	--
Doan Creek	Mouth to Headwaters	Date of adoption	June 1 - Oct 31	--
Mud Creek	Mouth to Headwaters	Date of adoption	May 1 - Oct 31 or whenever Walla Walla River below confluence of Mud Creek falls below 50.0 cfs	--
Pine Creek	Mouth to Headwaters	Date of adoption	May 1 - Oct 31 or whenever Walla Walla River at confluence of Pine Creek or Touchet River falls below 50.0 cfs	--
Stone Creek	Mouth to Headwaters	Date of adoption	May 1 - Oct 31	--
Alkali Flat Creek		Not yet adjudicated		Low flow All year
Asotin Creek		Not yet adjudicated		Low flow All year
Pataha Creek		Not yet adjudicated		Low flow All year
Tucannon River		Not yet adjudicated		Low flow All year
Alpowa Creek		Not yet adjudicated		Adjudication
Deadman Creek		Not yet adjudicated		Adjudication
Meadow Gulch Creek		Not yet adjudicated		Adjudication
Penawawa Creek		Not yet adjudicated		Closure
South Meadow Creek		Not yet adjudicated		Bypass Flow
WaWaWai Canyon		Not yet adjudicated		Adjudications

Sources: WAC 173-532, WRIA 32 Level 1 Assessment, EES 2002.

2.5.3 Ground Water

Aquifer Units

An aquifer is an underground rock or soil unit that stores and transmits groundwater. Whiteman et al. (1994) developed a conceptual model of the major aquifer units in the Columbia River Plateau. There are two primary types of aquifers: the Columbia River Basalts and the sedimentary (overburden) units that overlie the basalts in low-lying basin areas or along streams.

The locations of overburden aquifers are shown on Figure 2-1. Relatively thick overburden aquifers occur in the Walla Walla Subbasin, in the Eureka Flat area between the Snake and Touchet rivers, and along the northwestern edge of the SEWMU north of the Snake River near Pasco. More localized occurrences of overburden aquifers are present as flood gravels or alluvium along streams and rivers. This type of aquifer is present along the Tucannon and Touchet rivers.

Both the Walla Walla and Pasco overburden aquifers are important sources of groundwater for drinking water and irrigation. Significant quantities of groundwater are withdrawn through pumping. The Eureka Flat area is generally not a major source of groundwater to wells. The Lewiston aquifer (Figure 2-1) was identified as a “sole source” aquifer in 1988. Sole source aquifers are established by the U.S. Environmental Protection Agency as protected drinking water supplies.

Overburden aquifers vary widely in their texture and permeability (ability to transmit water). The coarse-grained portions generally store and transmit water readily, and their permeability can be much greater than the underlying basalts. In the Walla Walla area, the aquifer is generally coarse-grained (more permeable) in its upper portion and finer-grained (less permeable) in its lower portion (Newcomb 1965).

The Columbia River Basalt aquifer consists of many thick individual basalt flows separated by minor sedimentary beds that were deposited between flows. The sedimentary beds are not significant sources of groundwater because they are discontinuous and of relatively low permeability. Most groundwater flow within the basalts occurs at the more porous boundaries between individual flows (interflow zones) that are fractured and contain vesicles (bubbles). These porous water-bearing portions of the flows comprise about 10 percent of the total basalt layer thickness, but can contain significant amounts of water. Where basalts are overlain by loess, the loess assists in recharge to groundwater by allowing rainwater to slowly percolate into the underlying basalt.

Occurrence and Movement of Groundwater

Geologic structures, such as folds, control the movement and direction of groundwater flow within the uppermost aquifers in the SEWMU. Groundwater flow direction generally tends to mirror topography. Most groundwater flow occurs in a direction along the slope of the basalt flows, although it is locally influenced by minor surface water features where they intersect the water table. Pumping and irrigation also alter groundwater flow directions locally. Areas of folding and faulting, which occur in the Blue Mountains, also cause impediments to groundwater flow by disrupting the continuity of adjacent interflow zones or by creating low permeability structures such as dikes that also serve as barriers to groundwater flow.

Groundwater within the uppermost aquifers typically occurs under “unconfined” or water-table conditions. Groundwater in deeper basalt aquifers, however, is under pressure and occurs under confined conditions. Over most of the region, the direction of groundwater movement (gradient) is downward, except near major surface water features such as the Snake and Columbia rivers, where the gradient is upward. Regional groundwater flow within deeper aquifers is generally toward major surface-water features such as the Snake and Columbia rivers.

Relationship Between Surface Water and Groundwater

Overburden and basalt aquifers that occur near the ground surface are generally in hydraulic communication with the surface-water bodies that overlie them. At higher elevations, streams typically recharge groundwater aquifers during the winter months. In the lower reaches, groundwater aquifers typically discharge water to streams and rivers. The Snake River receives inflow from groundwater aquifers along its reach, including upper aquifers and deeper basalt aquifers. The minor streams and rivers originating in the Blue Mountains typically flow year-round, but may lose water to groundwater in some reaches and gain water from seeps and springs in other reaches. For example, in the Tucannon watershed, virtually all the base flow comes from groundwater discharge. Thus, the Tucannon River is considered a “gaining” stream throughout its length (Covert et al. 1995).

There are three primary sources of recharge to groundwater in the Columbia River Plateau: 1) infiltration from precipitation, 2) infiltration from irrigation, and 3) seepage from surface water bodies such as rivers and creeks. The relative importance of each source varies throughout the year, with precipitation being the greatest contributor in the winter and spring months, and seepage and irrigation being more important during the summer months. Estimated annual recharge ranges from 10 to 28 inches per year in the Blue Mountains to less than 0.5 inches per year in the western portion of the region west of Walla Walla (Whiteman et al. 1994). Where basalts are overlain by loess, the loess assists in recharge to groundwater by allowing rainwater to slowly percolate into the underlying basalt.

There are three primary sources of discharge from the aquifer system: 1) seepage to surface water bodies, including major rivers and creeks and minor springs and seeps along canyons and valley walls, 2) evaporation and use by plants, and 3) pumpage and stream diversion. Groundwater withdrawal, primarily for drinking water and irrigation, increased between the 1940s and 1970s and has decreased since then (Bauer and Vaccaro 1990). Most of the groundwater pumped from the SEWMU comes from wells in the overburden aquifer and underlying basalt aquifers near Walla Walla, and in the overburden aquifer near Pasco. Some pumping from basalt aquifers also occurs from wells scattered throughout the region and near Lewiston. Declines in water levels of up to 100 feet due to pumping have been observed in the Walla Walla Subbasin (Whiteman et al. 1994).

Natural groundwater recharge and discharge patterns have been modified by groundwater withdrawal and irrigation (Bauer and Vaccaro 1990). Land has been developed for irrigated agriculture along the Snake River, in the Walla Walla Subbasin in the southwestern portion of the area, and in the Lower Snake and Tucannon subbasins in the northeastern portion of the area. Pumping for irrigation occurs during the summer dry months when precipitation is lowest and demand for water is the greatest. Because groundwater and surface water are typically interconnected, pumping from either shallow overburden or basalt aquifers usually has the effect of reducing groundwater discharge to tributaries of the Snake and Columbia rivers such as the Walla Walla River while pumping from deeper basalt aquifers typically leads to decreased groundwater discharge directly to the Snake and Columbia rivers.

The Walla Walla River illustrates the complex interrelationship between surface water and groundwater (Newcomb 1965; Molenaar 1968). In the upper reaches of the tributaries to the Walla Walla River, the groundwater table is generally near the bottoms of the most deeply downcut streams. The streams carry stormwater runoff and snow melt, and are also fed by perennial springs that discharge where the stream valleys intersect groundwater flowing within basalt interflow zones. Further downstream where these streams cross the upper portions of the overburden aquifer, some of the stream flow infiltrates into groundwater and then discharges as springs in the Walla Walla area.

Groundwater Use

Groundwater within the SEWMU is used for agricultural, domestic, and commercial purposes. Most groundwater is used for irrigation, although urban areas rely primarily on groundwater for their needs. Actual volumes of groundwater used are not well-documented. Therefore, distribution and trends in groundwater usage are based on groundwater rights rather than actual usage.

Approximately 73 percent of water rights in the Middle Snake subbasin are groundwater rights (Economic and Engineering Services 2002). Agricultural demand in the rural areas is expected to remain fairly constant over the foreseeable future, while groundwater usage is expected to increase at approximately the same rate as population growth.

In the Walla Walla subbasin, approximately 63 percent of water rights are for groundwater. As with the Middle Snake, it is expected that agricultural demand for groundwater will remain fairly constant and that urban demand will rise. However, because urban water demand relies on a slightly lower percentage of groundwater, it is expected that the future demand will be slightly less than population growth.

Table 2-6 shows that most groundwater rights have been granted for irrigation in both the Walla Walla and Middle Snake subbasins. Given that irrigation demands for agriculture are expected to remain constant, the greatest demand for groundwater will come from urban areas. Overall, projected increases in population within the SEWMU are expected to be relatively low, and consequent increases in total groundwater demand are expected to reflect this trend.

Table 2-6 Summary of Groundwater Rights within the Southeast Washington Recovery Management Unit

Purpose of Use	Number of Records	Annual Quantity (afy)	Instantaneous Rate (cfs)
Middle Snake Subbasin Portion of the Recovery Plan			
Irrigation	60	15,423	24,402
Commercial	19	4,080	5,803
Municipal	6	1,991	3,919
Domestic	116	5,350	8,612
Railway Maintenance	1	6	100
Fish & Wildlife Propagation	2	1,440	900
Mining	1	NA	100
Subtotal Consumptive	203	26,850	42,936
Subtotal Non-Consumptive	2	1,440	900
Total Primary	205	28,290	43,836
Total Secondary	20	22,102	18,672
Water Right Applications	17	--	--

Purpose of Use	Number of Records	Annual Quantity (afy)	Instantaneous Rate (cfs)
Walla Walla Subbasin Portion of the Recovery Plan			
Irrigation	1,106	240,426	361,485
Commercial	26	39,246	35,321
Municipal	37	38,636	34,962
Domestic	76	8,125	16,937
Railway Maintenance	11	697	1,350
Stock Watering	9	1,329	1,162
Walla Walla Subbasin Portion of the Recovery Plan			
Fish & Wildlife Propagation	3	1,478	930
Recreation	5	96	470
Subtotal Consumptive	1,265	328,458	451,217
Subtotal Non-Consumptive	8	1,574	1,400
Total Primary	1,273	330,032	452,617
Total Secondary	380	107,663	126,589
Water Right Applications	229	9,722	222,075
Totals	**5,080**	**1,214,454**	**1,856,695**

Sources: EES 2002, 2004.

2.5.4 Water Quality

Water quality conditions can have detrimental effects on salmon and their habitats. For example, a stream may contain adequate vegetative cover, substrate, and flow volume, but if the water temperatures are too high or if there are contaminants present in the water, the stream may not support salmon. Primary water quality concerns for salmonids in Snake River tributaries include high water temperatures, which can cause direct mortality or thermal passage barriers, and high sediment loads, which can cause siltation of spawning beds. Total dissolved gas is also an issue on the Snake River mainstem associated with hydropower operations. Water plunging from spill events at the Lower Snake River dams entrains (captures) air and carries it to depths where hydrostatic pressure forces the gases into solutions at high concentrations. High total dissolved gas can cause “gas bubble trauma” in fish resulting in chronic or acutely lethal effects (WDOE 2003). Conditions limiting the viability of salmon within the SEWMU are discussed in more detail in Chapter 5.0.

The federal Clean Water Act (CWA), adopted in 1972, established a process to identify and clean up polluted waters. Every two years, states are required to prepare a list of water bodies that do not meet water quality standards. This list is called the 303(d) list because the process is described in Section 303(d) of the CWA. Section 303(d) also established the Total Maximum Daily Load (TMDL) as a standard for water quality improvement. Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards and to develop TMDLs to address those pollutants. The TMDL establishes limits on pollutants that can be discharged to water bodies while allowing state standards to be met.

WDOE has included several water bodies in the SEWMU on its 2003/2004 303(d) list. Table 2-7 lists the water bodies and the constituents causing impairment for which a TMDL has been or will be developed. The water bodies included in Category 5 are those for which WDOE must develop TMDLs; WDOE has already developed TMDLs for those in Category 4a. More information on water quality within the SEWMU is available in the Walla Walla, Tucannon, Asotin, and Lower Snake subbasin summaries (Columbia Conservation District 2001; Saul et al. 2001; and Asotin County Conservation District 2001).

Table 2-7 CWA 303(d) Water Quality Impaired Surface Waters within the Southeast Washington Recovery Management Unit

	Water Quality Parameter																	
Water Body (WRIA No.)	**Temperature**	**Sediment Bioassay**	**Chlorine**	**DDT**	**Hexachloro-benzene**	**pH**	**Fecal coliform**	**4,4'-DDE**	**Chlordane**	**Dieldrin**	**Heptachlor epoxide**	**Total PCBs**	**Dissolved oxygen**	**Dioxin**	**Total dissolved gas**	**ALPHA-BHC**	**Ammonia-N**	**Turbidity**
Blue Creek (WRIA 32)	5																	
Caldwell Creek (WRIA 32)	5																	
Cold Creek (WRIA 32)	5																	
Columbia River (WRIA 32)		5												4a				
Coppei Creek (WRIA 32)	5																	
North Fork Coppei Creek (WRIA 32)	5																	
South Fork Coppei Creek (WRIA 32)	5																	
Cottonwood Creek (WRIA 32)	5																	
Doan Creek (WRIA 32)	5																	
Dry Creek (WRIA 32)	5																	
Garrison Creek (WRIA 32)	5		5	5	5													
Jim Creek (WRIA 32)	5																	
Lewis Creek (WRIA 32)	5																	
Little Walla Walla River, East (WRIA 32)	5																	
Little Walla Walla River, West (WRIA 32)	5																	
Mill Creek (WRIA 32)	5		4a			5											4a	
Pine Creek (WRIA 32)	5																	
Robinson Creek (Fork) (WRIA 32)	5																	
Russell Creek (WRIA 32)	5																	
Touchet River (WRIA 32)	5						5											5
North and East Fork Touchet River (WRIA 32)	5																	
South Fork Touchet River. (WRIA 32)	5																	

(continued)

Table 2-7 CWA 303(d) Water Quality Impaired Surface Waters within the SEWMU (continued)

	Water Quality Parameter																	
Water Body (WRIA No.)	**Temperature**	**Sediment Bioassay**	**Chlorine**	**DDT**	**Hexachloro-benzene**	**pH**	**Fecal coliform**	**4,4'-DDE**	**Chlordane**	**Dieldrin**	**Heptachlor epoxide**	**Total PCBs**	**Dissolved oxygen**	**Dioxin**	**Total dissolved gas**	**ALPHA-BHC**	**Ammonia-N**	**Turbidity**
Walla Walla River (WRIA 32)	5				5			5	5	5	5	5						
Whiskey Creek (WRIA 32)	5																	
Wolf Creek (Fork) (WRIA 32)	5																	
Yellowhawk Creek (WRIA 32)	5																	
Snake River (WRIA 33)	5							5	5	5		5	5	4a	4a			
Palouse River (WRIA 34)	5					5	5	5		5	5	5	5			5		
Alkali Flat Creek (WRIA 35)	5																	
Almota Creek (WRIA 35)	5																	
Alpowa Creek (WRIA 35)							5											
Asotin Creek (WRIA 35)	5						5											
North Fork Asotin Creek (WRIA 35)	5																	
South Fork Asotin Creek (WRIA 35)	5																	
Charley Creek (WRIA 35)	5																	
Couse Creek (WRIA 35)	5																	
Cummings Creek (WRIA 35)	5																	
Deadman Creek (WRIA 35)	5						5											
North Fork Deadman Creek (WRIA 35)							5											
South Fork Deadman Creek (WRIA 35)	5																	
George Creek (WRIA 35)	5																	
Lick Creek (WRIA 35)	5																	
Little Almota Creek (WRIA 35)	5																	
Meadow Creek (WRIA 35)	5																	
Menatchee Creek (WRIA 35)	5																	

(continued)

Table 2-7 CWA 303(d) Water Quality Impaired Surface Waters within the SEWMU (continued)

	Water Quality Parameter																	
Water Body (WRIA No.)	**Temperature**	**Sediment Bioassay**	**Chlorine**	**DDT**	**Hexachloro-benzene**	**pH**	**Fecal coliform**	**4,4'-DDE**	**Chlordane**	**Dieldrin**	**Heptachlor epoxide**	**Total PCBs**	**Dissolved oxygen**	**Dioxin**	**Total dissolved gas**	**ALPHA-BHC**	**Ammonia-N**	**Turbidity**
Mill Creek (WRIA 35)	5																	
Pataha Creek (WRIA 35)	5					5	5										4a	
Penawawa Creek (WRIA 35)	5																	
Pintler Creek (WRIA 35)	5																	
Snake River (WRIA 35)	5					5		5				5	5	4a	4a			
Steptoe Creek (WRIA 35)	5																	
Tenmile Creek (WRIA 35)	5																	
Tucannon River (WRIA 35)	5					5	5											5
Wawawai Creek (WRIA 35)	5																	

Legend: 5 = Category 5, on the 303(d) list and requires a TMDL.

4a = Category 4a, TMDL has been established.

Source: Washington Department of Ecology 2002.

Many of the streams and rivers in the SEWMU do not comply with water quality standards for temperature, primarily due to lowered summer flows. Past and current agricultural practices, manufacturing, erosion, among other activities, have resulted in impaired water quality. Some of these activities have also introduced pesticides such as DDT, 4,4'-DDE, chlordane, dieldrin, heptachlor epoxide, and hexachlorobenzene into the water and have raised levels of fecal coliform and PCBs as well as other constituents. In some water bodies, pH has been negatively affected. In groundwater, nitrate and coliform bacteria contamination of the overburden aquifer near Walla Walla have been identified and are believed to be associated with agriculture and/or septic tanks. It must be recognized that the DOE listing of these waterbodies was conduced in 2002 and were partially based on information prior to 2002. An updated assessment of these designations is warranted considering that signiciant improvements to water quality in many of the rivers/streans has occurred since their listing.

2.6 VEGETATION

Prior to the arrival of settlers in the early 19th century, the Middle and Lower Snake River watersheds were covered by prairie and canyon grasslands and shrub-steppe vegetation at low to mid-elevations. Forests dominated as elevation and proximity to the Blue Mountains increased. The Walla Walla watershed lowlands historically were described as dominated by shrubs, herbaceous plants, and grasses. Trees were rarely found on the lowlands except near streams.

The interface between the aquatic and terrestrial environments, i.e., the riparian zone, was normally covered with lush vegetation ranging in composition from grasses and forbs to shrubs and large trees, depending upon the location within a watershed. In the SEWMU, riparian zones were historically dominated by deciduous species such as willow, cottonwood, birch, and alder (Mudd 1975; Meinig 1968; Saul et al. 2000). Closer to the Blue Mountains, coniferous trees such as pine and fir, began to dominate (Mudd 1975). Riparian vegetation is important to aquatic species because it helps to regulate water temperatures by shading the water, it contributes woody debris to the water body, and it provides food for aquatic species through debris and leaf litter.

Since the arrival of settlers in the 19th century, much of the riparian habitat has been lost or modified. Today, throughout the SEWMU, much of the herbaceous, prairie grassland, and shrub-steppe vegetation has been converted to cropland and livestock pasture. The federal Conservation Reserve Program (CRP) has successfully assisted farm operators and owners in conserving and improving soil, water, and wildlife resources. Under the CRP, highly erodable and other environmentally sensitive lands that have produced crops are converted to a long-term resource-conserving vegetative cover. Participants in the CRP are required to seed native or introduced perennial grasses or a combination of shrubs and trees with native forbs and grasses.

Franklin and Dyrness (1988) describe two vegetation provinces in the SEWMU: the Blue Mountain Province in the southeast corner and the Columbia Basin Province in the remainder. Two major vegetation groups—forested regions and steppe regions—are present in these provinces. The forested regions, which are present along the slopes of the Wallowa Mountains at the northeastern end of the Blue Mountains and which extend into the southeastern part of the SEWMU, include:

- Ponderosa Pine (*Pinus ponderosa*) Zone, in the southern portion of the SEWMU, is found along the lower elevations of the Wallowa Mountain slopes.
- Subalpine forests (including subalpine fir [*Abies lasiocarpa*] and mountain hemlock [*Tsuga mertensiana*] Zones) in the south central portion of the SEWMU are found at higher elevations of the Wallowa Mountain slopes.

The steppe regions, present in the majority of the SEWMU, include:

- Steppe (without big sage brush) covers the majority of the SEWMU.
- Shrub-steppe (with big sage brush) covers a relatively small area at the southwest corner of the SEWMU.

The dominant species in each vegetative zone are presented in Table 2-8. These are the species that dominate the vegetative communities within the large vegetation provinces in the SEWMU.

Table 2-8 Dominant Species in Vegetative Zones within the Southeast Washington Recovery Management Unit

***Pinus ponderosa* Zone**	**Subalpine forests**	**Steppe**	**Shrub-steppe**
Populus tremuloides quaking aspen	*Abies lasiocarpa* subalpine fir	*Agropyron spicatum* bluebunch wheatgrass	*Artemisia tridentata* var. *tridentata* big sagebrush
Abies grandis grand fir	*Picea engelmannii* Engelmann spruce	*Poa sandbergii* Sandberg bluegrass	*Symphoricarpus albus* common snowberry
Pseudotsuga menziesii Douglas-fir	*Pinus contorta* lodgepole pine	*Festuca idahoensis* Idaho fescue	*Rosa nutkana* nootka rose
Larix occidentalis western larch	*Pseudotsuga menziesii* Douglas-fir	*Symphoricarpos albus* common snowberry	*Agropyron spicatum* bluebunch wheatgrass
Pinus monticola western white pine	*Abies grandis* grand fir	*Rosa nutkana* nootka rose	*Festuca idahoensis* Idaho fescue
Festuca idahoensis Idaho fescue	*Larix occidentalis* western larch		*Stipa comata* needlegrass
Purshia tridentata antelope bitterbrush	*Pinus monticola* western white pine		*Stipa thurberiana* Thurber's needlegrass
			Poa cusickii Cusick's bluegrass
			Sitanion hystrix Bottlebrush squirreltail
			Poa sandbergii Sandberg bluegrass
			Bromus tectorum downy brome
			Lappula redowskii western sticktight
			A surface crust composed of crustose lichens and acrocarpous mosses

Sources: Kuttel, Jr. 2000, 2002.

2.6.1 Riparian Vegetation

Riparian vegetation is present in relatively small areas within the SEWMU, usually restricted to narrow strips along rivers and streams. Dominant riparian vegetation species are shown in Table 2-9.

Table 2-9 Dominant Riparian Vegetation in the Southeast Washington Recovery Management Unit

Common Plant Name	Scientific Plant Name
Sedges	*Carex* spp.
Rushes	*Juncus* spp.
Douglas hawthorn	*Crataegus douglasii*
Black cottonwood	*Populus balsamifera*
Cottonwoods	*Populus* spp.
Willows	*Salix* spp.
Douglas-fir	*Psuedotsuga menziesii*
Grand fir	*Abies grandis*
white alder	*Alnus rhombifolia*
Alder	*Alnus* spp.
Ponderosa pine	*Pinus ponderosa*
Red-osier dogwood	*Cornus stolonifera*
Cheatgrass	*Bromus tectorum*
Kentucky bluegrass	*Poa pratensis*
Reed canarygrass	*Phalaris arundinacea*
Common mullien	*Verbascum thapsus*
Chicory	*Chicorium intybus*
Scotch thistle	*Onopordum acanthium*
Englemann spruce	*Picea engelmannii*
Western larch	*Larix occidentalis*
Golden willow	*Salix alba*
Locust	*Robinia* spp.
Chokecherry	*Prunus virginiana*
Coyote willow	*Salix exigua*
Rose	*Rosa* spp.
Sticky currant	*Ribes viscosissimum*
Snowberry	*Symphoricarpus albus*
Few-flowered spike rush	*Eleocharis pauciflora*

Source: Kuttel Jr. 2002.

WRIA 33 (Lower) and WRIA 35 (Middle) Snake River. WRIA 33 and 35 encompass six subbasins with varying riparian conditions. Grasses and a few small shrubs dominate the riparian vegetation along the Grande Ronde River mainstem within Washington; the limited tree canopy consists of an occasional pine tree. The riparian cover along fish-bearing tributaries to the Grande Ronde within Washington is relatively sparse. For example, Joseph Creek has a narrow buffer of deciduous trees about 20 to 30 feet in height (Kuttel, Jr. 2002). The upper reaches of Schumaker Creek have shrubs with a few scattered pines; the lower reaches have patchy areas of deciduous trees. Rattlesnake Creek has a narrow, but continuous, buffer of immature alder trees. Cottonwood Creek has a relatively contiguous buffer of deciduous trees. The riparian zones of Grouse, Cougar, and lower Menatchee creeks have generally narrow riparian buffers with sparse vegetation which likely provide little shade.

Along Couse Creek in the Tenmile-Couse subbasin, the riparian zone is patchy to absent. The dominant riparian vegetation consists of forbs, grasses, sedges, rushes, shrubs, and scattered trees. Tenmile Creek, from the headwaters to Mill Creek, has a riparian buffer of alders, cottonwoods, willows, and conifers. From Mill Creek to the mouth of Tenmile Creek, the riparian vegetation ranges from partial stands of grasses, sedges, and rushes in the understory and deciduous trees in the overstory to no vegetation.

The Asotin subbasin riparian vegetation is a mixture of mature alders, young cottonwood, willow and sparce immature connifers in the mid to lower reaches and primarialy mature cottonwood and connifers in the upper reaches. Forested riparian vegetation along Asotin Creek and other subbasin streams remains in transition, having been affected by flooding events in 1996 and 1997. Damage to riparian cover in the upper portion of the watershed reduced the canopy cover by approximately half compared to pre-flood (1993) surveys. Douglas-fir and grand fir were the successional dominants in these older stands, with alder and ponderosa pine as notable components. Understory shrubs typical of riparian forests include red-osier dogwood and willows, significant for their wildlife values (NRCS 2001). Herbaceous understory growth demonstrates disturbance in these communities. Cheatgrass, Kentucky bluegrass, mullein, chicory, and Scotch thistle are among the most frequently encountered species.

The Alpowa-Deadman Subbasin includes the lower, middle, and upper reaches of Alpowa and Deadman creeks. The Soil Conservation Service described the lower reaches of Alpowa Creek as having been heavily grazed within the riparian zone (SCS 1981). The result was poor herbaceous vegetation quality and quantity. Shrubby vegetation was described as poor along most of the creek and absent along the remainder. The trees were considered to be in poor to fair condition and were described as “relicts” of little or no reproductive value.

Livestock grazing and some cultivation are present on the middle reach. Again grazing was described as “heavy” to “moderate” on the banks. Herbaceous, shrubby, and tree vegetation was characterized as either “poor” or “lacking” throughout this portion (SCS 1981). Noxious weeds, such as false indigo, have invaded the area.

Riparian vegetation is minimal along the upper reach (Mendel et al. 1999). Herbaceous and shrubby streambank vegetation was either in poor condition or completely lacking in 1981. Trees were in fair condition on more than half of the streambanks and poor on the remainder. This reach contained streambanks that were significantly more vegetated and stable than the middle reach (SCS 1981).

Livestock grazing along Deadman Creek and some cultivation occur along the full length of the Deadman Creek watershed. Herbaceous, shrubby, and tree vegetation was characterized as either “poor” or “lacking” throughout the reach.

The Tucannon riparian vegetation is made up of mature alders, young cottonwood, willow and sparce immature connifers in the mid to lower reaches and primarialy mature cottonwood and connifers in the upper reaches. Tree species present along the streambanks include black cottonwood, white alder, Douglas-fir, grand fir, Douglas hawthorn, and Engleman spruce. Common tree species in the riparian plant community include western larch, ponderosa pine, golden willow, and locust. Common shrub species include chokecherry, coyote willow, wild rose, sticky currant, and snowberry. Few-flowered spike rush, various sedge species, and a variety of weedy forbs are common. Conifer species were dominant in the higher elevations and deciduous species were dominant in the lower elevations.

Kuttel, Jr. (2002) described the riparian vegetation in the Lower and Middle Snake River as including forbs, grasses, sedges, rushes, grazed pasture, and some shrubs and trees. In some areas, the riparian trees are as tall as 30 feet and the buffer as wide as 40 feet. Much of the riparian areas are grazed.

Walla Walla River (WRIA 32): Common deciduous trees and shrubs in riparian areas of the Walla Walla subbasin include cottonwood, alder, willow, and red osier dogwood (USFS and Bureau of Land Management 2000). Cottonwood, white alder, and willow dominate the riparian community in the lowlands (USACE 1997b). These species also occur in the upper riparian zone, but coniferous species increase in prominence.

The Salmonid Habitat Limiting Factors reports prepared for WRIAs 32, 33, 34, and 35 contain assessments of the riparian condition along fish-bearing streams within the SEWMU (Kuttel, Jr. 2002). The evaluation system was applied to riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris, and nutrient delivery systems (Kuttel, Jr. 2001, 2002). This report was based on conditions in the 1990's and while we do not have a more recent assessment, conditions have improved considerably in the last decade, primarily due to implementation of the Conservation Reserve and Enhanceent Program (CREP) where nearly 80% of all CREP-eligible/salmon bearing streams now have riparian buffers.

- **Poor**: Riparian areas are fragmented, poorly connected, or provide inadequate protection of habitats for sensitive aquatic species, i.e., less than 70 percent of the area is intact and it does not provide a refugium for aquatic species. The area does not adequately buffer land use impacts and less than 25 percent of the area's riparian vegetation is similar to the potential natural community.

- **Fair**: Riparian areas exhibit moderate loss of connectivity or function; there is incomplete protection of habitats and refugia for sensitive aquatic species (approximately 70 to 80 percent is intact) and moderate buffering of land use impacts; percent similarity of riparian vegetation to the potential natural community/composition is 25 to 50 percent or better.

- **Good**: Riparian areas provide adequate shade, large woody debris is present in the water course, habitat protection and connectivity is present in subwatersheds. Buffers or known refugia for sensitive species are more than 80 percent intact. The zone adequately buffers land use impacts. The riparian vegetation is more than 50 percent similar to the potential natural community.

Table 2-10 presents the riparian zone ratings for stream reaches in the SEWMU.

Table 2-10 Riparian Assessment by Stream Reach within the Southeast Washington Recovery Management Unit

Key:

P = Average habitat condition considered poor (not properly functioning)

F = Average habitat condition considered fair (at risk)

G = Average habitat condition considered good (properly functioning)

1 = Quantitative studies or published reports documenting habitat condition

2 = Professional knowledge of the WRIA 32, 34, 53 TAG members

DG = Data Gap

Stream Name	Riparian Condition
WRIA 32	
Upper Touchet Subbasin	
North Fork Touchet River: Headwaters to Lewis Creek	F1, 2
North Fork Touchet River: Lewis Creek to Wolf Fork	P1
North Fork Touchet River/Touchet River: Wolf Fork to L/C Trail State Park	P2
Wolf Fork: Headwaters to Whitney Creek	F2
Wolf Fork: Whitney Creek downstream	P1, 2
Robinson Fork	P1, 2
South Fork Touchet River: Griffin fork to mouth	P1
South Fork Touchet River: Griffin, Burnt, Green Forks	P1
Lower Touchet Subbasin	
Touchet River: L/C Trail State Park to Coppei Creek	P1
Touchet River: Coppei Creek to Hwy. 125	P1
Coppei Creek	F1, 2
Touchet River: Hwy. 125 to mouth	P2
Lower Walla Walla Subbasin	
Walla Walla River: Stateline to Mill Creek	P2
Walla Walla River: Mill Creek to McDonald Rd.	P2
Walla Walla River: McDonald Rd. to mouth	F1
Pine and Mud creeks	P2
Dry Creek: Headwaters to Hwy. 12 at Smith Rd.	F2
Dry Creek: Hwy. 12 at Smith Rd. to mouth	P2
Mill Creek: Bennington Lake Dam to mouth	P1, 2
Garrison Creek	P2
Yellowhawk Creek	F2
Cottonwood, Russell, and Reser creeks	P2
Upper Mill Creek Subbasin	
Mill Creek: Headwaters to Bennington Lake Dam	F1-G1
Mill Creek Tributaries (USFS)	G1
WRIA 33, 35	
Grande Ronde Subbasin	
Grande Ronde River : Washington portion	F2
Grande Ronde Tributaries : Washington portion	F2
Wenaha River Tributaries: within Washington	F1-G1

Key:

P = Average habitat condition considered poor (not properly functioning)

F = Average habitat condition considered fair (at risk)

G = Average habitat condition considered good (properly functioning)

1 = Quantitative studies or published reports documenting habitat condition

2 = Professional knowledge of the WRIA 32, 34, 53 TAG members

DG = Data Gap

Stream Name	Riparian Condition
Tenmile-Couse Subbasin	
Couse Creek	F1
Tenmile Creek: Headwaters to Mill Creek	F1-G1
Tenmile Creek: Mill Creek to mouth	P1
Asotin Subbasin	
North Fork Asotin Creek	F1-G1
South Fork Asotin Creek	F2-G2
Asotin Creek: Forks to George Creek	P1
Asotin Creek: George Creek to mouth	P2
Charley Creek	P1-F2
George Creek: Headwaters to Wormell Creek	G1
George Creek: Wormell Creek to mouth	P1-G1
Pintler Creek	F2-G2
Alpowa-Deadman Subbasin	
Alpowa Creek: Headwaters to Stember Creek	P1-F2
Alpowa Creek: Stember Creek to mouth	F2
Meadow Creek	P1
North and South Deadman creeks	P1
Deadman Creek: Forks to mouth	P1
Tucannon Subbasin	
Tucannon River: Headwaters to Panjab Creek	G1
Tucannon River: Panjab Creek to Marengo	P1-G1
Tucannon River: Marengo to U.S. Hwy. 12	P1
Tucannon River: U.S. Hwy. 12 to mouth	P1
Pataha Creek: Headwaters to Columbia Center	F1
Pataha Creek: Columbia Center to Pomeroy	P1
Pataha Creek: Pomeroy to mouth	P1
Snake Subbasin	
Steptoe Creek	P1
Wawawai Creek	F1
Almota Creek	F1
Little Almota Creek	P1-G1
Penawawa Creek	DG
Alkali Flat Creek	DG
Palouse River below Palouse Falls	G2

Source: Kuttel, Jr. 2000, 2002.

It must be noted that the riparian assessment was conducted in 2000 and 2002; considerable improvements to many of the rivers/streams has occurred in the last decade and this assessment warrants updating.

2.6.2 Noxious Weeds and Invasives

Two alien species are well adapted to parts of the Columbia Basin Province Steppe Zone: cheatgrass and Kentucky bluegrass (Franklin and Dyrness 1988). They invade or increase under heavy grazing and the native species are slow to recover, if at all, when grazing is removed. Cheatgrass competes with more desirable perennial grasses for moisture because of its winter and early spring growth habit, and after maturity, it becomes a nuisance and a fire hazard (Whitson et al. 2001). Kentucky bluegrass is undesirable on rangeland because of low production, summer dormancy, and propensity to invade native grasslands. Few grasses are able to withstand heavy grazing and cheatgrass, which recovers rapidly on overgrazed pastures and ranges (Ehrenreich and Aikman 1963).

The Asotin County Weed Board visually surveys an estimated 130 out of 627 square miles in Asotin County on an annual basis. The Columbia County Weed Board visually surveyed approximately 48 miles of the Tucannon River, including private and public lands. Invasive species found within these riparian areas include members of Asteraceae plant family, notably yellow starthistle (*Centaurea solstitialis*), diffuse knapweed (*C. diffusa*), spotted knapweed (*C. biebersteinii*), and Russian knapweed (*Acroptilon repens*). Limited amounts of rush skeletonweed (*Chondrilla juncea*) and leafy spurge (*Euphorbia esula*) were also observed.

All of the *Centaurea* species mentioned here were introduced from Europe and represent a threat to pastures and rangeland. Russian knapweed is a native of Eurasia and is now widely established in the West. It forms colonies in cultivated fields, orchards, pastures, and roadsides (Whitson et al. 2001).

Rush skeleton weed is an introduced species that generally inhabits well-drained, light textured soils along roadsides, in rangelands, grain fields, and pastures. Soil disturbance aids establishment. Because of its extensive root system, it can be difficult to control (Whitson et al. 2001).

Leafy spurge causes severe irritation of the mouth and digestive tract in cattle and may even result in death (Whitson et al. 2001). Seed capsules explode when dry, often projecting up to 15 feet, and seeds may be viable in the soil for up to 8 years. The extensive root system and seed viability make this species very difficult to control.

The Dayton Weed Board recognizes false indigo (*Amorpha fruticosa*), as a regional problem. This weed is classed as a Class B Noxious Weed, which means that it is established in parts of Washington, but its distribution is limited or it is absent in other parts of the state (WDOE 2004). False indigo is considered an invasive species in the western United States, but is native to the eastern United States. It is often planted as an ornamental or for bank stabilization. In eastern Washington, false indigo has spread along stream corridors. The plant has a very high water demand.

2.7 FISH AND WILDLIFE SPECIES

The SEWMU supports a large number of anadromous and resident fish species and provide important habitat for terrestrial wildlife. Fish and wildlife species listed as state and/or federally endangered, threatened, or candidates under the Endangered Species Act (ESA) are discussed in Section 2.6.3.

2.7.1 Aquatic Species

The SEWMU supports a variety of salmonid and non-salmonid fish. Primary anadromous salmonid species in the SEWMU include fall and spring/summer Chinook salmon, sockeye salmon, and summer steelhead; resident salmonid species include bull trout, rainbow trout, mountain whitefish, and the non-native brown trout. Table 2-11 includes a representative list of fish species present within the SEWMU. For a complete list of fish species in each subbasin, see the respective subbasin plans for the Asotin, Grande Ronde, Lower Snake Mainstem, Tucannon, and Walla Walla subbasins.

Table 2-11 Fish Species Present in the SE Washington Salmon SEWMU

Species	Origin
Bull trout (*Salvelinus confluentus*)	Native
Spring/summer Chinook salmon (*Oncorhynchus tshawytscha*)	Native
Fall Chinook salmon (*O. tshawytscha*)	Native
Summer steelhead (*O. mykiss*)	Native
Rainbow trout (*O. mykiss*)	Native
Mountain whitefish (*Prosopium williamsoni*)	Native
Brown trout (*Salmo trutta*)	Exotic
Lamprey (*Lampetra* spp.)	Native
Longnose dace (*Rhinichthys cataractae*)	Native
Speckled dace (*R. osculus*)	Native
Umatilla dace (*R. umatilla*)	Native
Leopard dace (*R. falcatus*)	Native
Chiselmouth (*Acrocheilus alutaceus*)	Native
Peamouth chub (*Mylocheilus caurinus*)	Native
Redside shiner (*Richardsonius balteatus*)	Native
Northern pikeminnow (*Ptychocheilus oregonensis*)	Native
Walleye (*Stizostedion vitreum)*	Exotic
Mountain sucker (*Catostomus platyrhynchus*)	Native
Common carp (*Cyprinus carpio*)	Exotic
Brown bullhead (*Ameiurus nebulosus*)	Exotic
Tadpole madtom (*Notorus gyrinus*)	Exotic
Channel catfish (*Ictalurus punctatus*)	Exotic
Smallmouth bass (*Micropterus dolomieu*)	Exotic
Largemouth bass (*M. salmoides*)	Exotic
Pumpkinseed (*Lepomis gibbosus*)	Exotic
Bluegill (*L. macrochirus*)	Exotic
White crappie (*Pomoxis annularis*)	Exotic
Black crappie (*P. nigromaculatus*)	Exotic
Warmouth (*L. gulosus*)	Exotic
Yellow perch (*Perca flavescens*)	Exotic
Paiute sculpin (*Cottus beldingi*)	Native
Margined sculpin (*C. marginatus*)	Native
Torrent sculpin (*C. rhotheus*)	Native
Threespine stickleback (*Gasterosteus aculeatus*)	Native
Sandroller (*Percopsis transmontana*)	Native

Source: Saul et al. 2001.

Life history and habitat information for the salmonid species that are the focus of this plan are found in Chapter 3.0. In general, salmon and steelhead species require cold, i.e., less than 64°F (18°C), clean streams with adequate cover for migration, spawning, and rearing. Dissolved oxygen must be at or near saturation levels for egg and alevin survival. High turbidity levels can adversely affect egg survival and emergence, juvenile respiration, feeding behavior, and abrade sensitive tissue such as gills. Following emergence, salmonid fry use backwaters and side channels in areas with overhanging branches, adequate cover, and food for rearing. The stream gradient in spawning areas should be less than three percent; spawning gravel should be free of fines and range in size from pea gravel to large cobbles.

Bull trout have distinct habitat requirements compared to other salmonids. Bull trout spawn in the fall after water temperatures drop below 48°F (8.9°C) in streams with unpolluted water, clean gravel/cobble substrate, and gentle stream gradients. Many spawning areas are associated with cold water springs or areas where stream flow is influenced by groundwater.

Resident fish in the Snake River Basin include both native and introduced species. The basin contains a mix of cold water and warm water species. Warm water species include smallmouth bass, largemouth bass, yellow perch, black crappie, bluegill, brown bullhead and pumpkinseed. Cold-water species include rainbow trout, brown trout, and mountain whitefish. Habitat conditions important to the various resident fish vary widely; however, factors such as water quality, flow conditions, abundant riparian vegetation, and channel modifications are important to most resident species.

Fish species of both native and exotic origin often compete with, and prey upon, salmonid species. Within the SEWMU, northern pikeminnow, smallmouth bass, and walleye are the primary predators upon other fish. Of these three species, only the northern pikeminnow is native. Other predatory resident species include channel catfish, yellow perch, brown trout, largemouth bass, and bull trout. Bull trout are native species. Smallmouth bass and northern pikeminnow are the dominant predators in the reservoirs of the lower Snake River. Northern pikeminnow and perches, as well as smallmouth bass, are primary predators in certain reaches of the Snake River system. Walleye are extremely voracious and are most abundant in dam tailraces in the Columbia where the potential for impacts to juvenile salmon are high, but few walleyes exist in the Snake River.

2.7.2 Terrestrial Wildlife Species

According to the Interactive Biodiversity Information System (IBIS), more than 250 species of reptiles, amphibians, birds and mammals occur within the SEWMU (IBIS 2004). Big game species present in the SEWMU project area include elk, black bear, and deer. Upland game birds include ring-necked pheasant, chukar, and wild turkey, among others. Additional information regarding fish and wildlife species in the Snake River Basin can be found in the appropriate draft subbasin plans.

Wildlife habitats within the Snake River Basin consist primarily of riparian/floodplain, shrub steppe, and agricultural lands. Other important habitats include forest lands and transitional steppe areas near the mountains and foothills. The riparian/floodplain habitat lies along the Snake River and its tributaries. The shrub steppe and agricultural habitats encompass the uplands and comprise agricultural croplands, rangeland, CRP lands, and undeveloped areas. Areas of healthy riparian vegetation in the lower elevations are important to wildlife because they provide refuge and habitat. The majority of wildlife is found in riparian, forest, and transitional steppe habitats where food and refuge are plentiful. Deer and elk are often found in agricultural fields.

Riparian zones are important habitats for a variety of wildlife species. Some species are dependent upon riparian zones and some use the areas only for specific life stages. For example, black-crowned night herons and great blue herons use riparian areas for nesting. Furbearers, such as mink, muskrat, and beaver, are found along rivers and streams in riparian zones. Deer often use riparian zones to have their fawns. Neo-tropical birds use riparian zones as they migrate back and forth from Central and South America.

Within the SEWMU, fish are an important part of the diets of a variety of wildlife species including giant salamander, common loon, grebes, American white pelican, double-crested cormorant, herons, turkey vulture, harlequin duck, common and Barrow's goldeneye, common and red-breasted merganser, osprey, bald eagle, golden eagle, gulls, terns, belted kingfisher, Steller's jay, black-billed magpie, American crow, common raven, and American dipper. Mammals that consume salmon include Virginia opossum, water shrew, coyote, black bear, raccoon, mink, northern river otter, and bobcat. During salmonid freshwater rearing, these wildlife species may consume salmonid eggs, juveniles, adults, and/or carcasses.

Double-crested cormorants (*Phalacrocorax auritis*) and gulls (*Larus* sp.) are the principal avian predators in the basin. The breeding season for these birds coincides with the juvenile salmon outmigration which provides an important source of prey for the birds. Piscivorous (fish-eating) birds often congregate near hydroelectric dams in the Columbia River Basin and eat large quantities of migrating juvenile salmonids. Diet analyses indicate that juvenile salmonids constitute a major food source for avian predators and that, throughout the Columbia River Basin, losses to birds account for a substantial proportion of fish mortality each year. Populations of gulls, in particular, have increased throughout the Columbia River Basin as a result of creation of nesting and feeding habitats through human activities. Dredge spoil deposited in rivers and wetlands, reservoir impoundments, and tailrace outfalls at dams are examples of habitats favored by gulls and other fish-eating birds.

Protected terrestrial species of special interest documented to occur within the Snake River SEWMU include the bald eagle, peregrine falcon, Washington ground squirrel, and the Canada lynx (Section 2.6.3). Of these, only the bald eagle has any direct effect upon salmonids. Fish are a major source of food for bald eagles and the birds are usually found in proximity to fish-bearing water bodies. Bald eagles are present in the SEWMU primarily during the winter.

2.7.3 Federal and State Species Listing

Management of Endangered and Threatened Species

Congress passed the Endangered Species Act (ESA) in 1973 with the intent to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Under the law, species may be listed as either "endangered" or "threatened." Endangered means a species is in danger of extinction throughout all or a significant portion of its range. Threatened means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. The ESA is administered by the USFWS and NMFS. USFWS has primary responsibility for terrestrial and freshwater organisms, while NMFS is responsible for marine species, including salmon and steelhead.

WDFW is the regulatory agency responsible for state listed species in Washington. Rule WAC 232-12-297 was implemented to identify and classify native wildlife species needing protection and/or management to ensure their survival as free-ranging populations in Washington and to define the process by which listing, management, recovery, and delisting of a species can be achieved.

The ESA requires the federal government to develop recovery plans for listed salmon. NMFS has determined that recovery plans must be developed on an Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) regional basis. State law also directs development of a statewide strategy to recover salmon on an ESU/DPS basis. NMFS has designated ESU/DPSs for different salmon and steelhead species and areas. Based on this, five regional organizations have formed to coordinate development of draft ESU-level recovery plans within Washington.

Washington’s salmon and steelhead fisheries are managed cooperatively in a government-to-government relationship between the State of Washington and the Indian tribes whose rights were established in treaties signed with the federal government in the 1850s.

Tribal, state, and federal biologists cooperate in estimating the size of fish runs as salmon and steelhead migrate back to their native rivers and hatcheries in the Columbia Basin as part of the court mandated process under *US v OR*. This “in-season management” ensures that sport, tribal, and non-Indian commercial fisheries are appropriate for the actual salmon returns and allow optimum numbers of fish to spawn. The state and tribes have been working closely to develop the scientific tools needed to address loss and degradation of freshwater and estuarine habitats. The state and tribes are continuing to work cooperatively to develop comprehensive management plans for anadromous species in the Pacific Northwest, and additional information on those processes can be found in Appendices D and E.

Listed Species

Table 2-12 lists federal and state species within the Snake River Salmon SEWMU which protected under the ESA and the Washington State ruling.

Table 2-12 Federal and State Listings for Aquatic and Terrestrial Species within the Southeast Washington Recovery Management Unit

Common Name/ESU	Federal Status	State Status	Description of ESU/DPS
Snake River fall Chinook salmon	Threatened	Species of Concern	Natural populations of fall-run Chinook salmon in the mainstem Snake River, Tucannon River, Asotin Creek, and Grande Ronde River..
Snake River spring/ summer Chinook salmon	Threatened	Species of Concern	Natural populations of spring/summer-run Chinook salmon using tributaries to the mainstem Snake River.
Snake River and Middle-Columbia River steelhead	Threatened	Species of Concern	Naturally spawning populations of steelhead in the Snake River and the Tenmile-Couse, Tucannon River, Asotin Creek, Alpowa-Deadman, Touchet, Walla Walla and Grande Ronde subbasins. Additional spawning occurs in small tributaries as well.
Bull trout	Threatened	Species of Concern	Exists primarily in the headwaters, but migrates to lower elevations during winter months. Very sensitive to elevated water temperatures.
River lamprey	Species of Concern	Candidate	Status unknown. May be present in limited numbers.
Pacific lamprey	Species of Concern	None	Present but limited numbers observed
Margined sculpin	Species of Concern	Sensitive	Present
Columbia spotted frog	Candidate	Candidate	No populations reported specifically in the Snake River region. Believed to be extirpated from the region due to the loss and degradation of wetlands and the introduction of the predatory bull frog.
Western toad	Species of Concern	Candidate	Presence unknown
Northern leopard frog	Species of Concern	Endangered	Presence unknown
Columbia spotted frog	Species of Concern	Candidate	Spotted frog populations have declined in the basin due to lose of wetlands and standing water. The current estimated population of the Columbia spotted frog is unknown.
Rocky mountain tailed frog	None	Candidate	Presence unknown
Sagebrush lizard	Species of Concern	Candidate	Presence unknown
Striped whipsnake	None	Candidate	Presence unknown
Golden eagle	None	Candidate	Declining population
Bald eagle	Threatened	Threatened	Primarily in the region for winter habitat and foraging, depending on the severity of the winter weather.
Northern goshawk	Species of Concern	Candidate	Presence unknown
Ferruginous hawk	Species of Concern	Threatened	Presence unknown
Peregrine falcon	Species of Concern	Sensitive	Present but rarely found in eastern Washington during the winter months
		(continued)	
Sharp-tailed grouse	Species of Concern	Threatened	Historical presence documented but no current observations.

Common Name/ESU	Federal Status	State Status	Description of ESU/DPS
Sage-grouse	Candidate	Threatened	Historical presence documented but no current observations.
Sandhill crane	None	Endangered	Historical presence documented but no current observations.
Yellow-billed cuckoo	Candidate	Candidate	Presence unknown
Burrowing owl	Species of Concern	Candidate	Presence unknown
Flammulated owl	None	Candidate	Presence likely
Vaux's swift	None	Candidate	Presence likely
Lewis' woodpecker	None	Candidate	Presence likely
Pileated woodpecker	None	Candidate	Presence likely
White-headed woodpecker	None	Candidate	Presence likely
Black-backed woodpecker	None	Candidate	Presence likely
Oregon vesper sparrow	Species of Concern	Candidate	Presence likely
Pallid Townsend's big-eared bat	Species of Concern	Candidate	Presence likely
White-tailed jack rabbit	None	Candidate	Presence unknown
Washington ground squirrel	Candidate	Candidate	Due to loss of habitat in the region, no ground squirrels have been observed in recent years.
Townsend's ground squirrel	None	Candidate	Presence unknown
Brush prairie pocket gopher	None	Candidate	Presence unknown
Gray wolf	Threatened Experimental Population, Non-Essential	Endangered	Presence unknown
Pacific Fisher	Species of Concern	Endangered	Presence unknown
Wolverine	Species of Concern	Candidate	Presence unknown
Canada Lynx	Threatened	Threatened	Documented in National Forest Lands in southeast Washington

Source: NOAA ESA Status Reviews and Listing Information: http://www.nwr.noaa.gov/1salmon/salmesa/; U.S. Fish and Wildlife Service no date a; WDFW no date.

Fish species of importance to the recovery plan include Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, Snake River steelhead, Middle Columbia River steelhead, bull trout, and lamprey.

Both fall and spring/summer Snake River Chinook salmon (*Oncorhynchus tsawytscha*) are listed as threatened. A number of factors have led to the decline of these populations and are detailed in Chapters 3 and 5.

Fall Chinook salmon were historically present as far upstream on the Snake as Shoshone Falls (RM 615). Snake River fall Chinook salmon will not be discussed within this plan. That ESU will be discussed in detail within the comprehensive Snake River recovery plan.

Steelhead were historically present in large numbers throughout the Snake River Region (Kuttel, Jr. 2002). They are the most widely distributed salmonid in the watershed and are found throughout a large proportion of the basin's streams. The Snake River and Middle Columbia River steelhead were listed as threatened in June 1998 and August 1999, respectively.

Bull trout were listed as threatened under the ESA in June 1998. In the Snake River region, they are present in the Grande Ronde, Asotin, Tucannon, Walla Walla, and Snake subbasins as well as the Snake River mainstem. Spawning and rearing are confined to headwater areas of those watersheds (Kuttel, Jr. 2002).

The Pacific lamprey (*Lampetra tridentata*) spends up to six years in the stream and an unknown time in saltwater, where it grows up to 30 inches. The river lamprey (*L. ayresi*) has a similar life history, but grows only to 12 inches. The western brook lamprey *(L. richardsoni*) rarely exceeds seven inches. All lamprey spawn in clean gravel and cool flowing water. Pacific lamprey spawn in June and July. Brook and river lampreys spawn in April, May, or June. The adults of all three species die after spawning. The young hatch in two to three weeks. Since their life histories are much the same as spring/summer Chinook salmon, lamprey suffer some of the same impacts. NMFS considers lamprey a species of concern. Only 40 adults were counted going upstream through Ice Harbor Dam in 1992; 10 were seen at Lower Granite Dam.

Wildlife species of greatest concern within the SEWMU include bald eagle, peregrine falcon, Washington ground squirrel, gray wolf, and Canada lynx. Of these, only the bald eagle is ecologically connected to salmonids in the Snake River system.

Bald eagle populations use the Snake River Basin primarily for winter habitat and foraging, depending on the severity of the winter weather. Although no nesting has been recorded in the basin it is anticipated in the future. Maintaining high quality habitat for prey species, fish, and waterfowl and protecting potential nesting and winter roost sites are critical to encourage and perpetuate eagle use of the area (Stinson et al 2001). Bald eagles were listed federally as threatened in March 1967.

The peregrine falcon hunts other birds, and nests in cliffs and rocky areas often along rivers and lakes. It has been re-introduced in Asotin County, but is still scarce within the SEWMU (Hayes and Buchanan 2002).

Washington ground squirrel colonies are declining in the region due to the loss of shrub steppe and grassland habitats as a result of agricultural development and livestock grazing. Sites containing historically known colonies were surveyed in 1997, but no ground squirrels were observed.

The gray wolf was federally listed as threatened in March 11, 1967, in the Western Distinct Population Segment. Currently, the gray wolf is not known to occur in the SEWMU; it was extirpated from the region by the early 1900s, but there is a known pack in the Imnaha Basin in Oregon, and it is conceivable that they could migrate and establish themselves again in the Blue Mountains. Potential wolf habitat occurs in the forested lands of the subbasins and it is generally assumed wolves will soon reoccupy the area. Wolves prefer areas with few roads, generally avoiding areas with a road density greater than one mile per square mile.

The current population status and distribution of the Canada lynx (*Lynx canadensis*) in the SEWMU is unknown. Surveys failed to detect the lynx within and adjacent to the basin in 1999 and the species may have been extirpated from the area. The lynx was listed federally as threatened, but is naturally rare in the subbasin (Stinson et al. 2001). Preferred habitat for the lynx consists of high elevation (greater than 4500 feet) stands of cold and cool forest types with a mosaic of structural stages for foraging and denning.

2.8 LAND USE, LAND OWNERSHIP, AND JURISDICTION

2.8.1 Land Use

The SEWMU is dominated by cropland/pastures, mixed rangelands, and forestlands with some residential, wildlife and recreational areas (USGS no date) (Figure 2-2). The section of the SEWMU within the Blue Mountains is generally forested, with cropland (both dry land and irrigated) and pasture occurring over most of the remaining areas. Areas adjacent to streams and rivers were often used as rangelands, but since inception of the USDA Conservation Reserve and Enhancement Program in the late 1990’s, nearly 80% of all salmonid bearing streams in the SEWMU area have been revegetated with native species and protected from impacts. Walla Walla is the most populous city, with smaller cities and towns located mostly along U.S. Highway 12 and Highway 124. Table 2-13 shows land use by county. Most of the land (55 percent or 2,421 square miles) is used for cropland and pasture followed by mixed rangeland (21 percent or 1,175 square miles). Evergreen forestland is the third most common land use at 715 square miles or 16 percent.

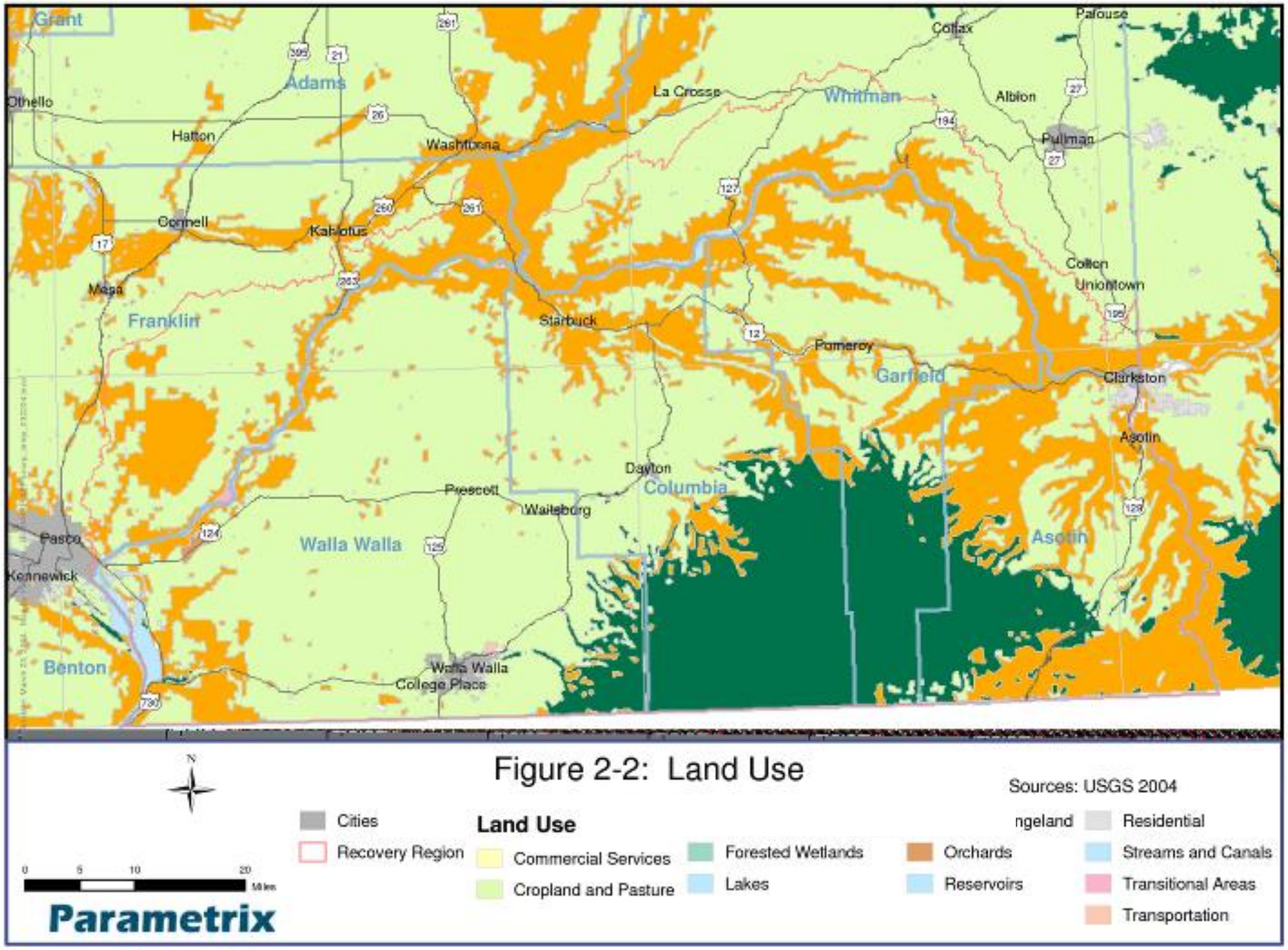


Figure 2-2 Land Use in the Southeast Washington Recovery Management Unit.

Table 2-13 Land Use by County in the Southeast Washington Recovery Management Unit.

	Area In Square Miles						
Description	Asotin	Columbia	Franklin*	Garfield	Walla Walla	Whitman*	Total
Commercial Services	0.8	0.3	0.2	0.2	3.6	0.2	**5.3**
Confined Feeding Operations					0.1		**0.1**
Cropland and Pasture	159.6	364.6	244.8	336.5	1025.7	290.4	**2421.6**
Evergreen Forest Land	140.0	341.6	0.4	168.1	64.3		**714.4**
Forested Wetlands					1.1		**1.1**
Herbaceous Rangeland					1.0		**1.0**
Industrial	0	0.2	0.2	0.1	1.4	0.1	**1.8**
Lakes			0		1.1		**1.1**
Mixed Rangeland	326.1	159.3	161.7	207.3	156.3	164.8	**1175.5**
Mixed Urban or Built-Up Land		0.2		0.1	0.2		**0.5**
Non-forested Wetlands					0.2		**0.2**
Orchards		0.3			4.5		**4.8**
Other Agricultural Land	0	0	0.1	0	0.1		**0.2**
Other Urban or Built-Up Land	1.0	0.1	0.2	0	1.0	0.2	**2.5**
Reservoirs	0.4	4.4	8.6	4.2	25.2	16.3	**59.1**
Residential	5.8	1.0	0	0.7	9.3	0	**16.8**
Shrub and Brush Rangeland		0.7					**0.7**
Streams and Canals	1.4						**1.4**
Strip Mines			0.2	0	0.7	0	**0.9**
Transitional Areas	0.1	0	1.6		0.4		**2.1**
Transportation		0	0		1.3		**1.3**
Total	**635.2**	**872.7**	**418**	**717.2**	**1296.6**	**472**	**4412.4****

Source: USGS no date.

*Includes only those portions of the county in the SEWMU.

** Total area shown on Tables 2-1 and 2-2 does not agree because the figures were derived from different sources.

In the SEWMU, land use is closely tied to water use. Land use practices affect water availability by modifying recharge and runoff patterns and by intercepting water flows. Land uses also differ significantly in the amount of water required. For example, un-irrigated rangeland or dry farm land uses considerably less water than irrigated crop land. Table 2-14 shows the acreages occupied by irrigated crops in each of the SEWMU counties. Note that the figure for Whitman County includes areas outside the SEWMU; most of the county within the SEWMU is classified as rangeland.

Table 2-14 Irrigated Crop Acreage within the Southeast Washington Recovery Management Unit.

Crop	Asotin	Columbia	Franklin	Garfield	Walla Walla	Whitman*
Corn	--	51	11,337	--	--	101
Wheat	21,110	77,740	109,627	71,689	239,200	478,098
Barley	10,205	17,547	--	36,082	22,100	160,110
Hay - alfalfa	4,671	4,178	72,728	2,826	17,400	12,637
Vegetables	--	1,787	30,145	--	38,300	5,792
Orchards	141	--	14,679	--	6,911	25
Vineyards	--	--	--	--	950	--
Total Irrigated Acres	**329**	**3,565**	**221,145**	**693**	**97,136**	**5,469**

Source: U.S. Dept. Agriculture 1997.

* Available data includes portions outside the SEWMU.

Asotin County

Asotin County lies entirely within the SEWMU. Commercial activities in the county are clustered around the City of Clarkston; residential development occurs primarily between Clarkston and the City of Asotin. The main transportation corridors are Washington Highway 129 which runs north-south and U.S. Highway 12 running east-west. The Port of Clarkston operates a 120-acre waterfront industrial site in Clarkston on the mainstem Snake River. The remainder of the county is characterized by mixed rangelands and cropland/pasture. The southwestern portion of the county contains parts of the Umatilla National Forest and the Wenaha-Tucannon Wilderness Area. In addition, the Asotin and Chief Joseph wildlife areas managed by WDFW encompass approximately 30,000 acres.

Garfield County

Garfield County lies entirely within the SEWMU. Commercial activities are grouped around the town of Pomeroy which is served by U.S. Highway 12. The rest of the county is mixed rangeland and cropland/pasture. Evergreen forests cover the southern parts of the county which are within the Umatilla National Forest and the Wenaha-Tucannon Wilderness Area.

Columbia County

Commercial activities within Columbia County, which is entirely within the SEWMU, are centered at Dayton. U.S. Highway 12 is the main transportation corridor in the county. The rest of the county is dominated by mixed rangeland and cropland/pasture except in the southern regions which lie within the Umatilla National Forest and the Wenaha-Tucannon Wilderness Area. The 16,000 acre Wooten Wildlife Area is also in the county. These areas are dominated by evergreen forestland. The approximately 11,000 acre Rainwater Wildlife Area was established in September 1998 by the CTUIR under the NPPC Fish and Wildlife Program and Washington Interim Wildlife Mitigation Agreement to protect, enhance, and mitigate wildlife impacted by development of the John Day and McNary hydroelectric dams. In 2009-2010 significant land purchases were made that added approximately 2400 acres to the pre-2009 Rainwater Wildlife Area boundary. The project is located in the upper South Fork Touchet River drainage in the Walla Walla River Subbasin approximately 8 miles south of Dayton, Washington adjacent to the Umatilla National Forest. The area was selected by the CTUIR and BPA as a regional mitigation project because of its large size, location in the upper headwaters of the Touchet River watershed, and its ability to provide anadromous fish, resident fish, and wildlife benefits in a watershed context.

The project area includes approximately 8,300 acres of upland and riparian coniferous forest, 2,500 acres of native and native-like grasslands, and 200 acres of deciduous riparian habitat. The Wildlife Area also provides 10 miles of headwater spawning and rearing habitat for Threatened summer steelhead, bull trout, and resident trout. The project provides 5,161 baseline Habitat Units (HU's) and an estimated 1,500 enhancement HU's for seven target mitigation species.

Walla Walla County

Walla Walla County lies entirely within the SEWMU. The cities of Walla Walla and College Place are the center of commercial activities; the remainder of the county is a mix of rangeland and cropland/pasture. Vineyards and orchards account for more than 1,000 acres and 2,800 acres of land within the county, respectively. U.S. Highway 12 is the main transportation corridor; the Port of Walla Walla was built following the completion of McNary Dam on the Columbia River.

Whitman County

The southern part of Whitman County is within the SEWMU. Pullman, just north of the SEWMU boundary, is the center of commercial activity for the county; major transportation corridors are U.S. Highway 195 and Washington highways 26 and 127. The primary land uses in the county are mixed rangeland and cropland/pasture.

Franklin County

The southeastern portion of Franklin County is within the SEWMU. Pasco, which lies outside the SEWMU, is the main city and the center of commercial activity. The remainder of the county is in rangeland and cropland/pasture. U.S. Highways 12 and 395 are the main transportation corridors. There are no salmon-bearing streams within the portion of Franklin County that lies within the SEWMU.

2.8.2 Land Ownership

Land ownership patterns within the SEWMU vary by county, although private landowners hold the majority of land in all counties (Figure 2-3, Table 2-15). A large amount of federal land is found in Franklin County (only the portion of Franklin County within the SEWMU was included), with the majority held by the Bureau of Land Management. Total acreage of privately held land is greatest in Walla Walla County which is home to the largest city in the SEWMU. The federal and state governments also are large landholders. The State of Washington manages a number of parks and wildlife management areas; the USFS is the largest federal landowner in the SEWMU.

The largest amount of federal land is found in Columbia County, primarily in the U.S. Forest Service’s Umatilla National Forest. The Umatilla National Forest also encompasses parts of Asotin, Garfield, Columbia, and Walla Walla counties. The Wenaha-Tucannon Wilderness Area is included in the national forest. Approximately 62 percent (111,048 acres) of the wilderness area is in the SEWMU. Roads and mechanized activities are not allowed in the wilderness area.

Table 2-15 Estimated Ownership by County (Square Miles) within the Southeast Washington Recovery Management Unit.

Agency	Asotin	Columbia	Franklin*	Garfield	Walla Walla	Whitman*	Total
Bureau of Land Management	11.5		29.7				**41.2**
Bureau of Reclamation			3.4		0.6		**4**
Department of Defense			0.3		0.5		**0.8**
Private	500.8	601	372	555.3	1268	465.5	**3762.6**
ST/CNTY/CITY	39.3	23.7	12.7	14.8	23.4	6.6	**120.5**
U.S. Forest Service	88.1	248.9		148	3.8		**488.8**
U.S. Fish & Wildlife Service					0.9		**0.9**
Tribal Lands		16.5					
Total	**639.7**	**890.1**	**418.1**	**718.1**	**1297.2**	**472.1**	**4435.3****

Source: USGS no date.

* Includes only those portions of the county in the Snake River Salmon SEWMU.

** Areas on Tables 2-1 and 2-2 differ because the data for the tables were derived from different sources.

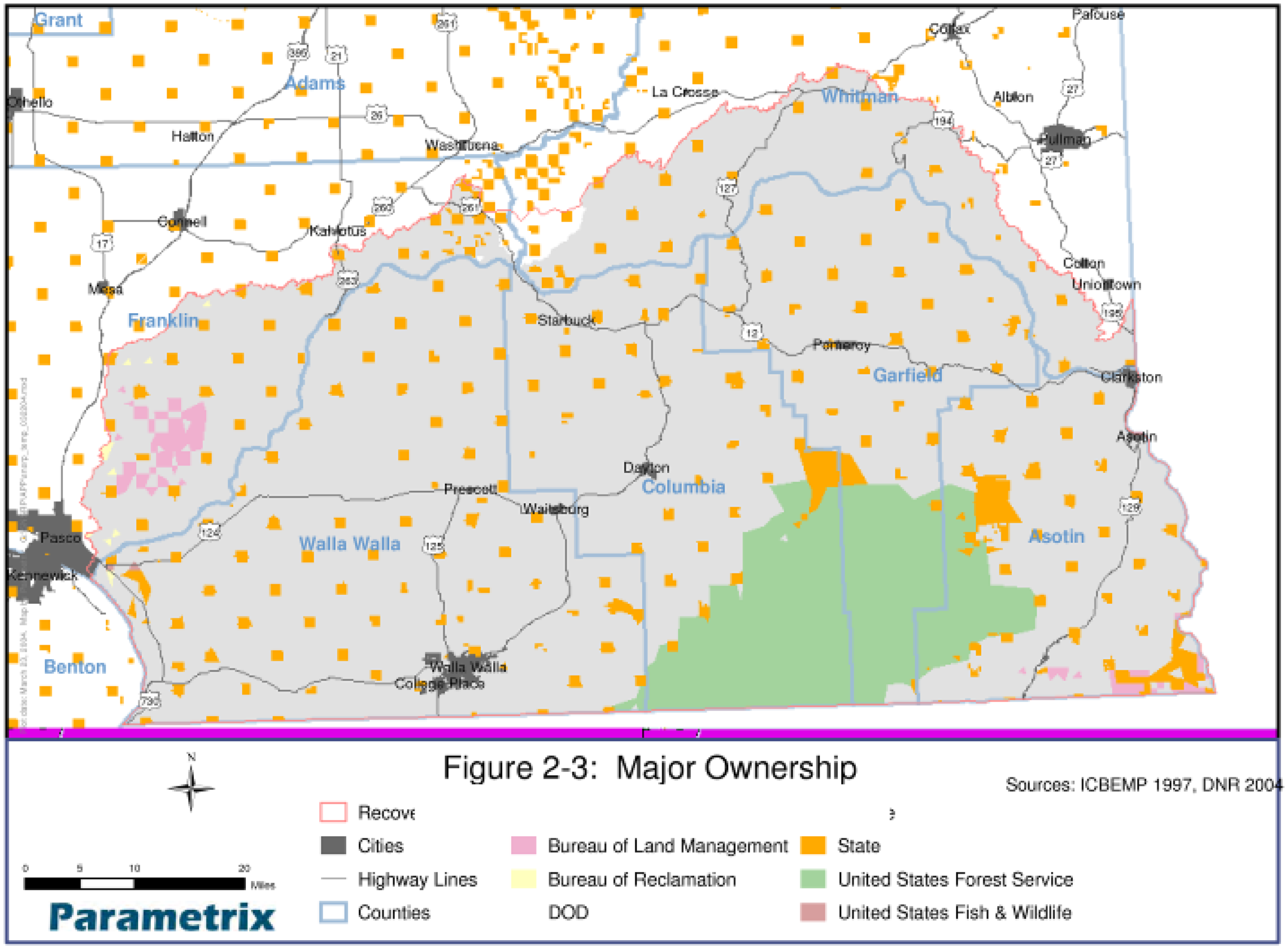


Figure 2-3 Major Ownership of land within the Southeast Washington Recovery Management Unit.

The USFWS manages the McNary Wildlife Refuge in Walla Walla County. The refuge is located south of the Snake River southeast of Pasco, Washington, and encompasses over 15,000 acres, including riverine wetlands and shoreline bays (USFWS 2004).

The Bureau of Land Management manages the Juniper Dunes Wilderness Area in the western portion of the SEWMU. The Juniper Dunes Wilderness area is approximately 7,140 acres located in Franklin County north of the Snake River. They also manage lands near the lower Grande Ronde River.

The U.S. Army Corps of Engineer (USACE) operates over one hundred park facilities in its Walla Walla Recreation District; many of which are in the SEWMU (USACE 2004b). Management of the parks is often by other government agencies or contractors. USACE parks within the SEWMU include:

- Charbonneau Park, located on the east side of the Snake River near the confluence of the Snake and Columbia rivers
- Hood Park, located on the east side of the Columbia River near its confluence with the Snake River
- Windust Park on the north bank of Lake Sacajawea in the lower Snake River
- Fishhook Park on the south bank of Lake Sacajawea
- Lyons Ferry, located in Whitman County along the Palouse River (1,282 acres)
- Chief Timothy State Park, located on an island in the Snake River eight miles west of Clarkston
- Central Ferry on the Snake River between Whitman and Garfield counties

The State of Washington owns a significant amount of land within the SEWMU. At statehood, the U.S. Congress provided 3 million acres of trustland to Washington. Trustlands were typically in sections 16 and 36 of each township (WDNR, no date), accounting for the “checkerboard” appearance of state-owned lands on Figure 2-3. State-owned lands within the SEWMU are primarily managed by the WDNR, although several other state agencies also manage land in this area. For example, the Washington Department of Fish and Wildlife manages the following wildlife areas:

- William Wooten Wildlife Area (16,000 acres) located in Columbia and Garfield counties south of Pomeroy
- Grouse Flats Wildlife Area (640 acres) located in Garfield County south of Clarkston
- Chief Joseph Wildlife Area (13,415 acres) in Asotin County south of the city of Asotin
- Asotin Creek Wildlife Area (30,000 acres) in Asotin County west of the city of Asotin (ACCD 2004)

The Washington State Parks Department (WSPD) also manages a number of large parks in the SEWMU:

- Sacajawea State Park, a 284-acre marine and day use park, located at the confluence of the Snake and Columbia rivers; includes 9,100 feet of shoreline
- Lewis and Clark Trail State Park, located on the shoreline of the Touchet River in Walla Walla County; includes 1,333 feet of shoreline
- Palouse Falls State Park (105 acres) in Whitman County along the Palouse River
- Field Springs State Park (793 acres) in Asotin County within the Blue Mountains

•

2.8.3 Jurisdiction

The State of Washington regulates use of land and water in the SEWMU through various programs including the Growth Management Act (GMA), the Shoreline Management Act (SMA), the Aquatic Resources Use Authorization Permit, and the State Environmental Protection Act. The State requires the counties to protect critical areas and natural resources through comprehensive plans and zoning ordinances. Federal agencies also influence land use through the Clean Water Act, the Endangered Species Act, and jurisdictional control by USACE over commercial waterways. Figure 2-4 shows jurisdictional boundaries within the SEWMU.

Management of Water and Water Bodies

Shoreline Management: The State of Washington exercises control of development on state shorelines through the Shoreline Management Act (SMA), adopted in 1972. SMA is intended to "prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." All counties in the SEWMU have adopted shoreline management programs and are the primary regulators of those programs. The Washington Department of Ecology (WDOE) has the authority to review local programs and permit decisions (WDOE 1999a).

State shorelines are defined as all marine waters and streams with a mean annual flow greater than 20 cubic feet per second, water areas of the state larger than 20 acres, and the upland areas that are 200 feet landward from the edge of these waters. Additionally, the SMA governs areas that are associated with these aquatic resources such as wetlands, river deltas, and 100-year floodplains (WDOE 1999a).

In 2003, the Washington legislature amended the SMA and required all local governments to amend their existing SMA programs according to the WDOE guidelines. All counties in the SEWMU are required to have their SMAs updated on or before December 1, 2013.

Water Resource Inventory Areas: The Snake River Salmon SEWMU includes the Water Resource Inventory Areas (WRIAs) of the Lower Snake (WRIA 33), Middle Snake (WRIA 35), and Walla Walla (WRIA 32), as well as the portion of the Palouse River (WRIA 34) that is accessible to anadromous fish. The Middle Snake watershed includes the Tucannon River and Asotin Creek and their tributaries. Figure 2-4 shows WRIA boundaries.

Other Programs: WDFW is responsible for preserving, protecting, and perpetuating all fish and shellfish resources of the state under the Hydraulic Code (RCW 75.20.100-160). Any construction activity near waterways must comply with the terms of a Hydraulic Project Approval (HPA). The HPA regulates activities occurring below the ordinary high water mark (OHWM) or waters of the state.

The Washington Department of Natural Resources (WDNR) also requires projects that cross or impact the bed, tidelands, or shore lands of a navigable water to submit notification under the Aquatic Resources Use Authorization. According to the Joint Aquatic Resource Permits Application (JARPA), notification is required because the State of Washington owns the commercially navigable waterways below the OHWM. Though WDNR owns the navigable waterways, the USACE regulates dredging and other activities under Section 404 of the Clean Water Act. Some activities require consultation under the Endangered Species Act.

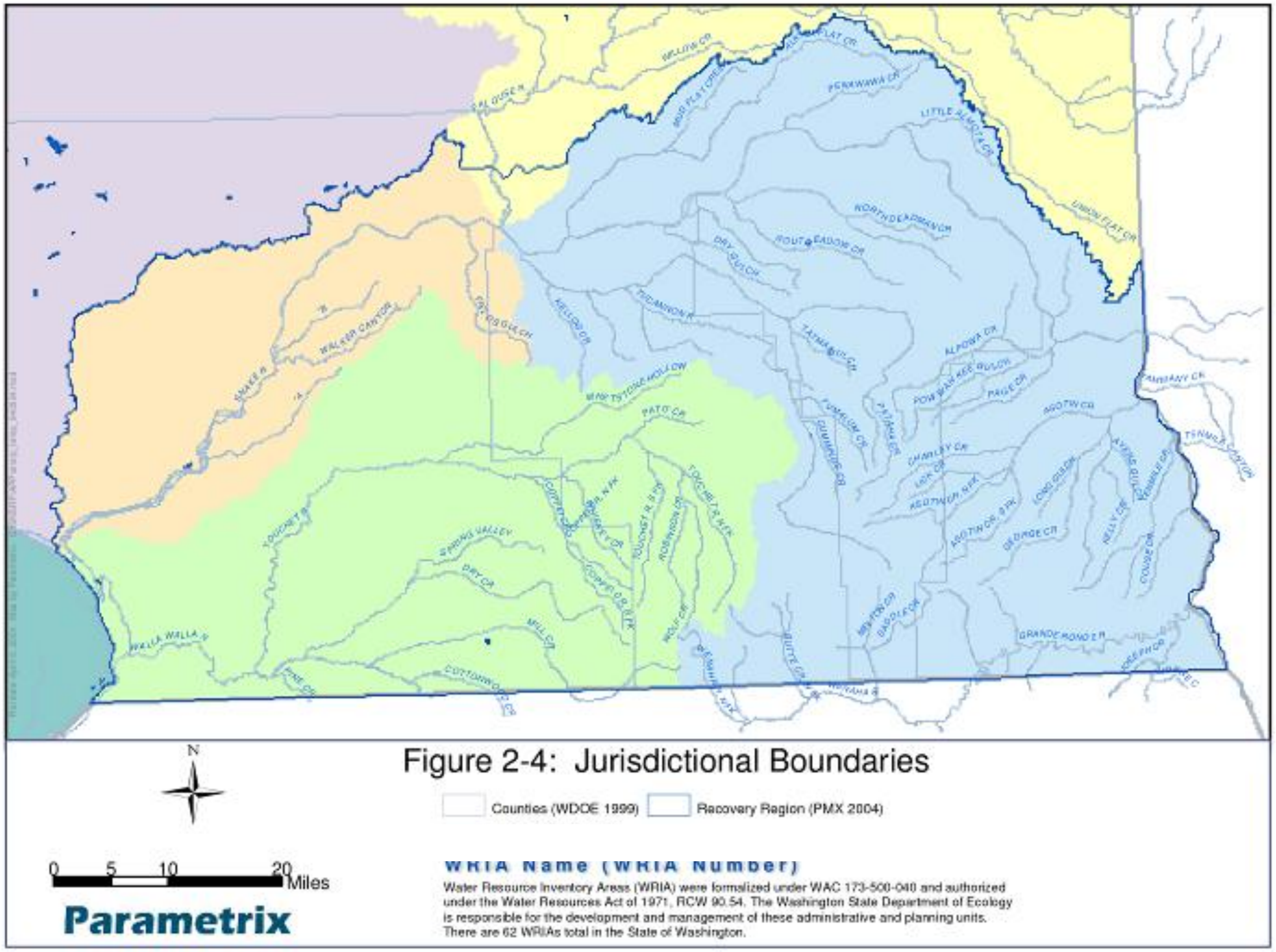


Figure 2-4 Jurisdictional Boundaries within the Southeast Washington Recovery Management Unit.

In addition, the State requires agencies to consider the environmental consequences of proposed activities before they are implemented under the regulations of the State Environmental Policy Act (SEPA). SEPA requires that all state and local governments "identify and develop methods and procedures, in consultation with the department of ecology and the ecological commission, which will insure that presently unquantified environmental amenities and values will be given appropriate consideration in decision making along with economic and technical considerations" (RCW 43.21C 2B).

Special Area Management

GMA requires state and local governments to manage growth by "identifying and protecting critical areas and natural resource lands, designating urban growth areas, and preparing comprehensive plans" (WRC 1990). The GMA states that counties meeting certain criteria are required to participate:

- Counties with populations greater than 50,000 which before May 1995 had greater than a 10 percent increase in the previous decade
- Counties which after May 1995 had a population increase of greater than 20 percent within 10 years
- Counties that choose to plan

Counties that do not meet these criteria and have chosen not to participate are still required to manage for critical areas and natural resources via development of regulations at the city and county levels. "Critical areas" are defined by GMA as wetlands, fish and wildlife habitat conservation areas, aquifer recharge areas, frequently flooded areas, or geologically hazardous areas. Natural resources are forest, agricultural, and mineral lands (RCW Title 36.70A 1990). Most counties and cities generally use maps provided by WDOE, the USFWS National Wetlands Inventory, the state shorelines list of aquatic resources, and USGS topographic maps to identify and regulate uses of critical areas.

The Eastern Washington Growth Management Hearings Board (EWGMHB), which operates within the SEWMU, was established to deal with dispute settlement between land use applicants and local governments. The following describes how each county within the SEWMU is implementing the GMA and **current** planning practices.

- Asotin County does not participate in Washington's GMA and has not implemented any growth controls or comprehensive plans. The county has a zoning ordinance. Asotin County plans for critical areas via Resolution 9.12.3, which identifies critical areas for shorelines, floodplains, and best management practices in conjunction with the Soil Conservation District (Asotin County 1992). A hearings board does not guide Asotin County (D. Caputo, personal communication). The cities of Asotin and Clarkston also have zoning ordinances. These two cities are bordered by lands along the Snake River owned by USACE and the Port of Clarkston.

- Columbia County voluntarily participates in Washington's GMA and manages growth via comprehensive plans and zoning. Columbia County is guided by the EWGMHB (J. Lapinski, personal communication). Columbia County implements the State's critical areas guidelines on a permit-by-permit basis. The county has a critical areas ordinance that requires wetland buffers. Planners for the city and county refer to wetland maps, topographic, and floodplain maps provided by WDOE and the Federal Emergency Management Act (FEMA) to determine compliance with the SMA and GMA (J. Lapinski, personal communication).

- Walla Walla County participates in Washington's GMA and regulates land use through a comprehensive plan and zoning ordinance. The EWGMHB guides Walla Walla County (K. Kuhn, personal communication). The county has a critical areas ordinance which maps special wetland, aquatic resource areas, and other critical areas including upland areas. This ordinance requires 25 to 100 foot protection zones of undisturbed native vegetation for critical areas (Walla Walla County 1995). The lands under the jurisdiction of the Port of Walla Walla exactly correspond to the area contained in the county. The Port manages 3,000 acres of which 20 percent is developed; development has been increasing 2 to 3 percent annually in recent years. The Port of Walla Walla does not manage any on-water facilities or facilities touching the shoreline with river access (P. Gerola, personal communication). USACE manages ports on the Snake River in the Walla Walla County area.

- Garfield County participates in GMA and has implemented a comprehensive plan and a zoning ordinance. Garfield County is guided by the EWGMHB (D. Deal, personal communication).

- Whitman County does not participate in Washington's GMA; however, Whitman County does have a comprehensive plan and zoning ordinance and does plan for critical areas and natural resources. The county plans for four types of critical areas and wetlands: 1) wetlands requiring special buffer protections, 2) floodplains identified by FEMA, 3) aquifers (two are identified in this county), and 4) sensitive habitat areas identified by the WDOE Priority Habitats and Species Database. In addition, The Port of Whitman County (PWC), which encompasses the entire county and extends along the Snake River from RM 83 to RM 138, has published a comprehensive plan (PWC 2000).

- Franklin County participates in Washington's GMA and regulates land use through a comprehensive plan and zoning ordinances. The EWGMHB guides Franklin County (Franklin County Planning, personal communication). The county manages critical areas by following guidelines established by the SEPA process (G. Wendt, personal communication).

Treaty Trust Obligations

In 1855, the United States government entered into treaties with the tribes inhabiting the eastern part of the Oregon Territory. In exchange for the preponderance of their lands, the tribes reserved certain rights, among them, "…the exclusive right of taking fish in all the streams where running through or bordering said reservation is further secured to said Indians; as also the right of taking fish at all usual and accustomed places in common with citizens of the Territory." Exercising those rights proved to be somewhat problematical, and a series of court actions sought to re-establish the tribes' rights. Probably the most definitive case was the *United States v Washington* 1974, otherwise known as the Boldt Decision after the presiding judge. This case established that the treaty tribes were entitled to the opportunity to catch up to fifty percent of the harvestable fish.

In *U.S. v Oregon*, the rights of treaty tribes to an equitable supply of the harvestable surplus of salmon in the Columbia Basin were re-affirmed. Harvest levels are set by the tribes, state agencies, and federal fisheries agencies. Management of the harvest is depicted more in Appendix E and the Harvest Module.

Treaty tribes within the SEWMU are the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation. Members of these tribes have a reserved right to fish for anadromous fish in the treaty area and, therefore, a major interest in the health and well-being of fish, particularly salmon, in the Snake River system. Salmon are of great importance to the tribes for ceremonial, subsistence, and economic purposes. The tribes, as co-managers, have been, and continue to be, active in planning, management, and other efforts aimed at increasing the numbers, viability, and range of salmon within the SEWMU.

2.9 SOCIO-ECONOMIC AND CULTURAL SETTING

2.9.1 Population and Growth

The Snake River Salmon SEWMU is generally sparsely populated, with residents scattered throughout the area in communities of less than 1,000 people or clustered in a few larger cities. Garfield County is the least populous with 2,300 persons and Walla Walla County has the highest population with 55,180. Table 2-16 shows the populations of the counties and major towns in the SEWMU.

Table 2-16 Population of Largest Communities within Southeast Washington Management Unit Counties in 2005.

City/Town	Population	County	Population
Walla Walla	29,686	Franklin	49,347
Pullman	24,948	Walla Walla	55,180
College Place	8,690	Whitman	40,740
Clarkston	7,337	Asotin	20,551
Dayton	2,655	Columbia	4,064
Pomeroy	1,517	Garfield	2,397

Source: State of Washington 2005

Development and growth within the SEWMU varies by county. Growth trends are as follows:

Asotin County: Most residents live in the area between Asotin and Clarkston in the valley created by the confluence of the Snake and Clearwater rivers. The Asotin County population grew 45 percent between 1970 and 1999 with the majority of growth occurring in the 1990s. During the 1990s, population in unincorporated areas grew 21.5 percent while incorporated cities grew 3.5 percent (Weeks 2000). The total population of Asotin County in 2000 was 20,551. Of this, 19,256 lived in the cities of Asotin and Clarkston and surrounding areas (Economic and Engineering Services 2004).

Garfield County: The southern portion of Garfield County's panhandle is densely forested and contains portions of the Umatilla National Forest and Wenaha-Tucannon Wilderness Area. Garfield County's population, the smallest in Washington, declined at an annual rate of 8 percent between 1970 and 1990. However, during the 1990s, Garfield's population grew 2.3 percent in Pomeroy, the county's only incorporated city, and 2.3 percent in unincorporated areas (Weeks 2000). In 2000, Pomeroy's population was 1,517. Although there are identified urban growth boundaries, population growth has not yet resulted in a need for those areas (D. Deal, personal communication).

Columbia County: Steady economic growth has occurred in Columbia County and is attributed to an increase in tourism dollars (J. Lapinski, personal communication). Destinations include historic buildings on the national register, a ski resort at the base of the Blue Mountains in the Umatilla National Forest, and other natural resource facilities such at the Wooten Wildlife Area or Camp Wooten (an environmental learning center). Between 1970 and 1999, the population decreased by 9.9 percent (Weeks 2000). During the 1990s, the population in incorporated cities increased by 7.8 percent, but decreased by 9.5 percent in unincorporated areas (Weeks 2002). Dayton is the largest town in Columbia County, with 2,707 residents in 2000 (Weeks 2002). The county has experienced a loss of population over the past 40 years; there were 4,569 residents in 1960 and 4,064 in 2000.

Walla Walla County: Between 1970 and 1990, the population of Walla Walla County increased by 29 percent. About 70 percent of the county's population lives in one of four incorporated cities (College Place, Prescott, Waitsburg, Walla Walla); 30 percent live in unincorporated areas. Growth during the 1990s in both unincorporated areas and incorporated cities was 9 percent (Bodeutsch 1999). Milton-Freewater, Oregon, is located within the Walla Walla Basin, but outside the SE Washington recovery area.

Whitman County: The population of Whitman County increased 9 percent between 1970 and 1990. About 84 percent of the county's population resides in incorporated cities. Between 1990 and 1999, incorporated areas grew by 8 percent and unincorporated areas grew by 1 percent. It should be noted that there are no population centers within the part of Whitman County included in the SEWMU.

Franklin County: Between 1970 and 1999, Franklin County grew by 78 percent. Population in the incorporated cities grew by 35 percent during 1990s while in the unincorporated areas, it grew by 3 percent. No data was available for the community of Burbank, which is within the SEWMU.

Table 2-17 shows projected population growth to the year 2025 for the unincorporated and incorporated portions of the counties within the SEWMUs. The Washington State Office of Financial Management (OFM) calculates projected population changes for unincorporated portions of the state in an effort to estimate future water demands. For the SEWMU, a moderate rate of growth was assumed by OFM for Asotin, Columbia, and Whitman counties. It should be noted that only small areas of Whitman and Franklin counties lie within the SEWMU; however, due to the lack of data specific to the SEWMU, data from the entire counties were used where available.

Table 2-17 Historic, Current, and Projected Populations in the Southeast Washington Recovery Management Unit

County	1990	1995	2000	2005	2010	2015	2020	2025
Asotin	17,605	19,574	20,551	21,466	22,582	23,569	24,650	25,671
Columbia	4,024	4,704	4,064	3,914	4,000	4,150	4,126	4,092
Franklin	37,473	45,756	49,347	52,642	56,392	60,216	64,687	68,997
Garfield	2,248	2,170	2,397	2,436	2,510	2,596	2,668	2,734
Walla Walla	48,439	53,269	55,180	57,475	60,030	62,398	64,856	67,158
Whitman	38,775	40,138	40,740	40,445	41,149	42,342	43,651	44,856
City/Town	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
Walla Walla	26,482	28,870	28,940	31,509	33,081	34,658	35,892	44,528
College Place	6,308	6,735	7,430	7,628	8,012	8,398	9,566	12,786
Prescott	275	305	335	337	354	371	393	505
Waitsburg	990	1,145	1,195	1,302	1,367	1,432	1,483	1,965
Dayton	2,468	2,520	2,495	2,677	2,771	2,901	3,032	3,516
Asotin	981	1,072	1,095	1,137	1,195	1,256	1,320	1,388
Clarkston	16,096	17,447	18,661	19,629	20,597	21,565	22,643	23,797
Pomeroy	1,393	1,491	1,517	1,536	1,591	1,647	1,706	1,766
Starbuck	170	165	165	165	165	165	165	165

Sources: EES 2002, 2004; USDA 1997.

2.10 HATCHERY FACILITIES

Lyons Ferry Fish Hatchery (LFH) was built in 1982 by the USACE as part of the Lower Snake River Compensation Plan (LSRCP). The hatchery is operated by WDFW, owned by USFWS, and funded by Bonneville Power Administration (BPA). LFH and other facilities are shown in Figure 2-5. The goal of the hatchery program is to restore dam-related losses of steelhead and Chinook salmon and the loss of fishing opportunity for anadromous and resident fish. Hatcheries are further discussed in detail in Appendix D and the Hatchery Module within the Snake River comprehensive recovery plan.

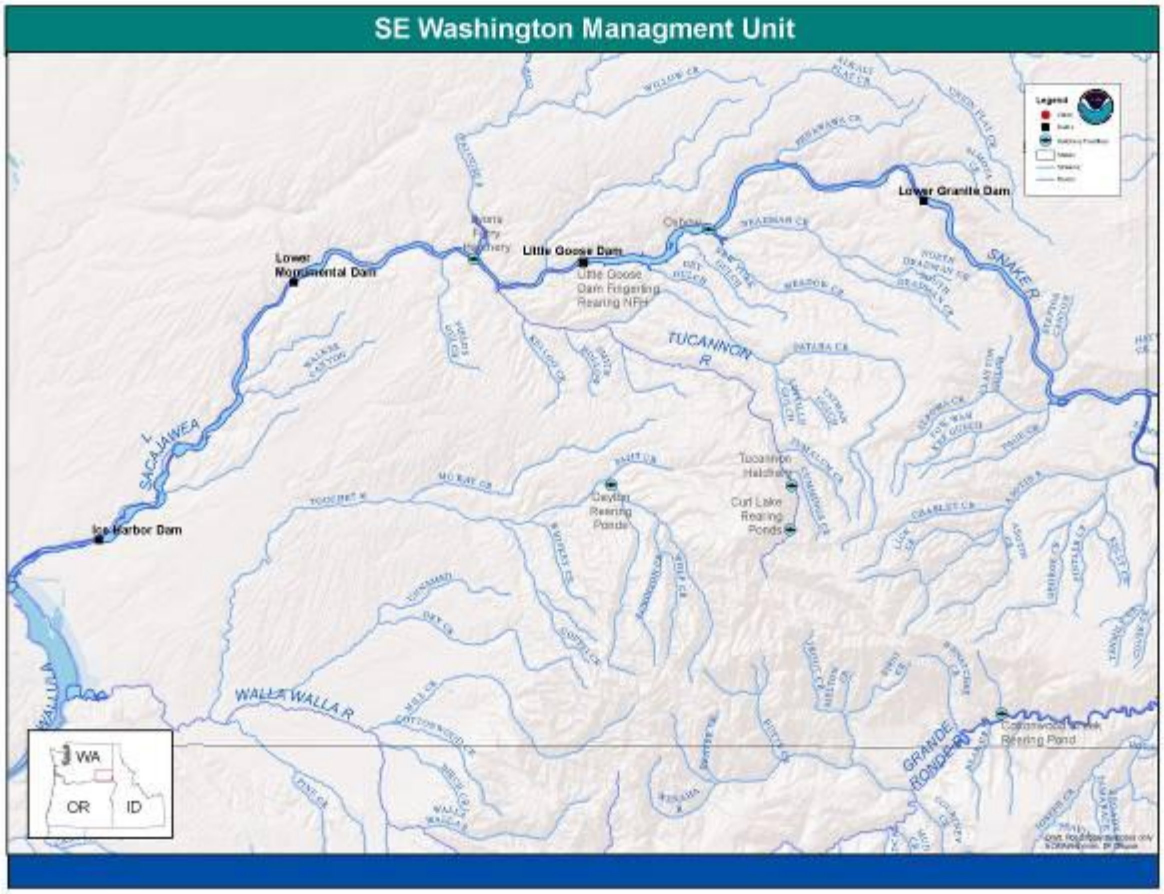


Figure 2-5.   Hatchery and major hydropower facilities within the Southeast Washington Management Unit.

2.11   HYDROPOWER FACILITIES AND OTHER SIGNIFICANT DAMS

There are four major hydroelectric dams located within the SEWMU (Figure 2-5). The USACE operates four dams on the mainstem Snake River: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. USACE also operates the Mill Creek Project for flood control on the Walla Walla River. Starbuck Dam is located on the Tucannon River and was owned by the Starbuck Power Company. It is no longer operated as a hydroelectric facility, but does continue to be used to divert flows for irrigation.

The dams in the SEWMU were built to provide hydroelectric power, river transportation (inland navigation), irrigation water, and flood control. The Lower Snake River slack-water navigation project was implemented to develop a navigation channel in the Snake River from its mouth near Pasco, Washington (confluence with Columbia River), to Lewiston ID.

The four Snake River dams were authorized by Section 2 of the River and Harbor Act of 1945 (Public Law 79-14, 79th Congress, 1st Session) and were approved March 2, 1945. The act authorized the construction of dams and open channel improvements for the purpose of providing slack water navigation and irrigation in accordance with House Document 704, 74th Congress, 3rd Session. It also specified that all surplus electrical power be delivered to the federal government.

There are also two dams that affect SEWMU that lie outside of the SEWMU. Hells Canyon Dam Complex affects water quality of the mainstem Snake River as it flows through the SEWMU. The reservoirs upstream of the dams act as a heat sink and elevates temperatures downstream. On the North Fork of the Clearwater River is Dworshak Dam, which has been used in recent years to modify the temperatures of the lower Snake River to make it more compatiable to adult salmonids as they ascend the Snake back to their natal stream.

Lower Granite Dam

The Walla Walla District of the USACE owns and operates the Lower Granite Dam which is located at RM 107.5 on the Snake River. Above the dam, the impounded Snake River is called Lower Granite Lake; below the dam is Lake Bryan. The dam is about 3,200 feet long with an effective height of 100 feet. Lower Granite Lake extends up the Snake River about 39.3 miles to Lewiston, Idaho, the upper terminus of the authorized Lower Snake River slack-water navigation project. Construction began in July 1965, with operations beginning in 1975.

The Lower Granite Dam has facilities to accommodate both juvenile and adult fish passage. Juvenile fish facilities include both a bypass system and a fish transportation system, in which fingerlings are moved by a barge or truck from the reservoir above the dam to a downstream site. Adult fish passage is accommodated with a fish ladder along the south shore with entrances on the north and south shores.

Little Goose Dam

The Little Goose Dam is at RM 70.3 on the Snake River. This dam forms Lake Bryan which extends 37.2 miles to the Lower Granite Dam. Construction started in June 1963 and the project was open to navigation in May 1970. The dam complex includes a juvenile fish collection facility.

The dam's juvenile fish facilities consist of a bypass system and juvenile transportation facilities. The adult fish passage facilities at Little Goose are composed of one fish ladder on the south shore and entrances on both the south and north shores. The powerhouse collection system consists of two downstream entrances and one side entrance into the spillway basin on the north end of the powerhouse, and a common transportation channel.

Lower Monumental Dam

The Lower Monumental Dam is located at RM 41.6 on the Snake River. It is owned and operated by the Walla Walla District of the USACE. Construction of the project began in June 1961 and it became operational in 1969. The Lower Monumental Dam forms Lake Herbert J. West which extends upstream 28.1 miles to Little Goose Dam. The dam is 3,791 feet long, with an effective height of 100 feet.

The Lower Monumental Dam provides facilities for both juvenile and adult fish passage. The juvenile facilities consist of fish passage structures and a transportation system. The adult fish passage facilities at Lower Monumental are composed of north and south shore fish ladders and collection systems with a common auxiliary water supply. The north shore fish ladder connects to two north shore entrances and the powerhouse collection system. The south shore fish ladder has two downstream entrances and a side entrance into the spillway basin. The dam complex includes a juvenile fish collection facility.

Ice Harbor Dam

The Ice Harbor Dam is located at RM 9.7 on the Snake River. The dam, owned and operated by the Walla Walla District of USACE, forms Lake Sacajawea which extends 32 miles upstream to Lower Monumental Dam. Construction of the Ice Harbor Project began in December 1955 and the project began operation in December 1961. The dam is 2,822 feet long, with an effective height of 100 feet.

This dam has two fish ladders, on the north and south shores, for passing adult migratory fish. In addition, there are facilities for juvenile fish passage.

Starbuck Dam

The Starbuck Dam is located on the Tucannon River about 5.5 miles upstream of the river mouth near Starbuck, Washington. The dam, which is about 6 feet high and 95 feet long, was built prior to 1909 to support a small hydroelectric plant at Starbuck, as well as supply irrigation water to surrounding farms. The hydroelectric plant was abandoned in 1944, but the dam continues to provide water for irrigation.

Until the early 1990s, the Starbuck Dam blocked fall Chinook salmon and delayed spring Chinook salmon and steelhead upstream migrations. In 1992-1993, BPA funded WDFW to improve fish passage at the dam. Improvements included the placement of a notch in the dam to allow passage for steelhead as well as modifications to the existing fish ladder to provide adequate access for Chinook salmon. The modified fish ladder was designed to remain open during the spring and fall to allow passage for Chinook salmon, but close during the winter to prohibit northern pikeminnow from migrating upstream, competing with salmon for spawning habitat, and preying on young salmon and steelhead.

Mill Creek Project

The Mill Creek Project dam and reservoir is operated by the USACE Walla Walla District. It is located in the drainage off Mill Creek west of the City of Walla Walla. A diversion on Mill Creek (Bennington Dam) sends water to be impounded behind the dam for flood control and recreation purposes. The dam is 800 feet wide at the base, 3,200 feet long at the crest and 125 feet high.

Construction of the dam and its associated works was completed in 1942. An auxiliary outlet channel from the dam to Russell Creek, and additional drainage facilities at the toe of the dam, were completed in 1944. Sealing the lake bottom, additional work on the drainage system in the foundation, and installation of an upstream outlet gate were completed in 1950.

Bennington Lake is the off-stream reservoir containing the diverted floodwaters of Mill Creek. The reservoir has a maximum storage capacity of 8,300 acre-feet at elevation 1265, with a five-foot freeboard. The reservoir is the only public lake within 45 miles of the City of Walla Walla.

The Mill Creek Project has two fish ladders, one at the Bennington Lake diversion dam and one at the first division works where water is diverted to Yellowhawk and Garrison creeks. Although they were designed to allow fish to pass during much of the year, there are times when fish cannot pass or when passage conditions are not adequate (Glen Mendel, WDFW, personal communication).

Mill Creek/Twin Reservoirs Project (City of Walla Walla Water Intake Dam)

The City of Walla Walla applied to add hydroelectric generation to its Mill Creek municipal water facility in 1987. Hydroelectric generation is approved as a water use subordinate to other uses such as municipal water withdrawal and provision of adequate instream flows for aquatic life. The City of Walla Walla agreed to ensure that minimum flows will be maintained in Mill Creek's natural channel "immediately below the diversion intake" (Economic and Engineering Services et al. 1998).

This section includes information only on the Snake River mainstem dams and major tributary dams currently impacting salmonids in the SE Washington SEWMU. Other dams in the SEWMU include Headgate Dam in Asotin Creek, Burlingame in the Walla Walla River, and Nursery and Cemetery dams on the Oregon side of the Walla Walla. For more detailed descriptions of dams and historical operations, see the Asotin, Grande Ronde, Lower Snake Mainstem, Tucannon, and Walla Walla subbasin plans (Hofer dam was identified as a passage barrer in the 2005 subbasin plan but has since been retrofitted with NOAA/WDFW compliant fish passage facilities).

3 BIOLOGICAL BACKGROUND

3.1 POPULATION IDENTIFICATION AND STRUCTURE

3.1.1 Important Concepts in Salmon and Steelhead Biology

Salmonid species' homing propensity (their tendency to return to the locations where they originated) creates unique patterns of genetic variation and connectivity that mirror the distribution of their spawning areas across the landscape. Diverse genetic, life history, and morphological characteristics have evolved over generations, creating runs highly adapted to diverse environments. It is this variation that gives the species as a whole the resilience to persist over time.

Historically, a salmon evolutionary significant unit (ESU) or steelhead distinct population segment (DPS) typically contained multiple populations connected by some small degree of genetic exchange that resulted from some spawners "straying" into neighboring streams. Thus, the overall biological structure of the ESU/DPS is hierarchical; spawners in the same area of the same stream will share more characteristics than those in the next stream over. Fish whose natal streams are separated by hundreds of miles will have less genetic similarity.

3.1.2 Definition of Evolutionarily Significant Units/Distinct Population Segments

An ESU is defined as a group of Pacific salmon that is "substantially reproductively isolated from other conspecific units and represents an important component of the evolutionary legacy of the species" (Waples et al. 1991). A "population segment" is considered distinct (a DPS and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics; or if it occupies an unusual or unique ecological setting; or if its loss would represent a significant gap in the species' range (71 FR 834).

ESUs/DPSs may contain multiple populations that are connected by some degree of genetic exchange through straying, and hence may have a broad geographic range across watersheds and river basins.

3.1.3 Major Population Groups

Within an ESU/DPS, independent populations can be grouped into larger populations that share similar genetic, geographic, and/or habitat characteristics (McClure et al. 2003). These major groupings, or "major population groups" (MPGs) are isolated from one another over a longer time scale than that defining the individual populations, but retain some degree of connectivity greater than that between ESUs/DPSs. The relationship between ESU/DPS, MPG, and independent populations is depicted in Figure 3-1.

Independent Populations

McElhany et al. (2000) defined an independent population as follows:

"…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season."

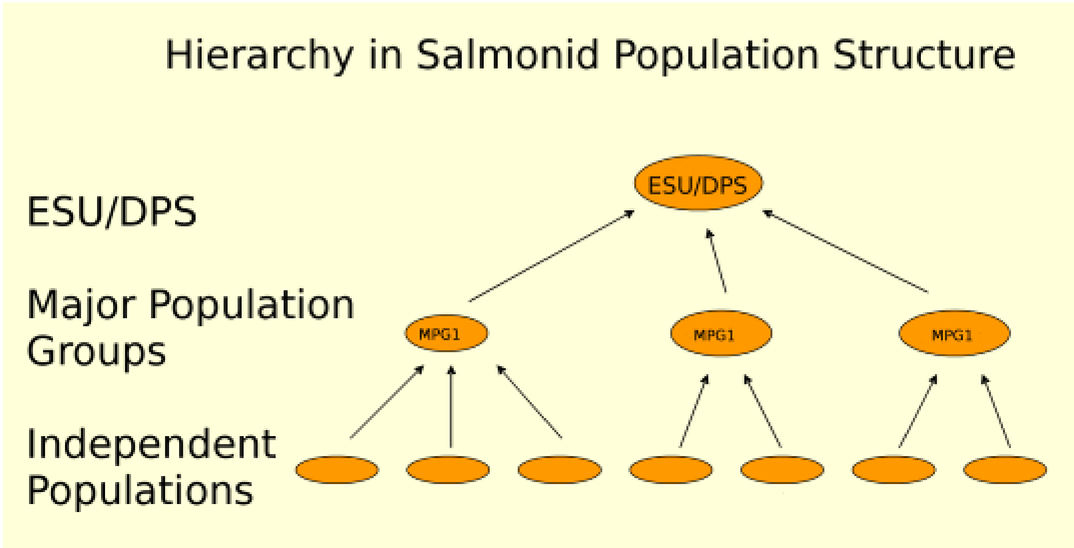


Figure 3-1. Hierarchical levels of salmonid species structure as defined by the TRTs for ESU/DPS recovery planning

3.2 KEY SPECIES AND LISTING STATUS

The key species for the Southeast Washington Management Unit (SEWMU) were chosen because of their status under the Endangered Species Act (Table 3-1). In addition, all of the key species in the SEWMU are listed as "Species of Concern" by the State of Washington.

Table 3-1 ESA Status of Key Species and Stocks within Recovery Region

Species	Stock/Race	ESU or DPS	ESA Listing Status	Listing Date	Critical Habitat
Bull trout	N/A	Columbia River DPS	Threatened	June, 1998	September, 2010
Steelhead trout	Summer	Snake River DPS	Threatened	August, 1997	September, 2005
	Summer	Mid-Columbia River DPS	Threatened	March, 1999	September, 2005
Chinook salmon	Spring/summer	Snake River ESU	Threatened	April, 1992	October,1999
	Spring/summer	Mid-Columbia River ESU	Not warranted	N/A	N/A
	Fall	Snake River ESU	Threatened	April, 1992	December, 1993

ESU = Evolutionarily Significant Unit; DPS = Distinct Population Segment.

Chinook Salmon

Snake River Spring-Summer Chinook are considered by NMFS to be one ESU, and fall Chinook another (see Section 3.3.2). Steelhead in the Snake River DPS contain fish from southeast Washington, northeast Oregon, and Idaho (see Section 3.3.3 for further information).

Snake River Chinook salmon (spring/summer and fall-runs[1]) were listed as threatened on April 22, 1992, . As a result of record low adult returns in 1994 and low projected returns for 1995, an emergency interim rule was announced August 18, 1994, to reclassify the Snake River spring/summer run and Snake River fall run as endangered; however, both Snake River Chinook salmon ESUs were subsequently classified in a final ruling as threatened (50 FR 37160). NMFS determined in March 1998, that listing was not warranted for spring/summer Chinook salmon in the Middle Columbia River ESU. These listings decisions were reaffirmed in 2005 (Good et al. 2005; 50 FR 37160).

Steelhead

Steelhead within the Snake River DPS were designated as threatened initially in August 1997 (at that time, steelhead populations were still considered an "ESU;" 62 FR 43937), and the Middle Columbia River DPS was listed as threatened in March, 1999 (64 FR 14517). In 2006, NMFS affirmed the middle-Columbia and Snake River steelhead populations, now considered DPSs, as threatened (71 FR 834).

Critical habitat was initially designated for all steelhead and salmon populations within the SEWMU in 2008 (70 FR 52630).

Bull Trout

The U.S. Fish and Wildlife Service (USFWS) issued a final rule listing the Columbia River population of bull trout as a threatened species on June 10, 1998 (63 FR 31647). A final rule was issued for critical habitat on September 10, 2010 (75 FR 63898) The Washington portions of the Snake River, Grande Ronde River and the Umatilla-Walla Walla Bull Trout Recovery Unit are part of the Columbia River DPS. The Snake River Washington Recovery Unit encompasses selected tributaries of the mainstem Snake River from Lower Monumental Dam at RM 42 upstream to the mouth of the Grande Ronde River (RM 169). The Umatilla-Walla Walla Recovery Unit encompasses the entire drainages of the Umatilla and Walla Walla rivers. The Grande Ronde Recovery Unit includes bull trout from one watershed: the Grande Ronde River. Although most of this watershed is in Oregon, the lower portion of the Grande Ronde River and the tributaries to the lower portion (including tributaries to the mainstem Wenaha River, a major tributary of the Grande Ronde) are located in Washington.

---

[1] Snake River fall Chinook salmon will be discussed in a separate appendix of the comprehensive Snake River salmon recovery plan, and therefore will not be discussed within this chapter.

3.3 SOUTHEAST WASHINGTON MANAGEMENT UNIT SALMONID POPULATION STRUCTURE[2]

3.3.1 Spring/summer Chinook Salmon

Spring/summer Chinook salmon in the SEWMU belong to two MPGs (Table 3-2; Figure 3-2). The Lower Snake spring/summer Chinook MPA is composed of independent populations in the Tucannon and Asotin subbasins and is entirely in SE Washington. The ICTRT (2007) considers the Asotin Creek population functionally extinct. The Wenaha population is partially in SE Washington and is part of the Grand Ronde MPG. From Ford et al. (2010):

> *The status of the Asotin Creek endemic population is uncertain and was classified as functionally extirpated based on redd surveys that have averaged only one redd per year between 1985 and 2003 (SRSRB 2006). The stock history of the relatively small number of spawners reported for the basin is not known, although WDFW is currently examining the genetics of spawners captured there in recent years.*[3]

[2] Sockeye salmon pass through the SEWMU, but have no spawning or rearing life histories within the SEWMU, and therefore are not discussed in this chapter.

[3]WDFW completed the genetic analysis after this was written by the ICTRT, (Blankenship and Mendel 2010) and most adults apparently are strays from the Tucannon River, although Imnaha and other stocks were also represented.

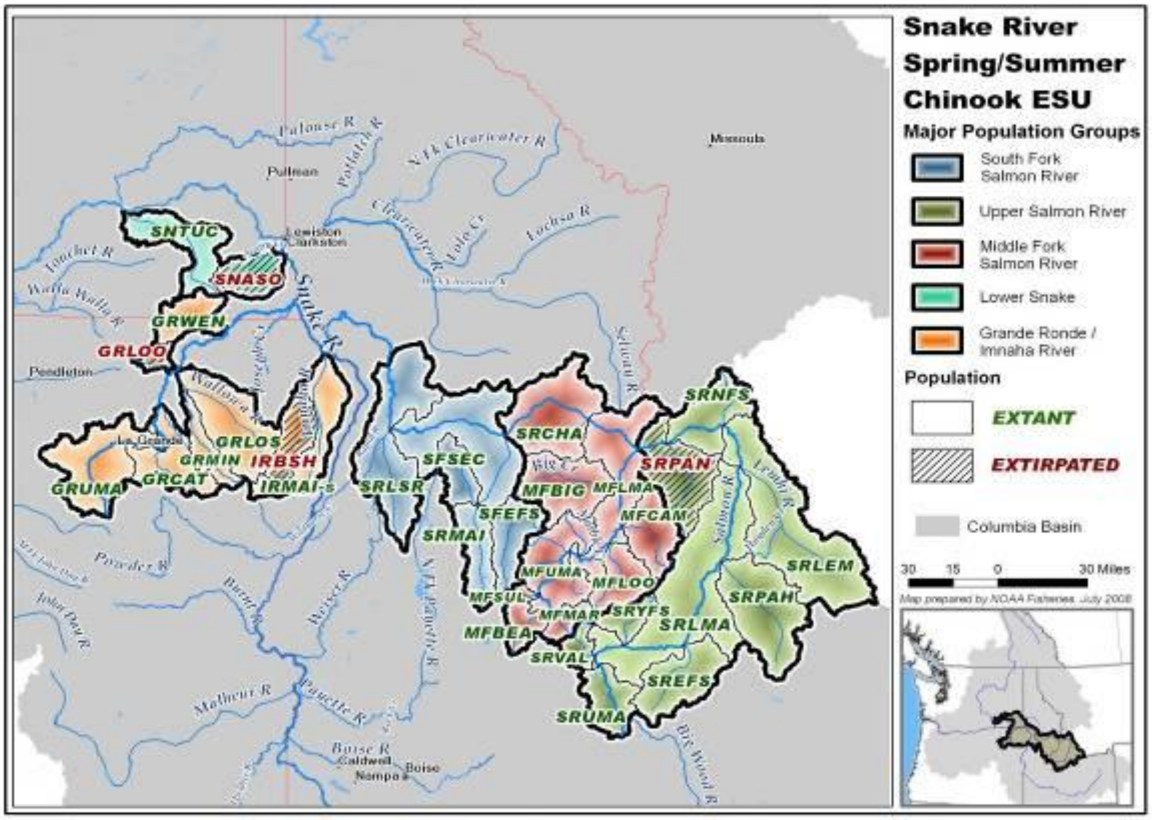


Figure 3-2. Snake River spring/summer Chinook salmon ESU. Major population groups (MPGs) with extant populations (from Ford et al. 2010).

Spring/summer Chinook in the Walla Walla River are considered functionally extinct and were not included by NMFS in the Middle Columbia River ESU.

Table 3-2 Major Population Groups for the Snake River Spring/Summer Chinook ESU (based on ICTRT 2007a).

Major Population Group	Populations	Populations within the SEWMU
Lower Snake	Tucannon River[a], Asotin Creek (extirpated)	Tucannon River, Asotin Creek
Grande Ronde	Upper Grande Ronde, Wallowa/Lostine, Imnaha, Catherine Creek, Minam, Wenaha, Big Sheep Creek, Lookingglass Creek	Wenaha (portion in Washington state)
S.F. Salmon River	S.F. Salmon, Secesh, Little Salmon Tribs, E.F. S.F. Salmon	
M.F Salmon River	Upper Middle Tribs, Chamberlin Creek/Tribs, Big Creek, Bear Valley/Elk Creek, Marsh Creek, Loon Creek, Camas Creek, Lower Middle Fork Tribs, Sulphur Creek	
Upper Salmon River	Lemhi, Upper Salmon and Tribs, Pahsimeroi, Upper Salmon Lower, Panther Creek, E.F. Salmon River, N.F. Salmon River, Valley Creek, Yankee Fork	

[a] Includes hatchery fish as part of the ESU

3.3.2 Steelhead

Steelhead from both the Middle Columbia River DPS (Walla Walla basin) and Snake River DPS (Tucannon, Asotin, lower Grande Ronde, Joseph) are found within the SEWMU. The Snake River Steelhead DPS includes all naturally spawned anadromous *O. mykiss* populations in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho as well as six artificial production conservation programs[4]: the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs (Table 3-3; Figure 3-3).

The Lower Snake steelhead MPG also consists of nine small tributaries to the Snake River that are considered as part of the Tucannon or Asotin steelhead populations (Alkali Flat, Almota, Alpowa, Couse, Deadman/Meadow, Penawawa, Steptoe, Tenmile and Wawawai creeks; Table 3-3).

[4] The programs listed in this paragraph are part of the DPS, but additional steelhead programs are currently operational in the SEWMU.

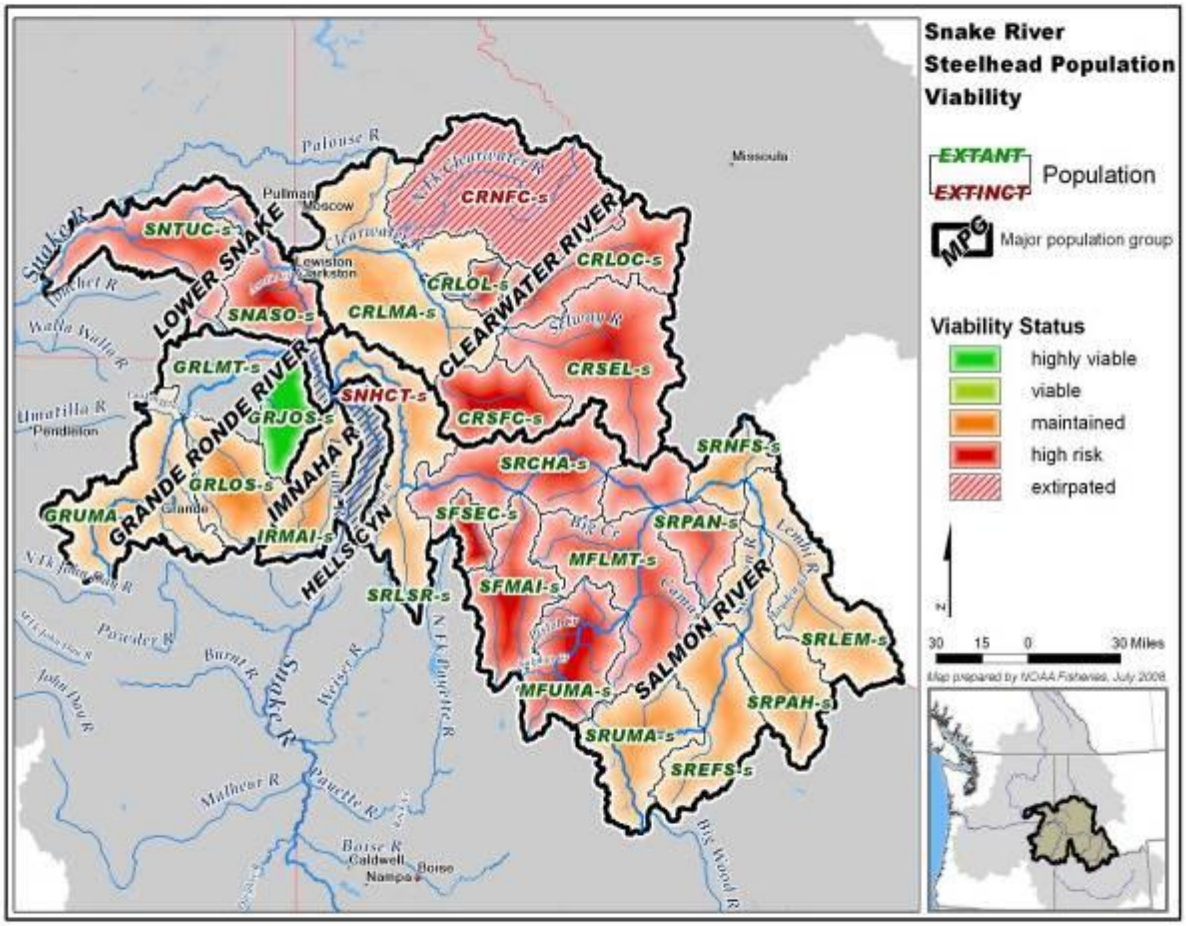


Figure 3-3. Snake River steelhead distinct population segment (DPS) populations - current status ratings based on ICTRT criteria (from Ford et al. 2010).

Steelhead within the Middle Columbia River DPS includes all naturally spawned populations of steelhead in drainages upstream of the Wind River, Washington, and the Hood River, Oregon (exclusive), up to, and including, the Yakima River, the Walla Wall River Washington, excluding steelhead from the Snake River Basin (Figure 3-4). Major drainages in this DPS are the Deschutes, John Day, Umatilla, Walla Walla, Yakima, and Klickitat river systems (Table 3-3; Figure 3-4). Steelhead produced in four artificial propagation programs are considered part of the DPS: the Touchet River Endemic Summer Steelhead Program, the Yakima River Kelt Reconditioning Program, and the Umatilla River and Deschutes River steelhead hatchery programs.

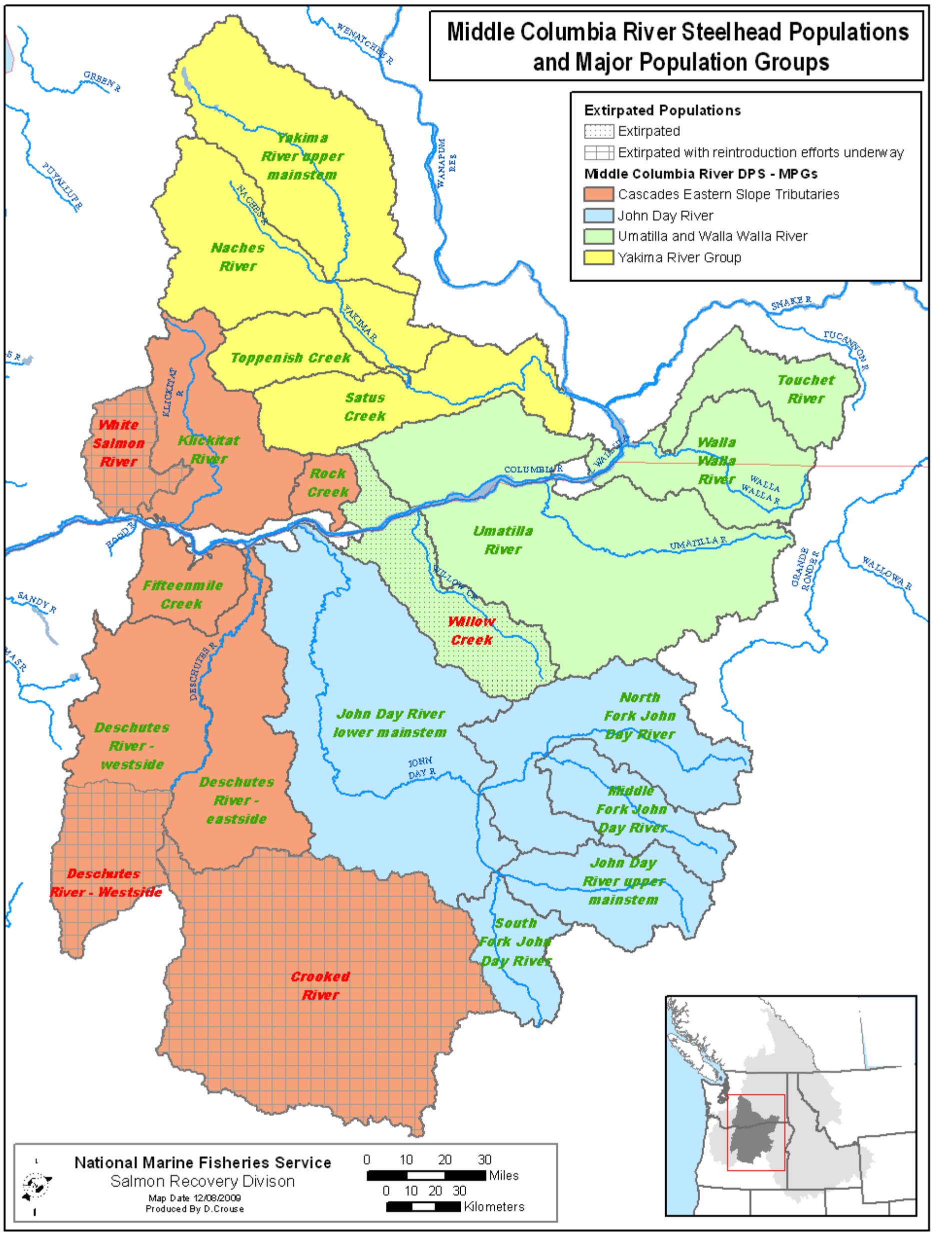


Figure 3-4. Middle Columbia steelhead DPS populations and major population groups (from NMFS 2009).

Table 3-3 Major Population Groups for the Snake River and Mid-Columbia Steelhead DPSs (based on ICTRT 2003).

Major Population Groups	Populations	Populations within the SEWMU
Snake River DPS		
Lower Snake River	Tucannon River (includes production from Penawawa, Alkali Flat, Deadman and Meadow creeks) [a] Asotin Creek (includes production from Almota, Tenmile, Steptoe, Couse, Alpowa, Wawawai creeks)	Tucannon Basin (includes production from Penawawa, Alkali Flat, Deadman and Meadow creeks)[a] Asotin Creek (includes production from Almota, Tenmile, Steptoe, Couse, Alpowa, Wawawai creeks)
Grande Ronde/Imnaha rivers	Upper Grande Ronde, Lower Grande Ronde (including the Wenaha River and Grande Ronde tributaries below the Wenaha confluence), Wallowa, Imnaha, Joseph Creek.	Lower Grande Ronde (including production from the Wenaha River Basin within Washington, and Grande Ronde tributaries in WA below the Wenaha confluence), Joseph Creek (portion within Washington State)
S.F. Salmon River	Lower Middle Fork, Upper Middle Fork, Upper Mainstem, Lemhi, S.F. Salmon, Little Salmon/Tribs, Chamberlain Creek/Tribs, Panther Creek, E.F. Salmon, Pahsimeroi, N.F. Salmon, Secesh, and Hells Canyon Tribs.	
Mid-Columbia DPS		
Cascade Eastern Slope Tributaries	Klickitat, Fifteen Mile, Deschutes (east and west), White Salmon, Rock Creek	
John Day	Lower mainstem Tribs, N.F. John Day, M.F. John Day, S.F. John Day, Upper Main John Day	
Umatilla/Walla Walla	Umatilla, Walla Walla, Touchet	Walla Walla (in WA), Touchet
Yakima	Naches, Yakima River Mainstem, Satus/Toppenish	

a- Fish in Penawawa, Alkali Flat , Deadman, Meadow, Almota, Tenmile, Steptoe, Couse and Alpowa Creeks were not considered by NMFS to be separate populations. Fish production from these streams is included in the Tucannon River or Asotin Creek populations.

Figures 3-2 - 3-4 show that the subbasins covered in this plan make up only a small portion of the Snake River and Middle Columbia River ESUs/DPSs. Because of this, the plan will not be able to determine if proposed actions lead to recovery at the ESU scale. This management unit plan will be part of the comprehensive Snake River recovery plan and middle Columbia steelhead recovery plan, which will evaluate ESU-DPS recovery.

3.3.3 Population Subdivisions: Major and Minor Spawning Areas

One additional level of geographic distinction is necessary to describe the steelhead and Chinook salmon populations covered in this recovery plan: the identification of Major Spawning Areas (MaSAs) and Minor Spawning Areas (MiSAs). This distinction is necessary because the intrinsic viability of a population increases with the number of discrete spawning areas and the complexity of their geographic distribution. Local catastrophes are less likely to decimate an entire population if it consists of a large number of spawning aggregations located in different watersheds. Moreover, such spatially complex populations are more likely to develop a wide variety of genotypes and phenotypes in response to local differences in environmental conditions. This genetic diversity represents a hedge against unpredictable environmental fluctuations. Therefore, all of the distinct populations of steelhead and spring/summer Chinook were subdivided by the ICTRT into MaSAs and MiSAs on the basis of estimates of the amount suitable habitat in contiguous reaches during historical times (ICTRT 2004).

The ICTRT, in an updated memorandum on procedures for estimating population level abundance and spatial structure (ICTRT 2004), states the following:

> *"The Tributary habitats associated with specific Interior Columbia Basin stream type Chinook and steelhead populations varied considerably in size and complexity [during historical times]. Within-population spatial structure is an important consideration in assessing risk levels relative to localized (watershed level) catastrophic events. In addition, the presence of multiple, relatively discrete spawning areas within a population can increase the potential for development and expression of within population phenotypic and genotypic diversity. The relative size of discrete spawning areas within the tributary habitat used by a particular population is also an important consideration. The ICTRT developed…an estimate of the minimum amount of tributary spawning habitat needed to support 500 spawners as a metric for use in characterizing within population spatial structure. Populations that include multiple, relatively discrete areas each capable of sustaining 500 or more spawners are hypothesized to be at less overall risk than populations with one such spawning area."*

MaSAs within a population are those that the ICTRT estimates to have had the capability of supporting at least 500 spawners historically. MiSAs are areas estimated to have had the ability to support fewer than 500 spawners. In the SEWMU, this Plan recognizes MiSAs as having had the historical ability to support between approximately 50 and 500 spawners.

For spring/summer Chinook, the total area of stream habitat constituting a MaSA is defined as greater than or equal to 100,000 m^2. A MaSA for steelhead is greater than or equal to 250,000 m^2. The number and spatial arrangement of the MaSAs present in a subbasin impact the extinction risk for each fish population. The higher the number of MaSAs present, the lower the risk of population extinction. Extinction risk is reduced further if the MaSAs are not connected "in series" (with one MaSA located directly upstream of another), thereby reducing risks associated with catastrophic floods or other events that affect everything downstream.

It is important to note that the SR RTT prioritizes habitat projects based on MaSA and MiSA designations and based on local knowledge, has reassigned, or provided greater detail than the ICTRT did when designating the major and minor spawning areas. For the ICTRT, the exact designations do not factor into risk extinction to a great deal, but they were more concerned with being consistent throughout the Columbia Basin.

Table 3-4 lists the major and minor spawning areas for the steelhead and spring/summer Chinook salmon populations in SEWMU, and compares the designation between those assigned by the ICTRT and the modifications from the SR RTT. Figures 3-5 - 3-13 depicts the ICTRT designations of each MaSA and MiSA in the SEWMU. The summer steelhead populations include the Walla Walla River, Touchet River, Tucannon River, Asotin Creek, Lower Grande Ronde River, and Joseph Creek populations. The spring/summer Chinook populations include those in Asotin Creek, Tucannon River, and Wenaha River.

Table 3-4 Major and Minor Spawning Areas within the SE Washington Recovery Region

DPS/ESU	Population	ICTRT designated		SR RTT designated	
		MaSA	MiSA	MaSA	MiSA
Mid-Columbia Steelhead DPS	Walla Walla	Walla Walla	Mud-Dry Creeks	Walla Walla River and tributaries, excluding Mill Creek and Touchet River watersheds	Pine-Dry Creek, Dry Creek (Dixie)
		Mill Creek (from mouth to headwaters and all tributaries)		Mill Creek and all tributaries from mouth to headwaters	
		Pine-Dry Creeks (from mouth to headwaters and all tributaries)			
	Touchet	Upper Touchet (includes upstream of Prescott and all tributaries)		Middle Mainstem Touchet River and all tributaries from Coppei Creek to Patit Creek confluence exclusive of Patit Creek	Patit Creek
				Upper Touchet and all tributaries upstream of Patit Creek confluence	
Snake River Steelhead DPS	Tucannon	Tucannon (from mouth to headwaters and all tributaries)	Pataha and Penawawa creeks	Tucannon River and all tributaries upstream of Pataha Creek (exclusive of Pataha Creek).	Penawawa and Alkali Flats creeks including all tributaries from mouth to headwaters, Kellog, Smith Hollow Creeks, and lower Tucannon mainstem below Pataha Creek, Deadman/Meadow Creek and all tributaries from mouth to headwaters
				Pataha Creek and all tributaries from mouth to headwaters,	

DPS/ESU	Population	ICTRT designated		SR RTT designated	
		MaSA	MiSA	MaSA	MiSA
	Asotin	Asotin Creek (from mouth to headwaters and all tributaries)	Tenmile, Almota, Tammamay (ID), Steptoe, and Tenmile Canyon creeks.	Asotin Creek mouth to headwaters including George Creek	Almota, Wawawai, and Steptoe creeks including all tributaries from mouth to headwaters, Tenmile Creek and all tributaries from mouth to headwaters Couse Creek and all tributaries from mouth to headwaters
				George Creek and all tributaries from mouth to headwaters	
		Alpowa Creek (from mouth to headwaters and all tributaries)		Alpowa Creek and all tributaries from mouth to headwaters	
	Lower Grande Ronde	Wenaha River, Mud Creek (in OR)	Courtney, Grossman, Menatchee (WA), Bear, and Elbow creeks	Wenaha River	
				All tributaries and mainstem Grande Ronde River (Cougar Creek, Menatchee Creek, Cottonwood Creek, Buford Creek, Deer Creek, Rattlesnake Creek, Courtney Creek (OR), Grossman Creek (OR), Bear Creek, Grouse Creek, and Shumaker Creek, Crooked Creek)	
	Joseph Creek	Joseph Creek (upstream of confluence of Elk Creek), Swamp Creek, Elk Creek	Cottonwood Creek, Lower Joseph Creek (downstream of Elk Creek)	Joseph Creek and all tributaries from mouth to headwaters	

DPS/ESU	Population	ICTRT designated		SR RTT designated	
		MaSA	MiSA	MaSA	MiSA
Snake River Spring/Summer Chinook ESU	Tucannon	Upper Tucannon (upstream of Pataha Creek, and all tributaries)		Tucannon River mainstem to headwaters and all tributaries from Pataha Creek to headwaters exclusive of Pataha Creek	
	Asotin	Asotin Creek (from mouth to headwaters and all tributaries)		Asotin Creek mouth to headwaters including	
	Wenaha	Wenaha River (from mouth to headwaters and all tributaries)		Wenaha River and all tributaries from mouth to headwaters	Butte Creek

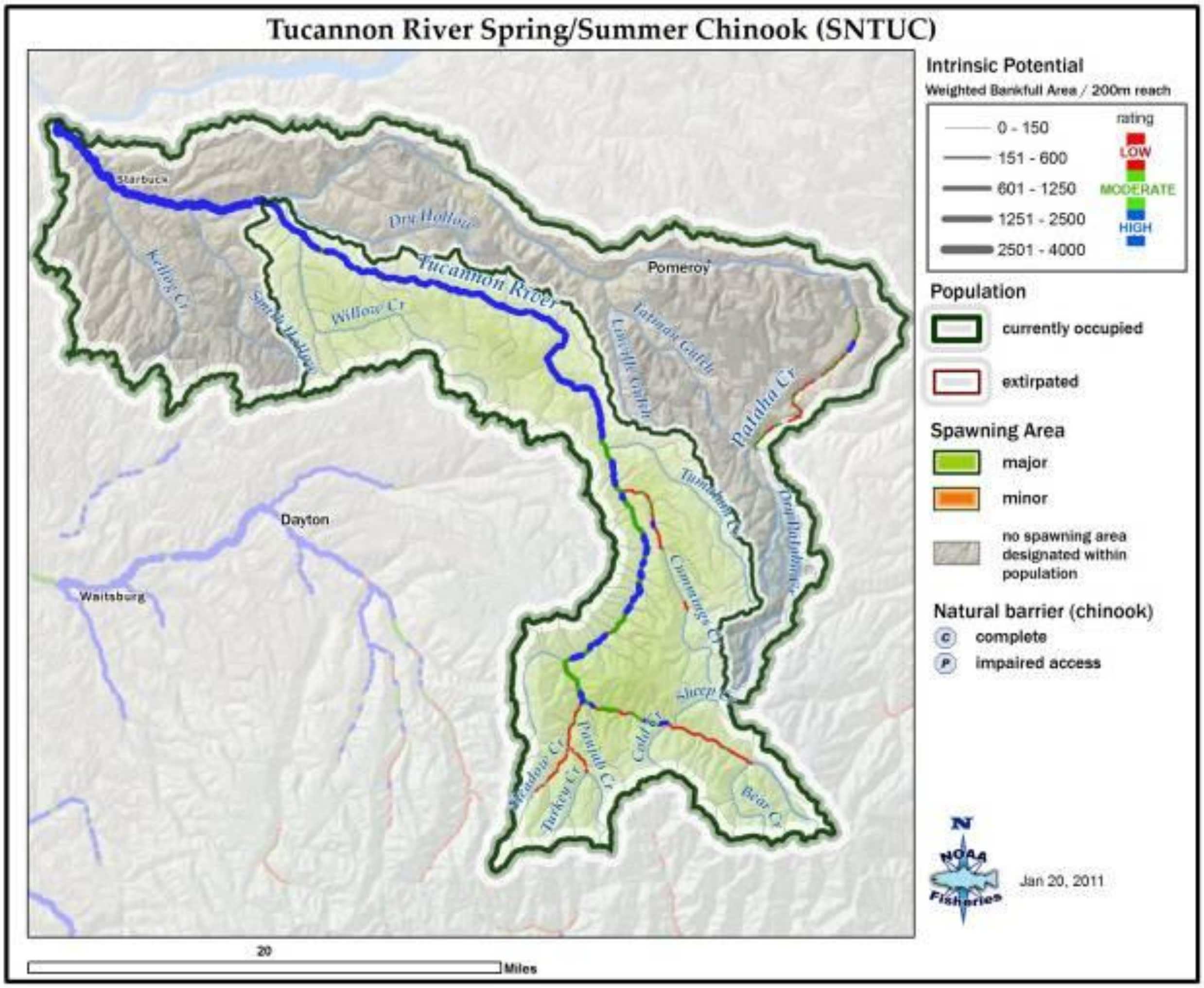


Figure 3-5. Tucannon River spring/summer Chinook salmon major and minor spawning areas (Damon Holzer, NMFS, personal communication). Note: spring Chinook currently spawn annually in the mainstem Tucannon River from several miles above Willow Creek upstream to Sheep Creek, or slightly above on some large return years.

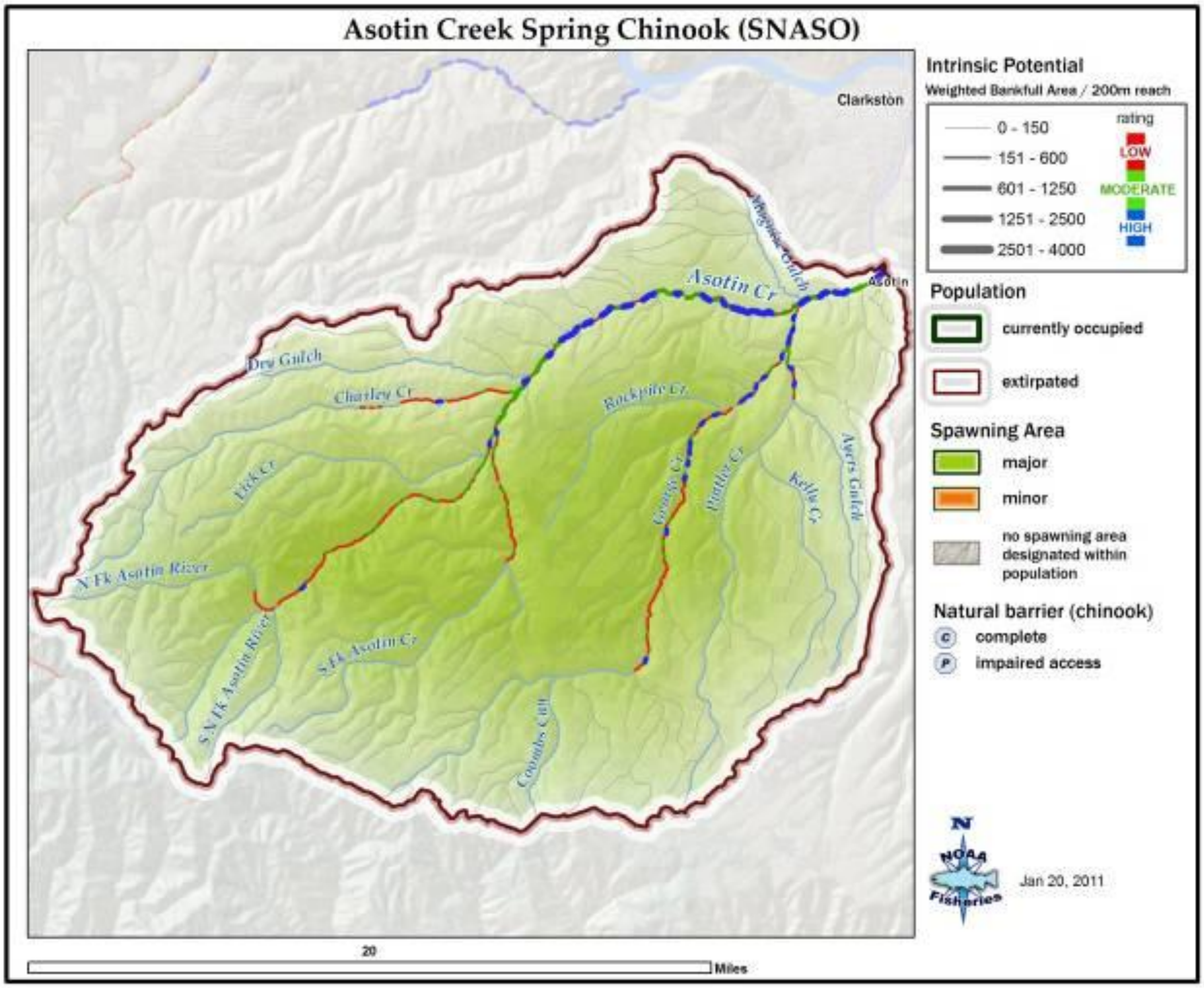


Figure 3-6. Asotin Creek spring/summer Chinook salmon major and minor spawning areas (Damon Holzer, NMFS, personal communication - this population is considered functionally extinct). Note that spring Chinook currently only spawn above Charlie Creek and in the North Fork.

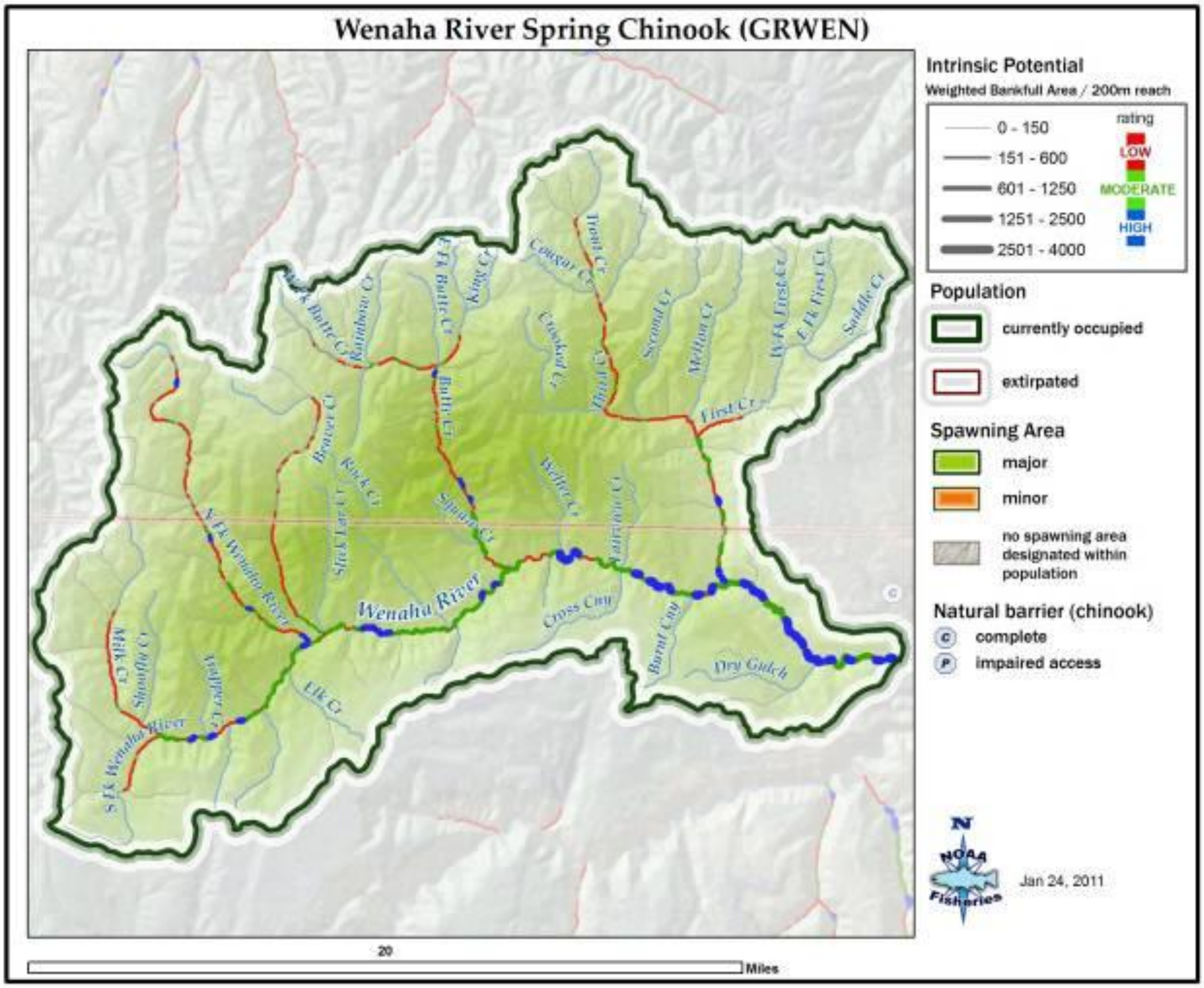


Figure 3-7. Wenaha River spring/summer Chinook salmon major and minor spawning areas (Damon Holzer, NMFS, personal communication). Note: that spring Chinook currently spawn annually in NF Wenaha to just above the state line, plus Butte Creek has annual spring Chinook spawning from the mouth up to at least confluence of E and W Butte creeks.

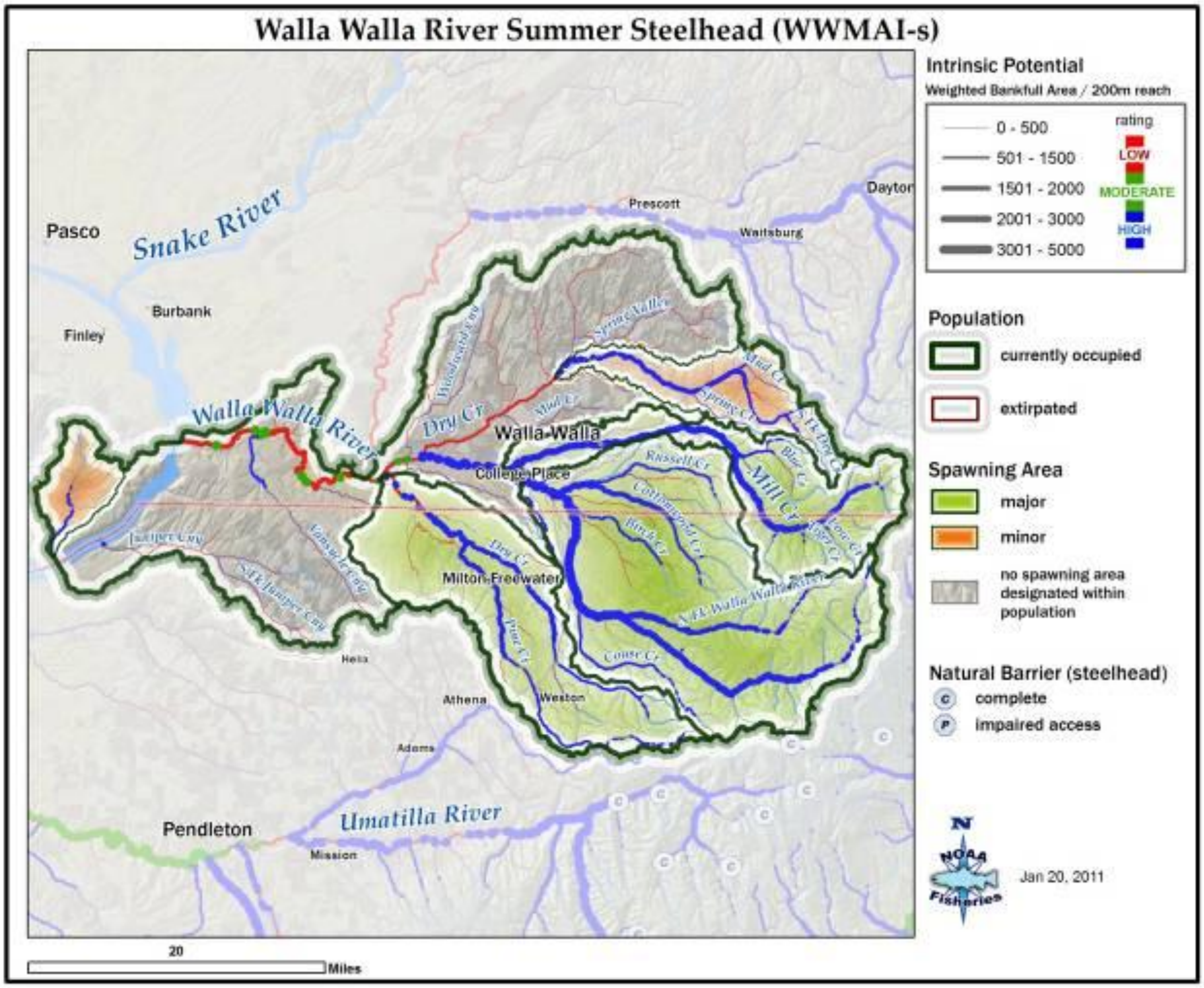


Figure 3-8. Walla Wall steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Note that steelhead have been documented spawning in Walla Walla River above Mill Creek, in Mill Creek and Blue Creek, upper Dry Creek (in WA) , Cottonwood Cr, Yellowhawk Creek, plus in the Oregon portions of the basin. Some spawning is likely in mainstem Walla Walla between upper Dry Creek (in WA) and Mill Cr.

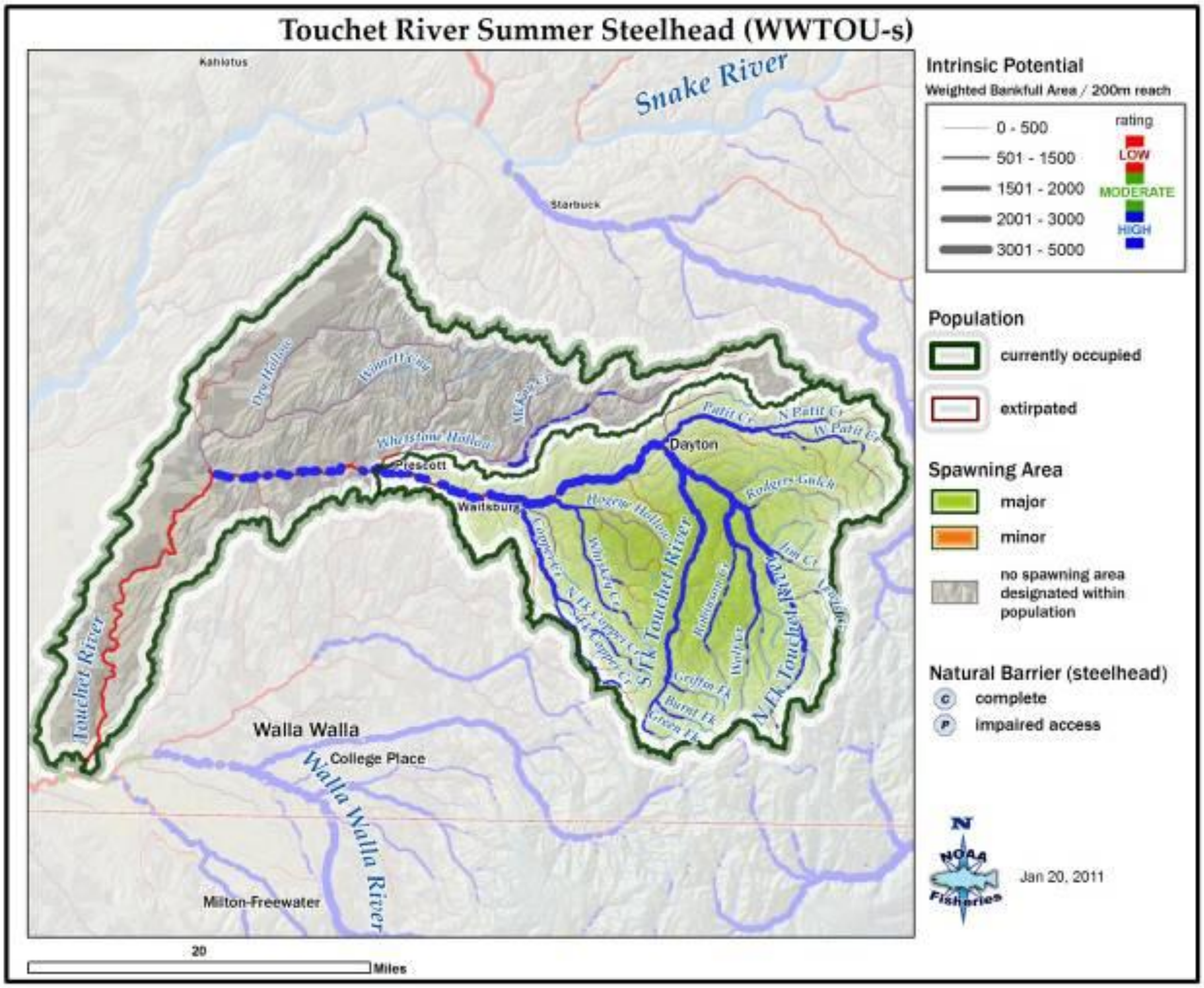


Figure 3-9. Touchet River steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Note steelhead spawning has been documented in recent years in Touchet River upstream of Coppei Creek, in Coppei Cr, in Whiskey Cr, upper Patit Cr, and the Touchet River and tributaries upstream of Dayton. Some spawning is likely between Prescott and Coppei Cr, at least some years.

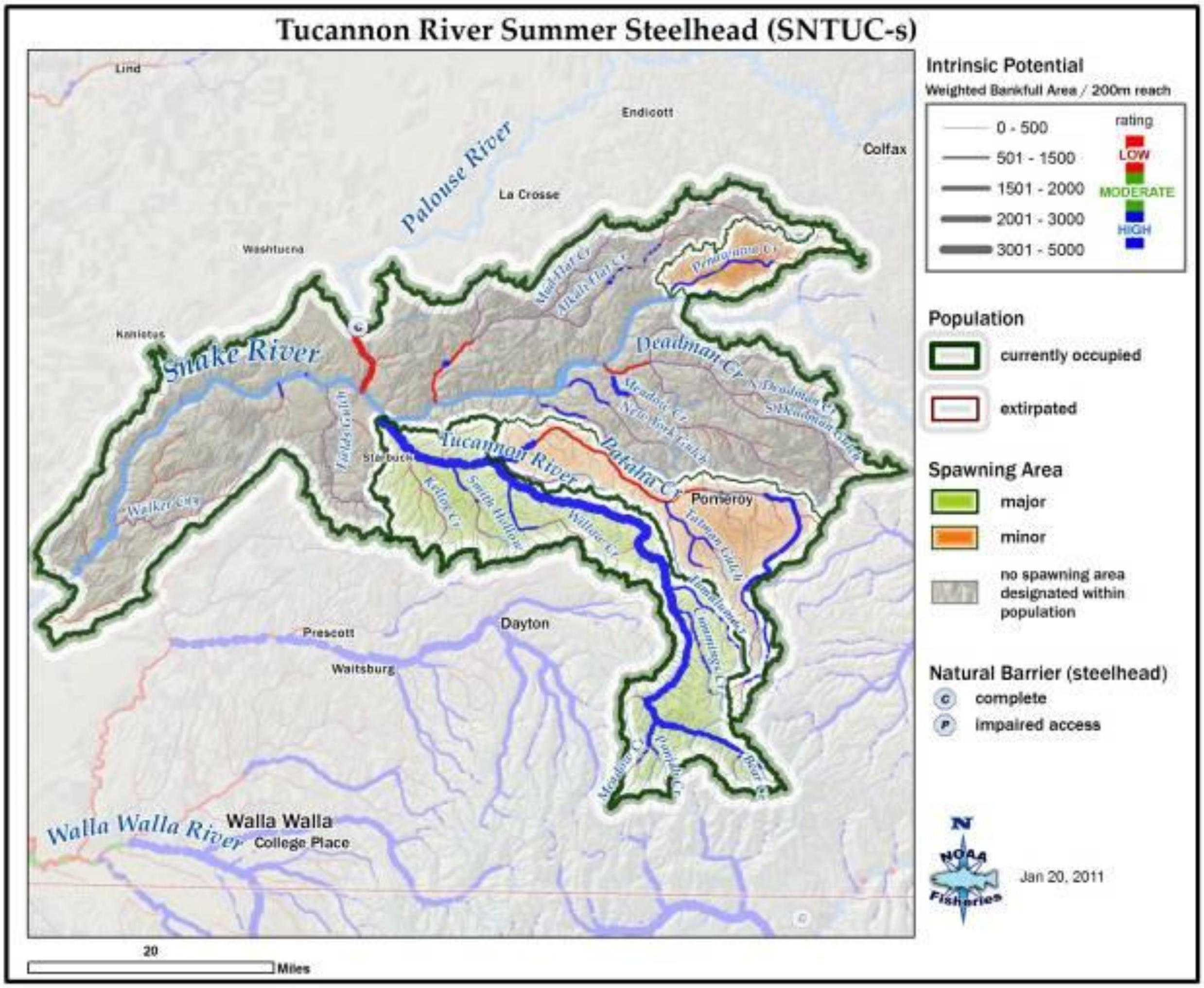


Figure 3-10. Tucannon River steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Steelhead are known to spawn in mainstem Tucannon River from near the mouth upstream to beyond Panjab Creek (and into its tributaries), in Cummings Creek and Little Tucannon River (recent), and suspected in Tumalum Creek. Steelhead are known to spawn in upper parts of Pataha Creek, and in Penawawa Cr and Deadman Cr. They are suspected to spawn in Alkali Flat Cr.

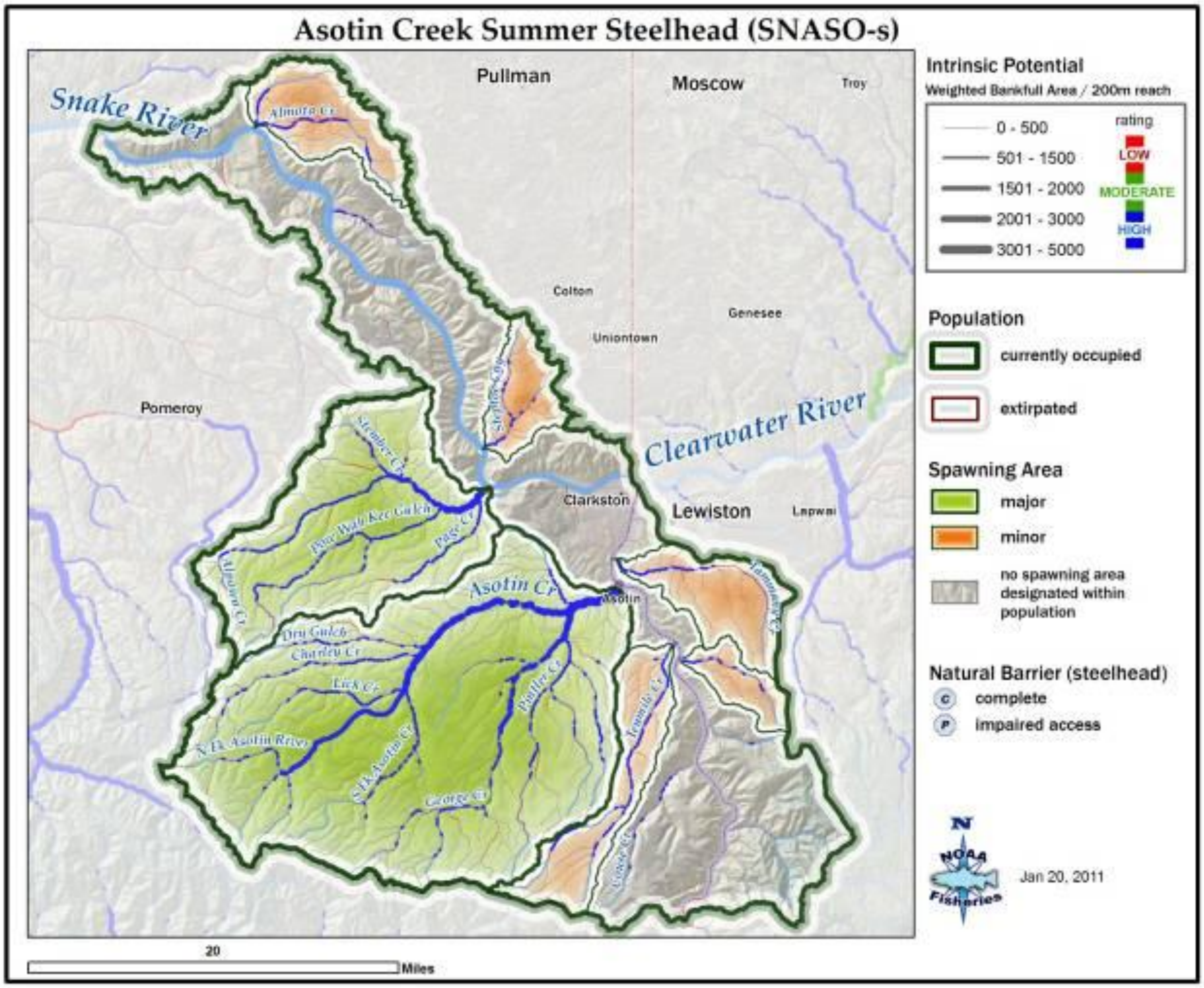


Figure 3-11. Asotin Creek steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Steelhead have been recently documented spawning in Almota Creek, Wawawai Cr, Knoxway Canyon?, Alpowa Cr, Tenmile and Couse creeks, and Asotin Creek and its tributaries (George Cr, Pintler Cr, Charley Cr, SF and NF Asotin Creeks.

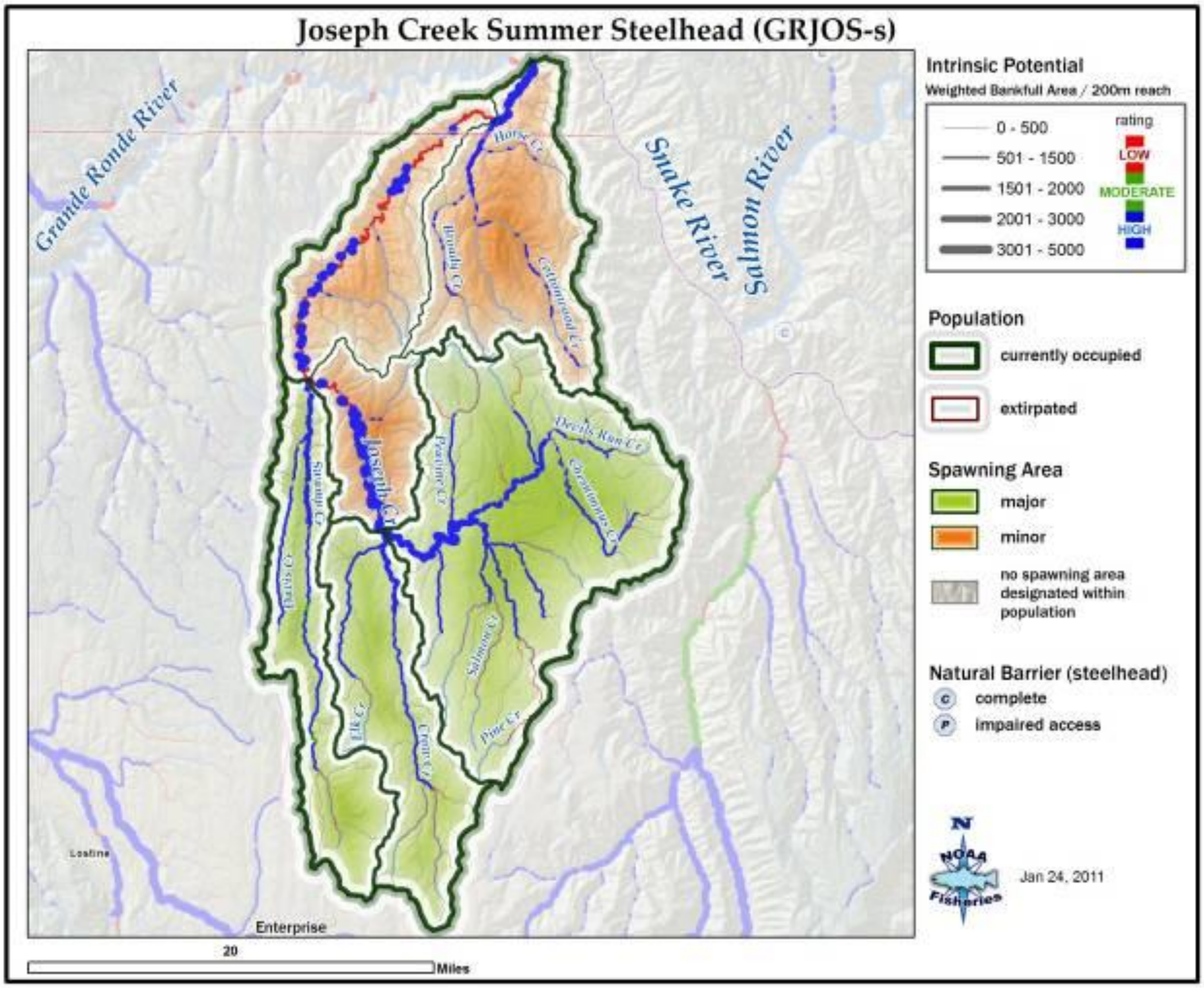


Figure 3-12.   Joseph Creek steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Steelhead are suspected of spawning in lower Joseph and Cottonwood creeks within WA.

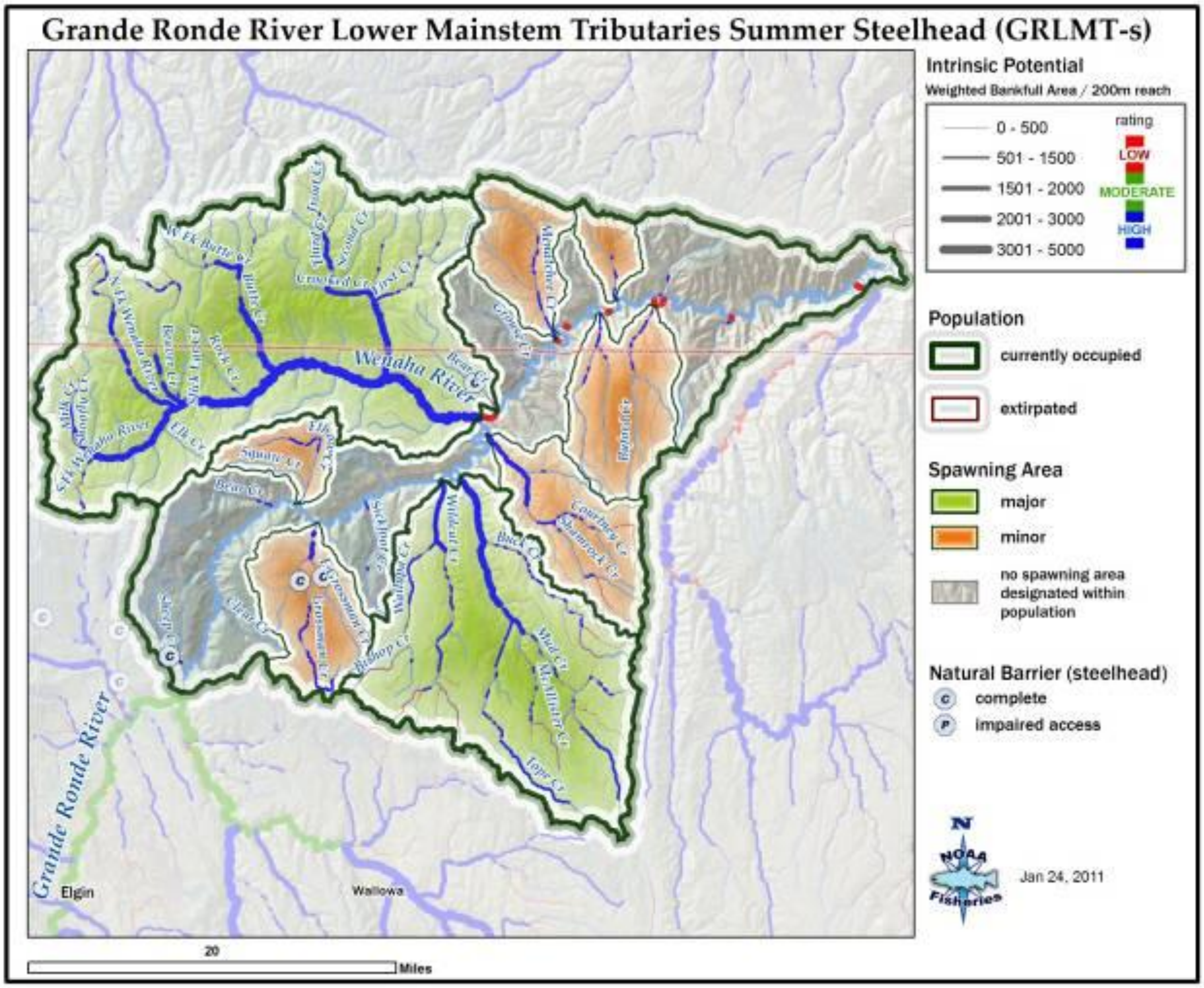


Figure 3-13. Grand Ronde Lower Mainstem steelhead major and minor spawning areas (Damon Holzer, NMFS, personal communication). Steelhead are documented to spawn in Rattlesnake Cr and Cottonwood Cr, and suspected to spawn in Cougar Cr, lower Menatchee Cr, Bear Cr, Buford Cr, and Grouse Cr. They may spawn in Shumaker Cr and several tributaries to the Wenaha River (particularly Crooked Creek).

3.4 GENERAL LIFE HISTORY OF SALMONIDS

Anadromous Pacific salmonids share similar life histories, although each species has developed its own variations and geographic preferences, which allow them to coexist in the same general environment. Salmon and steelhead hatch and rear in freshwater streams and lakes[5], but migrate to the ocean to grow and mature. Anadromous salmonids typically remain in or near their natal stream during rearing and feed primarily on aquatic invertebrates such as stoneflies and mayflies. The length of time juvenile fish remain in freshwater streams before migrating to the ocean (outmigrating) varies with species and population. For example, some Chinook salmon emigrate shortly after the yolk sac is absorbed (Myers et al. 1998), while steelhead may reside in their natal stream for up to 7 years (Peven et al. 1994). Migration timing appears to be influenced by several factors including distance to the marine environment, stream stability, stream flow and temperature regimes, stream productivity, moon phase, and general weather conditions (Myers et al. 1998, Cheng and Gallinat 2004). Prior to outmigrating, juvenile salmonids undergo physiological and morphological changes that prepare them for the transition from a freshwater to a marine existence. This adaptation, known as “smoltification,” is the most significant process in the juvenile phase of an anadromous salmonid’s life history. Once in the ocean, salmon feed primarily on crustaceans and other species of fish. They grow rapidly and generally attain peak size prior to re-entering freshwater. The length of ocean residence varies by species, but generally ranges from 1 to 4 years.

Anadromous salmonids complete their life cycle by returning to their natal streams to spawn. The timing of re-entry into freshwater varies widely both among and within species; anadromous salmonids can be found migrating in mainstem Snake and Columbia Rivers during all months of the year. However, seasonal peaks in migration, referred to as “runs” or “races”, have been identified and are used to differentiate between members of the same species within the same geographic area, e.g., spring/summer and fall Chinook salmon (Sections 3.3 and 3.4). If flow and temperature conditions are suitable, returning adults typically will hold in their natal stream until they are ready to spawn. If conditions in their natal stream are unsuitable, fish will hold in a nearby river, delaying entry until flows increase and/or temperatures decrease. Adult Pacific salmon generally do not feed during migration and spawning.

All Pacific salmonids spawn in cold, flowing water with high levels of dissolved oxygen. Generally, they prefer pool “tail-outs” with clean gravel and cobble substrates. Snake River Chinook spawn in the fall and steelhead spawn in the late winter and spring. With the exception of bull trout (Section 3.7) and a small percentage of steelhead (Section 3.6), all Pacific salmon die shortly after spawning.

Bull trout exhibit both resident and migratory life-history strategies. Resident bull trout complete their entire life-cycle in the tributary streams in which they spawn. Migratory bull trout spawn in tributary streams where juvenile fish rear for one to four years before migrating either into a lake (adfluvial form) or river (fluvial form) and returning upstream to spawn in natal waters. In coastal streams (outside the recovery region), some bull trout may migrate into salt water (anadromous form) (USFWS 2002a).

Salmon and bull trout require good water quality, high concentrations of dissolved oxygen, cool or cold water temperatures, sufficient flows, stable stream channels, clean spawning gravels, diverse instream and riparian habitat, a sufficient and diverse food supply, access to spawning and rearing habitat, and barrier-

[5] Note that no salmon or steelhead rear in lakes within the SEWMU.

free migration corridors. Each of these factors is essential to the health and survival of individual fish and the population as a whole (CDFG 2002).

3.4.1 Spring/Summer Chinook Salmon

3.4.1.1 Life History

Chinook salmon in the Columbia and Snake basins are divided into spring, summer, and fall runs based on their migration timing. Spring/summer Chinook salmon generally pass Bonneville Dam from March through May. Summer Chinook salmon begin their freshwater journey a few months later; generally passing Bonneville Dam during June and July, with fall Chinook salmon following during August, September, and October (Matthews and Waples 1991). Other than variations in run-timing, spring and summer Chinook salmon in the Snake River Basin exhibit similar life history characteristics and will be referred to in this document as “spring/summer Chinook”. NMFS also considers these two groups as one ESU; for recovery to occur under the ESA, both forms must meet recovery requirements.

Differences between the runs or races, are evident in juvenile outmigration characteristics. In the Snake River Basin, spring/summer Chinook salmon emigrate to the ocean as yearling smolts from March through June, while fall Chinook salmon generally emigrate as subyearlings from July through August, but some are observed migrating as late as the fall (Matthews and Waples 1991). These variations are used to classify Chinook salmon as “stream-type” and “ocean-type” respectively. Ocean-type fish emigrate as subyearlings, whereas stream-type fish spend an additional year (occasionally more) in fresh water before outmigration. Stream-type Chinook salmon predominate in colder latitudes and higher elevations, and ocean-type fish are more common in warmer areas, usually associated with larger stream systems. In general, Snake River fall Chinook salmon are ocean-type, although recent studies have shown that some fish overwinter in Snake River reservoirs and emigrate the following spring as yearlings (Connor et al. 2005).

The final differentiation between the Chinook salmon runs is in terms of preferred spawning habitat. In the Snake River Basin, spring/summer Chinook salmon use medium-sized streams at relatively high elevations. Fall Chinook salmon prefer large, low elevation rivers such as the lower mainstem Grande Ronde, Tucannon and mainstem Snake. Due to these distinct spawning habitat preferences, individual stream reaches typically support spawning by either fall or spring/summer Chinook salmon, and therefore produce either ocean-type or stream-type juveniles. In streams where both spring and summer Chinook salmon co-exist, spring Chinook salmon generally spawn earlier and in the upper portions of available spawning habitat, whereas summer Chinook salmon spawn later and in lower reaches. The earlier spawning timing for spring Chinook salmon is thought to be an adaptive trait acquired in response to the extended incubation period required in colder water (Matthews and Waples 1991).

Adult spring/summer Chinook salmon spawners typically enter Asotin Creek and the Tucannon, Walla Walla, and Grande Ronde rivers from late April through late June or early July. Adults move upstream to areas with adequate flow and sufficiently cool water to hold until spawning. Spawning lasts from late mid August (in the Wenaha Basin) to the end of September, with a peak in early to mid-September in the Tucannon River. By early October, all spawners have died (ACCD 2004, CCD 2004, WWWPU & WWWC 2004).

Most natural-origin Tucannon spring/summer Chinook salmon spawn at age 4 (~68 percent) or age 5 (~28 percent); however, a small percentage (~4 percent) may spawn at age 3 (Gallinat and Ross 2009). While age 6 spawners do exist, they are rarely documented (CCD 2004). The age composition of hatchery-origin adults is younger, where about 67% are age 4, 23% are age 3, and 10% are age 5 (Gallinat and Ross 2009). The age composition of spring/summer Chinook salmon spawners in Asotin Creek and the Walla Walla and Wenaha rivers are similar to that of spawners in the Tucannon River (ACCD 2004, WWWPU & WWWC 2004, and ODFW file data for Wenaha R).

As discussed previously, juvenile spring/summer Chinook salmon in the Snake River Basin rear in or near their natal stream for approximately one year and are therefore classified as stream-type Chinook salmon (CCD 2004, Behnke 2002). The outmigration is generally bimodal; with one mode occurring in the fall, and the other peak from March through May (ACCD 2004, CCD 2004, WWWPU & WWWC 2004). Numerous factors affect outmigration timing including water temperature, spring "freshets", and flow (Cheng and Gallinat 2004).

Once in the ocean, Chinook salmon grow rapidly as a result of a rich diet composed primarily of fish and crustaceans. Spring/summer Chinook salmon remain in the ocean for one to three (rarely four; primarily two) years before maturing sexually and returning to freshwater (Behnke 2002).

3.4.1.2 Habitat Usage

Habitat within the Snake River basin is different from that found in other areas inhabited by Chinook salmon. For example, Snake River basin Chinook salmon migrate up to 900 miles from the ocean (farther than most Chinook populations in the world) and the Snake River flows through terrain that is typically warmer and drier than other ecoregions containing Chinook salmon. The Tucannon spring Chinook population spawns at lower elevations than other Snake Basin spring Chinook. This warmer climate, combined with highly erodible soils, in southeast WA produces a river system that is warmer, more turbid, and has higher alkalinity, than most systems in the species' range.

Table 3-5 shows the habitat preferences for spring/summer Chinook salmon during various life stages.

Table 3-5 Habitat Preferences for Spring/Summer Chinook Salmon

Life Stage	General Area Found	Channel Units	Flow Velocity	Depth	Temperature Range	Substrate
Spring/Summer Chinook Salmon						
Rearing	Mainstem reaches with suitable habitat conditions. Typically not found in tributaries.	Edge habitat along the main channel with a variety of cover types	Slow but flowing	Max of 4 feet	53°F - 60°F (max of 77°F for short periods)	Variable
Pre-spawn Holding		Deep holes Log jams	Variable	Min of 5 feet (Min of 3 feet if significant cover available)	53°F - 60°F (max of 77°F for short periods)	Variable
Spawning		Pool or glide tail-outs	Min of 3 ft/sec	20-36 inches	42°F - 51°F (max of 60.8°F)	1 to 4 inches

Source: USACE 2004a.

Chinook salmon spawn in areas with generally stable substrates so that shifting gravel and cobbles do not damage eggs. Since salmon spawn in the fall and their offspring don't emerge from the gravel until the following spring, streambed stability is critical for survival. Juveniles rear in areas with a variety of cover types that provide protection. Smolts are found primarily in mid-channel in water of varying velocities; they usually outmigrate at night to avoid predators. Adults returning to spawn are found in areas with complex habitat features which offer protection from predators. More specific information about habitat attributes of individual streams may be found in the Asotin, Tucannon, Lower Snake River, Grande Ronde and Walla Walla subbasin plans (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004).

3.4.1.3 Historical Populations

Information about historical Chinook distribution in the Washington portion of the Snake River ESU is limited. However, anecdotal accounts suggest that spring and/or summer Chinook salmon spawned in virtually all accessible and suitable habitats in the Snake River basin (Matthews and Waples 1991). Because habitat use and migration currently are limited by culverts, dams, seasonally dewatered stream reaches, and unsuitable water quality in some areas, it is likely that historic distribution exceeded current distribution. Historical abundance of spring/summer Chinook salmon in the Snake River Basin may have exceeded 1.5 million adults during the 19th century (ACCD 2004, CCD 2004).

Information on the historical distribution and abundance of Tucannon spring/summer Chinook is not available, although the Tucannon Subbasin Plan (CCD 2004) cites an estimate of 30,000 adult spawners in the Tucannon River prior to 1916 and approximately 5,000 in the 1950s.

3.4.2 Steelhead Trout

3.4.2.1 Life history

Steelhead in the SEWMU are classified as summer steelhead, which enter freshwater in a sexually immature condition and require several months to mature and spawn. Snake River summer steelhead are further subdivided into "A-run" and "B-run" fish. A-run steelhead begin migrating up the Columbia River from June to August, generally passing Bonneville Dam by August 25 and Lower Monumental Dam between June and the following spring (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004). Adult B-run steelhead enter freshwater from late August to October and are an average of 3 to 4 inches larger than A-run fish of the same age, due primarily to a longer residence time in the ocean (CCD 2004). The majority of steelhead within the Snake River basin exhibit A-run characteristics, and aside from a few B-run fish that might enter some tributaries within the SEWMU, they are primarily native to the Clearwater and Salmon River basins in Idaho.

Low water conditions and warm temperatures in smaller streams and rivers within the SEWMU during summer and fall usually cause returning adults to hold in the Snake River or Columbia River until conditions are right to allow entry into their natal streams (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004). In larger tributaries such as the Tucannon, Walla Walla, and Grande Ronde rivers, adults begin to enter as early as June or early July; most enter during fall through spring (CCD 2004, WWWPU & WWWC 2004). In Asotin Creek, peak entry occurs from February through April (Mayer et al. 2010). Spawning begins as early as February, lasting until May with a peak in early to mid-April (ACCD 2004, CCD 2004, WWWPU & WWWC 2004).

The majority of Snake River basin steelhead return to spawn after one year in the ocean. Monitoring has shown that slightly more fish spend one year in the ocean. Between 2000-2008 in the Tucannon and 1994-2008 in the Touchet, Bumgarner and Dedloff (2009) documented 49.5% (Tucannon River) and 56.6% (Touchet River) of the fish sampled had spent one year in the ocean. The rest of the fish sampled were two-ocean age fish. In some return years two-ocean steelhead predominate.

Steelhead differ from other members of the genus *Oncorhynchus* in that individuals may spawn more than once, although the majority of individuals die after spawning the first time. Between 2000 and 2008, less than one percent of Tucannon River summer steelhead were repeat spawners (Bumgarner and Dedloff 2009). Mayer et al. (2005, 2006, 2010) and Mayer and Schuck (2009) found that between 0.4% and 2.9% of the adult natural-origin steelhead sampled in Asotin Creek are repeat spawners, and all repeat spawners were female. In the Walla Walla and Touchet rivers, repeat spawners can comprise up to 5-8% of the spawning population (Bumgarner and Dedloff 2009, and Mahoney et al. 2009).

Juveniles emerge from spawning gravels in late May or June and typically rear in or near their natal stream for one to four years before outmigrating (Bumgarner and Dedloff 2009). The majority of fish in the Tucannon and Touchet rivers spend two years in freshwater prior to migrating to the ocean, while Mayer et al. (2010) showed the same general pattern in Asotin Creek. Bumgarner and Dedloff (2009) found the following age structure:

Freshwater age	Tucannon River	Touchet River
Age 1	15.2%	6.2%
Age 2	76.3%	78.7%
Age 3	7.5%	14.6%
Age 4		0.4%

Outmigration occurs primarily from February through June (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004), with a peak in most portions of the basin in April (ACCD 2004). Numerous factors affect outmigration timing including water temperature, spring "freshets", flow, and moon phase.

Relationship of Steelhead DPS to Resident *O. mykiss*

The impact of an interbreeding rainbow trout population on the viability of a steelhead population has not been determined. "Steelhead" is the name commonly applied to the anadromous form of the species *Oncorhynchus mykiss*. The common names of the non-anadromous form are rainbow trout and redband trout (interior populations). When NMFS originally listed the Snake River steelhead as threatened on August 18, 1997 (62 FR 43937), it was classified as an "evolutionarily significant unit" (ESU) of salmonids that included both the anadromous and resident forms. Recently, NMFS revised its species determinations for West Coast steelhead under the ESA, delineating anadromous, steelhead-only "distinct population segments" (DPS). NMFS listed the Snake River steelhead DPS as threatened on January 5, 2006 (71 FR 834). Rainbow trout and redband trout are under the jurisdiction of the states unless they are listed, when they come under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). This recovery plan addresses steelhead and not rainbow trout, as is consistent with the 2006 ESA listing decision, although WDFW manages them similarly regarding habitat needs and fishing regulations in the anadromous zones of the SEWMU.

NMFS based its DPS determination on the fact that "despite the apparent reproductive exchange between resident and anadromous *O. mykiss*, the two life forms remain 'markedly separated' as a consequence of physical, physiological, ecological, and behavioral factors. . . . Steelhead differ from resident rainbow trout physically in adult size and fecundity, physiologically by undergoing smoltification, ecologically in their preferred prey and principal predators, and behaviorally in their migratory strategy" (71 FR 838).

NMFS acknowledges that the data necessary to evaluate the current status and trends of resident populations are generally lacking, as well as historical data necessary to evaluate trends in abundance and distribution of the two life history forms. NMFS concluded that the collective contribution of the resident life history form to persistence of steelhead is unknown, and may not substantially reduce the overall extinction risk of the steelhead DPS (71 FR 834). The co-managers and other stakeholders may identify research and monitoring needs to better understand the status and trends of resident rainbow trout in order to address these data gaps within the SEWMU.

3.4.2.2 Habitat Conditions and Usage

Habitat conditions in the Snake River basin differ from those found in other regions inhabited by steelhead. For example, the Snake River basin contains suitable spawning habitat at elevations higher than those seen in other areas (up to 6,000 feet) and the Snake River flows through terrain that is typically warmer and drier than other areas containing steelhead. This warmer climate, combined with highly erodible soils, produces a river system that is warmer, more turbid, and has higher pH and alkalinity, than most systems in the species' range. Smaller streams in the SEWMU also have irregular stream flows. This is particularly true during spring and summer, when highly variable flows create dewatering and re-watering issues during critical life history stages, such as spawning and egg incubation (G. Mendel, WDFW, personal communication).

Steelhead prefer different habitats during each life history stage as shown on Table 3-6 (CDFG 2002, USACE 2004a).

Table 3-6. Habitat Preferences for steelhead.

Life Stage	General Area Found	Channel Units	Flow Velocity	Depth	Temperature Range	Substrate
Steelhead						
Rearing	Tributaries and mainstem, depending on age and time of year.	Edges and pocket water of main channel flow (protected areas behind large boulders)	Variable	Variable	53°F - 64°F (max of 77°F for short periods)	Variable
Pre-spawn Holding	Tributaries and mainstem	Pool-like runs	Variable	2-6 feet	53°F - 64°F (max of 77°F for short periods)	Variable
Spawning	Primarily in small tributaries and side channels.	Tail of pool, long runs, and in areas of spring upwelling	Variable	1-2 feet	50°F - 60°F	1 to 3 inches

Source: USACE 2004a.

Steelhead are particularly effective at accessing stream reaches with suitable habitat and generally use all accessible reaches within the Snake River basin with suitable temperatures and flow (G. Mendel, WDFW, personal communication, May 2004). However, distribution is limited seasonally due to dewatering, degraded habitat quality, and migration barriers (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004).

G. Mendel (WDFW, personal communication, May 2004) states that many of the smaller systems in the basin suffer from a substantial lack of water due to a combination of natural and manmade causes. Reaches within many of these small streams are dewatered during portions of the year and others are too warm for steelhead during summer and fall months (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004). Pintler, George, and Tenmile creeks are examples of creeks that contain reaches that are periodically or completely dewatered during portions of the year. Dewatered sections are serious barriers to fish passage and greatly reduce the amount of habitat available to steelhead throughout the year. Although most of the passage barriers are not complete impediments, they often limit juvenile and adult migration and maximum distribution to periods of high flow. This is particularly detrimental during summer and early fall when significant reaches are dewatered, thereby rendering them unavailable for juvenile rearing and limiting the carrying capacity of the system (ACCD 2004). It is important to note that the SRSRB has focused habitat restoration efforts over the last 10 years to ameliorate some of the problems discussed in this paragraph, with much success in some areas. The SRSRB will continue to focus on fixing these types of threats in the future.

3.4.2.3 Historical Populations

Data regarding historical steelhead distribution in the Washington portion of the Snake River DPS are limited. However, because habitat use and migration currently are limited in some areas by culverts, dams, seasonally dewatered stream reaches, and unsuitable water quality or habitat, it is likely that historic distribution significantly exceeded current distribution.

The limited data available regarding historic abundance clearly indicate that run sizes were significantly greater prior to the 20th century (WWWPU & WWWC 2004). Dams, harvest, and land management practices including timber harvest, road construction, agriculture, and urban development, have severely depleted anadromous salmonid stocks in the region. For example, historical estimates place Tucannon River adult escapement prior to 1970 at 3 percent (approximately 3,400 adults) of the Snake River basin’s total steelhead return (CCD 2004).

3.4.3 Bull Trout

3.4.3.1 Life History

Bull trout are categorized as either resident or migratory. Stream-resident bull trout complete their entire life cycle in their natal streams. Migratory bull trout spawn in tributary streams where the juveniles usually spend from one to four years before migrating to either a larger river (fluvial) or lake (adfluvial) where they rear before returning to the headwater tributary stream to spawn (Fraley and Shepard 1989). Adfluvial bull trout are generally larger than their fluvial counterparts which, in turn, are larger than resident forms. Migratory forms occur where conditions allow movement from spawning locations to downstream waters that provide greater foraging opportunities and more temperate conditions during winter (Hemmingsen et al. 2002, Faler at al. 2004). They return to their natal streams as a refuge from warm summer temperatures and to spawn. Resident and migratory forms may occur together and either form can produce resident or migratory offspring (Rieman and McIntyre 1993).

Bull trout prefer stream reaches with cold water and loose clean gravel for spawning, which begins in late August and continues through the first part of October (Fraley and Shepard 1989). Although emergence typically takes place in the spring, it may occur as late as August in some cold-water headwater areas. Thus, bull trout eggs or fry may be in the gravels at any time of the year (Saul et al. 2001). In addition, juvenile bull trout are typically found near or within the stream bottom (Buchanan et al. 1997). This year-round reliance on the streambed makes bull trout more susceptible than other salmonids to the effects of sedimentation and channel instability, and the SRSRB has begun to focus on restoration problems with an understanding of these issues.

Bull trout have more specific habitat requirements than most other salmonids. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, substrate for spawning and rearing, and migratory corridors. Bull trout are found in colder streams and require colder water than most other salmonids for incubation, juvenile rearing, and spawning. Spawning and rearing areas are often associated with cold-water springs, groundwater infiltration, and/or the coldest streams in a watershed (USFWS 2002a).

3.4.3.2 Historical Distribution and Populations

Data describing the historic distribution of bull trout throughout the Washington portions of the Snake and Grande Ronde rivers and the Umatilla-Walla Walla recovery units are limited. Observations indicate that mainstem reaches and many tributaries within the Tucannon River, Asotin Creek, Walla Walla, Touchet and Grande Ronde watersheds were, or still are, used by bull trout at various life stages. Weeber et al. (2007), Faler et al. (2008), and Mahoney et al. (2011) found that bull trout from tributaries in the Walla Walla River, Tucannon River, Grande Ronde River, and Asotin Creek watersheds migrate into the mainstem Snake River (Columbia River from the Walla Walla River), presumably to forage and overwinter.

No data exist regarding historic distribution of bull trout in any of the subbasins listed above. The Snake River Washington Bull Trout Management Unit Team believes that before the habitat was significantly modified, fluvial bull trout from both the Tucannon River and Asotin Creek migrated into the Snake River to forage and overwinter (G. Mendel, WDFW, personal communication). WDFW suspects that bull trout were likely present, at least during the winter and spring, in George Creek, Charley Creek, and the North and South Forks of Asotin Creek and some of their major tributaries, as well as in the Asotin Creek mainstem.

Migrations between the Touchet and Walla Walla systems may have occurred prior to the mid- to late 1800s (WDFW 1998). Fluvial bull trout were likely present prior to the arrival of pioneers and probably moved freely throughout the Walla Walla and Touchet systems (WDFW 1998). Radiotelemetry data and other evidence reported by Baxter (2002) indicate that migratory bull trout also exist in the Wenaha and migrate into the Grande Ronde rivers, and some may use use the Snake River for foraging and overwintering.

3.4.3.3 Habitat Usage

Bull trout have more specific habitat requirements than other trout and salmon (Rieman and McIntyre 1993). These habitat requirements include a diverse range of cover types, low turbidity, and water temperatures colder than those generally found in the lower reaches of southeastern Washington watersheds. Table 3-7 shows bull trout habitat preferences for different life stages.

Table 3-7 Bull Trout Habitat Preferences by Life Stage

Life Stage	General Area Found	Channel Units	Flow Velocity	Depth	Temperature Range	Substrate
Rearing	Complex cover areas that provide dark shaded areas such as large wood debris, undercut stream banks, boulders, etc.	Edge habitat and log jams	Pockets of slow water within swift stream flow	Variable	44°F to 47°F and above 56°F is a limit	Variable
Adult Resident			Swiftly flowing	2-ft to 4-ft	44°F to 47°F and above 56°F is a limit	Variable
Spawning	Only in headwaters and tributaries. Low gradient stream reaches with loose, clean gravel.	Pool or glide tail-outs	Variable	To 2.6-ft	40 to 46°F	1-in to 2-in

Rieman and McIntyre 1993.

Research indicates that water temperature influences bull trout distribution more consistently than any other factor (Rieman and McIntyre 1993). Temperatures in excess of 15°C (approximately 60°F) are thought to limit bull trout distribution (Fraley and Shepard 1989; Rieman and McIntyre 1993); however, field studies indicate that even colder temperatures (less than 12°C [~54°F]) are required for bull trout populations to effectively compete with other species (Haas 2001). Even colder temperatures are required for spawning (5-9°C [41-48.2°F]), rearing (7-8°C [44.6-46.4°F]), and egg incubation (2-4°C [35.6-39.2°F]) (Goetz 1989). These thermal limitations generally restrict bull trout to the upper reaches of a watershed.

Bull trout also are extremely sensitive to competition from, and hybridization with, introduced, non-native species such as brook trout. However, in some areas with suitable temperature regimes, bull trout successfully co-exist with native species such as cutthroat trout (*O. clarki* ssp.) and resident and anadromous rainbow trout (*O. mykiss* ssp.) (Rieman and McIntyre 1993). In addition, bull trout are considered easier to catch than most salmonids because of their aggressive nature, and therefore are more susceptible to overharvest from sport fishing.

Because of their specific habitat requirements, bull trout are particularly susceptible to habitat degradation, such as altered flow regimes, impaired water quality, and physical habitat modifications. Examples of human activities responsible for these modifications include timber harvest, livestock grazing, irrigated agriculture, road development, mining, and urban development.

4 RECOVERY AND RESTORATION GOALS AND DELISTING CRITERIA

4.1 SALMON AND STEELHEAD

In this chapter we describe in greater detail the recovery and restoration goals in the SEWMU and the delisting criteria NMFS will use in future reviews of the SEWMU populations (as part of the larger ESUs and DPSs). The recovery goals that are incorporated into a locally developed recovery plan may include delisting and other "broad sense" goals - in the SEWMU, the broad sense goals are known as "restoration goals." The delisting criteria are a NMFS determination and may include both technical and policy considerations. Delisting criteria must meet the ESA requirements, while restoration may be defined more broadly. Broad sense goals are goals defined in the recovery planning process that go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic, and ecological values. Recovery scenarios are combinations of viability status for individual populations within the ESU/DPS that will meet the ICTRT criteria for overall ESU/DPS viability.

The ESA requires that recovery plans, to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). These criteria are of two kinds: the biological viability criteria, which deal with population or demographic parameters, and the "threats" criteria, which relate to the five listing factors detailed in the ESA (Figure 4-1). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B) for the delisting decision.

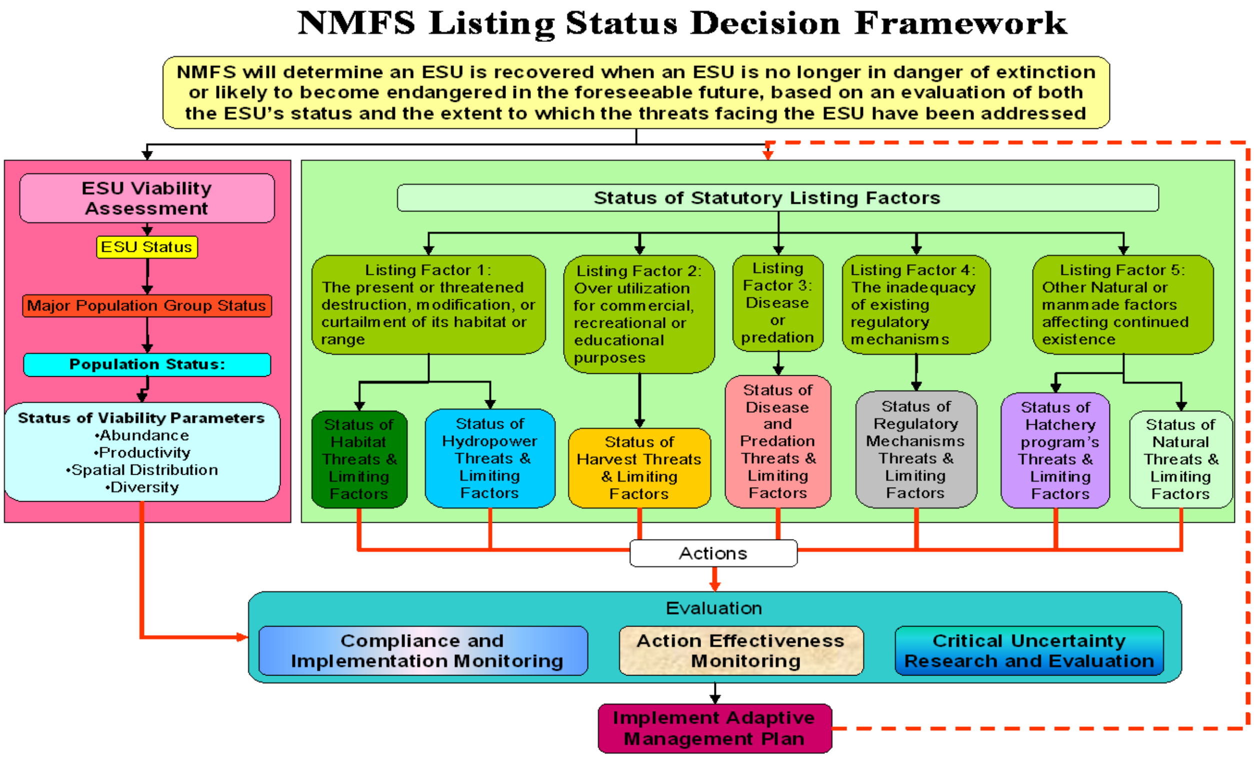


Figure 4-1. NMFS listing status decision framework.

The delisting criteria are based on the best available scientific information and incorporate the most current understanding of the ESU/DPS and the threats it faces. As this recovery plan is implemented, additional information will become available that can increase certainty about whether the threats have been abated, whether improvements in population and ESU/DPS status have occurred, and whether linkages between threats and changes in salmon status are understood. These criteria will be assessed through an adaptive management program under development for this Plan, and NMFS may review the criteria if appropriatee during its 5-year reviews of the ESU/DPS.

In accordance with responsibilities under section 4(c)(2) of the ESA, NMFS will conduct reviews of Middle Columbia steelhead every five years to evaluate the status of the DPS and determine whether it should be removed from the list or changed in status. NMFS intends to rely on status reviews of the species and of the threats that incorporate best available science and current information, including information provided by the ICTRT and salmon recovery implementers, e.g. recovery boards. Such evaluations will take into account the following:

- The biological recovery criteria (ICTRT 2007a) and listing factor (threats) criteria.
- The management programs in place to address the threats.
- Principles presented in the Viable Salmonid Populations paper (McElhany et al. 2000).

- Best available information on population and DPS status and new advances in risk evaluation methodologies.

- Other considerations, including: the number and status of extant spawning groups; the status of the major spawning groups; linkages and connectivity among groups; the diversity of life history and phenotypes expressed; and considerations regarding catastrophic risk.

4.1.1 Interior Columbia Technical Recovery Team (ICTRT)

Beginning in the early 2000s, NMFSs' Northwest Fisheries Science Center convened and chaired a collaborative, mulit-agency Technical Recovery Team to develop recommendations on biological viability criteria for interior Columbia Basin ESUs/DPSs and their component populations. The purpose of the ICTRT was to provide scientific support to local and regional recovery planning efforts, and to provide scientific evaluations of recovery plans. The intent of establishing the ICTRT was to seek unique geographic and species expertise and to develop a solid scientific foundation for the recovery plans. The ICTRT established their own criteria, but were guided (as all TRTs were) by the viable salmonid population (VSP) parameters (McElhany et al. 2000; see below for further discussion on VSP). NMFS has clarified, through Federal Register Notices on interim and proposed recovery plans, how it applies the TRT products to the plans (e.g., 71 FR 13094, 71 FR 26052, and 72 FR 57303).

The ICTRT defined the status of a salmonid ESU or DPS expressed in terms of likelihood of persistence or in terms of risk of extinction, within 100 years. The ICTRT defines viability at two levels: less than 5 percent risk of extinction within 100 years (viable) and less than 1 percent risk of extinction within 100 years (highly viable). A third category, "maintained," represents a less than 25 percent risk. The risk level of the ESU/DPS is built up from the aggregate risk levels of the populations and MPGs. All four VSP parameters must be taken into account to determine the overall risk level.

4.2 BIOLOGICAL VIABILITY CRITERIA

Viable Salmonid Populations

All the TRTs used the same biological principles for developing their recommendations for ESU/DPS and population viability criteria – criteria that may be used, along with criteria based on mitigation of the factors for decline, in determining whether a species has recovered sufficiently to be downlisted or delisted. These principles are described in a NMFS technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000).

Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, productivity (population growth rate), spatial structure, and diversity. A viable ESU/DPS is **naturally** self-sustaining, with a high probability of persistence over a 100-year time period. Each TRT made recommendations using the VSP framework, based on data availability, the unique biological characteristics of the ESUs/DPSs and habitats in the domain, and the members' collective experience and expertise. Although NMFS has encouraged the TRTs to develop regionally specific approaches for evaluating viability and identifying factors limiting recovery, all the TRTs are working from a common scientific foundation. Viability criteria are an important part of recovery goals.

[1] The ESA, under Section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must

determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for salmon and steelhead occurred in 2006 and 2011.

In 2007, the ICTRT completed its Technical Review Draft of *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs* (ICTRT 2007a). The ICTRT calculated varying levels of risk of extinction and related the risk levels to their criteria. An evaluation of the status of all Columbia basin salmonids is in the process of being updated through the required 5-year updates.

The following defines the VSP parameters:

Abundance is the number of fish produced by natural processes that have spent their entire life cycle in nature (i.e., natural-origin fish). This is often referred to as gravel-to-gravel survival or fish originating from naturally spawning parents that hatch in a stream's gravel and that survive to spawn naturally themselves years later.

Productivity is a measure of reproductive effectiveness at the population level. Typically it is stated as the number of adult offspring (recruits; which adds the number of adults harvested or taken for broodstock to the number actually arriving on the spawning grounds – this primarily applies to salmon as there is no recreational harvest of wild steelhead) produced per parent (spawner). In its most basic form it is calculated by dividing the total number of spawners in any year into the number of adult recruits that are subsequently produced by these spawners. Although it is used as an indicator of population health and resilience, it is only appropriate to do so if it has been standardized for two very strong confounding effects: 1) yearly variations in survival rates (e.g. marine conditions), and 2) yearly variations in the density of spawners relative to habitat capacity. Once a means is developed to standardize for these two confounding effects, values obtained for population productivity are indicative of a population's resilience and likelihood of persistence. A population with a low standardized productivity is at greater extinction risk than one with a high standardized productivity.

Spatial structure is the range or distribution of wild fish within a population's habitat range. Any viability evaluation must consider spatial structure within a population (or group of populations) because spatial structure affects extinction risk (McElhany et al. 2000).

Diversity refers to the distribution of traits within and among populations of salmon and steelhead. These traits include anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, physiology and molecular genetic characteristics. A combination of genetic and environmental factors largely causes phenotypic diversity. Variation or diversity in these and other traits is important to viability because a) it allows fish to take advantage of a wider array of environments; b) it spreads the risk (e.g., different ocean distribution patterns mean not all fish are at risk from local or regional varying ocean conditions); and c) genetic diversity allows fish to adapt to changing environmental conditions. Habitat, harvest, and hatchery factors can all affect diversity. In the case of hatchery programs, gene flow influences patterns of diversity within and among salmon and steelhead populations.

4.2.1 ESU/DPS Viability Criterion

Since major population groups (MPGs)are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS spatial structure and diversity. Having all MPGs within an ESU/DPS at low risk provides the greatest probability of persistence for the ESU/DPS. The ESU/DPS viability criterion defined by the ICTRT (ICTRT 2007a) is as follows:

All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS should be at low risk.

The ICTRT explains that the major objectives of the ESU/MPG-level viability criteria are to ensure preservation of basic historical metapopulation processes, including: 1) genetic exchange across populations within an ESU over a long time frame; 2) the opportunity for neighboring populations to serve as source areas in the event of local population extirpations; 3) populations distributed within an ESU/DPS so that they are not all susceptible to a specific localized catastrophic event. In addition, the presence of viable populations across MPGs would preserve a high level of diversity, promoting long-term evolutionary potential for adaptation to changing conditions (ICTRT 2007a).

4.2.2 Major Population Group Viability Criteria

The ICTRT recommended MPG-level viability criteria that take into account the level of risk associated with the MPG's component populations (Figure 4-2). While individual populations meeting viability criteria are expected to have low risk of extinction, the MPG-level criteria ensure robust functioning of the metapopulation and provide resilience in case of catastrophic loss of one or more populations. MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations. The ICTRT developed the following MPG- level criteria considering relatively simple and generalized assumptions about movement or exchange rates among individual populations. In developing these criteria, the ICTRT assumed that catastrophes do not increase dramatically in frequency, that populations are not lost permanently (because of catastrophe or anthropogenic impacts), and that permanent reductions in productivity, including long-term, gradual reductions in productivity, do not occur (ICTRT 2005).

Major Population Group Viability Criteria
(ICTRT 2007a)

The following five criteria should be met for an MPG to be regarded as at low risk (viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.
2. At least one population should be classified as "Highly Viable."
3. Viable populations within an MPG should include some populations classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate," generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.
4. All major life history strategies (e.g. spring and summer-run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.
5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.

Figure 4-2. Major Population Group Viability Criteria (ICTRT 2007a

Specifically, the first criterion for one-half of the populations to meet "viability standards" refers to the "Viable" standard, or less than 5 percent risk of extinction within 100 years. In the second criterion, "Highly Viable" means less than 1 percent risk of extinction within 100 years. These criteria follow recommendations in McElhany et al. (2000). The presence of viable populations in each of the extant MPGs and some number of highly viable populations distributed throughout the ESU/DPS would result in sustainable production across a substantial range of environmental conditions. This distribution would preserve a high level of diversity within the ESU/DPS, and would promote long-term evolutionary potential for adaptation to changing conditions. The presence of multiple, relatively nearby, highly viable, viable, and maintained populations acts as protection against long-term impacts of localized catastrophic loss by serving as a source of re-colonization. These criteria are consistent with recommendations for other ESUs in the Pacific Northwest (e.g., McElhany et al. 2006, Ruckelshaus et al. 2002, ICTRT 2007a).

4.2.3 Population-Level Viability Criteria

To be determined to be viable, populations should meet criteria for all four VSP parameters (abundance, productivity, spatial structure, and diversity). The abundance and productivity criteria are related to population size. The ICTRT developed criteria for characterizing the relative size and complexity of Interior Columbia Basin steelhead and Chinook salmon populations based on their analysis of the intrinsic or historical potential habitat available to the population (ICTRT 2005). This analysis used available Geographic Information System (GIS) data layers showing stream characteristics (e.g. channel width, gradient, valley confinement) and empirically derived relationships between habitat type, stream structure, landscape processes, and spawning. The ICTRT built a model that also incorporated information from local biologists and recovery planners to identify natural barriers to migration and other local variations (ICTRT 2007a).

The ICTRT categorized historical population sizes as Basic, Intermediate, Large, and Very Large, and set minimum abundance thresholds for viable salmonid populations of each type (Table 4-1). The abundance thresholds are associated with minimum productivity thresholds, based on modeling studies described in ICTRT 2007a and 2007b. Abundance and productivity are linked, within limits; above a certain threshold, higher productivity can compensate for lower abundance and vice versa.

Of the nine SEWMU populations (including the Asotin spring/summer Chinook salmon functionally extinct)[2] three are categorized as Basic, and six as Intermediate. No populations are classified as, Large or as Very Large (ICTRT 2007a). Table 4-1 shows the minimum abundance and productivity thresholds for the SEWMU populations to have a 95 percent probability of persistence for the next 100 years.

4.2.3.1 Abundance and productivity

The ICTRT defined abundance and productivity criteria for SEWMU populations (ICTRT 2005 and 2007a) based on analyses of the intrinsic potential of the historically available habitat, the locations and sizes of major and minor spawning areas, and, within these areas, the abundance and productivity relationships that would result in a probability of low risk of extinction within 100 years (Table 4-1). The abundance "thresholds" shown in the table represent the number of spawners needed for a population of the given size category to achieve the 5 percent (low) risk level at a given productivity (or, in the case of Tucannon spring/summer Chinook salmon, < 1% risk[6]). Abundance thresholds are 500, 1,000, 1,500, and 2,250 for population sizes of Basic, Intermediate, Large, and Very Large, respectively.

---

[2] A functionally extinct population has so few remaining fish that there are not enough fish or habitat in suitable condition to support a fully functional population. Because the Lower Snake River Chinook salmon MPG consists of the Tucannon and Asotin Creek populations and Asotin Creek is functionally extinct, the ICTRT suggests that the for the MPG to be viable, the Tucannon needs to meet high viability criteria.

Table 4-1. Abundance and Productivity Thresholds (ICTRT 2007a) for populations within the Southeast Washington Management Unit (some MPGs have more populations than listed within the table)

Major Population Grouping	SEWMU Population	Population Size	Minimum Abundance Threshold	Productivity Threshold
Lower Snake River spring/summer Chinook	Tucannon River	Intermediate	750	2.10[a]
	Asotin Creek (functionally extinct)	Basic	500	1.90[b]
Grande Ronde/Imnaha spring/summer Chinook	Wenaha	Intermediate	750	1.76
Umatilla / Walla Walla Rivers steelhead	Walla Walla R.	Intermediate	1000	1.35
	Touchet R.	Intermediate	1000	1.35
Lower Snake River steelhead	Tucannon R.	Intermediate	1000	1.20
	Asotin Cr.	Basic	500	1.20
Grande Ronde steelhead	Lower Grande Ronde.	Intermediate	1000	1.14
	Joseph Cr.	Basic	500	1.27

[a] Because the Lower Snake River spring/summer Chinook MPG consists of only two populations, and that the Asotin is considered functionally extinct, the ICTRT recommends that the Tucannon spring/summer Chinook population should be at a "Very Low Risk" level of abundance and productivity (< 1%) for the MPG to meet delisting criteria.

[b] The ICTRT considers the Asotin Creek spring/summer Chinook salmon population to be functionally extinct.

4.2.3.2 Spatial structure and diversity

Spatial structure and diversity criteria are more complex. The ICTRT cautions that there is a good deal of uncertainty in assessing the status of spatial structure and diversity in a population. These criteria are based on a set of biological goals and the mechanisms that achieve those goals, and are specific to each population.

The ICTRT defined two goals, or biological or ecological objectives, that spatial structure and diversity criteria should achieve:

- Maintaining natural rates and levels of spatially mediated processes. This goal serves (1) to minimize the likelihood that populations will be lost due to local catastrophe, (2) to maintain natural rates of recolonization within the population and between populations, and (3) to maintain other population functions that depend on the spatial arrangement of the population.

- Maintaining natural patterns of variation. This goal serves to ensure that populations can withstand environmental variation in the short and long terms (ICTRT 2007a).

4.3 BULL TROUT

Recovery goals and metrics for bull trout are similar, but not the same as for steelhead and Chinook. The USFWS, which has regulatory authority for bull trout, developed a goal and objectives for bull trout recovery throughout its range (USFWS 2002a). The goal for all populations is:

> *. . . ensure the long-term persistence of self-sustaining, complex interacting groups (or multiple local populations that may have overlapping spawning and rearing areas) of bull trout distributed across the species' native range.*

The USFWS recognized that recovery of bull trout will also require reducing threats to the long-term persistence of populations, maintaining multiple interconnected populations of bull trout across the diverse habitats of their native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations).

To recover bull trout, the USFWS identified four objectives:

- Maintain current distribution of bull trout within core areas as described in recovery unit chapters and restore distribution where recommended in recovery unit chapters.
- Maintain stable or increasing trend in abundance of bull trout.
- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.
- Conserve genetic diversity and provide opportunity for genetic exchange.

Specific recovery criteria for each bull trout core area is identified below.

4.4 RESTORATION GOALS

As stated in section 1.1 of the Introduction, the primary purpose of this recovery plan is to present implementable actions that can lead to the de-listing of populations of salmon, steelhead, and bull trout within the SEWMU. This recovery plan adopts the ICTRT minimum abundance thresholds as de-listing goals. However, the recovery board and regional fish managers are clearly interested in more than de-listing. The ultimate goal of the fish restoration effort is to create conditions allowing the establishment of salmonid populations that are both viable, harvestable, and of sufficient abundance to meet other socio-economic goals. Thus, de-listing salmonid populations is the first step on the road to restoring populations within the SEWMU.

The restoration goals summarized in Table 4-2 are aimed at achieving healthy, sustainable and harvestable salmonid populations. The goals are expressed in terms of adult abundance and exceed the values needed for ESA delisting. The restoration goals in Table 4-3 were proposed in tribal recovery plans, the Lower Snake River Compensation Plan, and other documents. It is important to note that restoration goals, and the proportion of hatchery and naturally-produced fish that would comprise the goals, have not been agreed to by the fishery co-managers at this time.

Table 4-2. Comparison between de-listing goals and restoration goals for Steelhead and Spring/Summer Chinook Populations within the SEWMU. Note that delisting goals are natural-origin only and restoration goals are hatchery- and natural-origin returning adults. ID = insufficient data.

Subbasin	De-listing Goal		Current Status[a]		Restoration Goal		Source for Restoration goals
	Steelhead	Chinook	Steelhead	Chinook	Steelhead	Chinook	
Asotin	500	500	587	ID	2,776-3,114	500	from LSRCP , NPT goal, etc., and spring Chinook = NPT/CRITFC goal
Tucannon River	1,000	750	308	371	1,823-3,400	2,400-3,400	from LSRCP goals and NPT goal
Lower Grande Ronde River[a]	1000		ID		1,855-5,101		from NMFS 2002 goal and proportion in Lower Grande Ronde and CRITFC
Wenaha River[b]		750		441	NA	1,335	from LSRCP goal and proportion in the Wenaha basin
Joseph Creek	500		2,208		2,149-5,909		from NMFS Grande Ronde goal and proportion of basin in Joseph Creek
Touchet River	1,000		461		1,563-2,205	?	from LSRCP goals and CTUIR goal
Walla Walla River	1,000		860		1,875-3,395	5,500 or 1,110 NOF, and 2,750 HOF	CTUIR goal to mouth of the Walla Walla R is 5,500, but 3,850 in the Walla Walla River, excluding Touchet and Mill Creek

[a] Current status based on full data set, see Appendix B. It is important to note that the current status review was conducted in 2011 but reflects data only as recent as 2008 or 2009; the current, i.e., 2009 through 2011 abundace is higher for many of the populations.

[b] The Lower Grande Ronde River population includes the Wenaha River and tributaries, Mud, Courtney, Grossman, Menatchee, Bear, and other lower Grande Ronde tributaries, and Elbow creeks.

5 LIMITING FACTORS AND THREATS

Historic and current human activities and governmental policies acting in concert with natural events have affected abundance, productivity, spatial structure, and diversity of SEWMU spring/summer Chinook salmon, steelhead, and bull trout populations. A brief discussion follows of factors that limit the abundance, productivity, spatial structure, and diversity of spring/summer Chinook salmon, steelhead, and bull trout in the SEWMU. It is important to the SRSRB that the reader of this recovery plan understand what the historical conditions were in SEWMU, and what the causes were for salmonid population decline, but more importantly is that the reader understand the current conditions, actions that have been taken to ameliorate past problems, and the actions recommended to be taken to address limiting factors and threats that remain.

As discussed in Chapter 1, the actions discussed in Chapter 6 and Appendix A are meant as recommendations to address the limiting factors and threats identified in this chapter and are not mandatory, nor should they be associated with any regulatory actions.

5.1 HISTORICAL CONDITIONS

The habitat elements salmonids require to complete their entire life cycle and allow for the expression of all life history strategies were presented in Section 3.2. Salmonids require good water quality, high concentrations of dissolved oxygen, cool water temperatures, sufficient stream flows, relatively stable stream channels, clean spawning gravels, diverse instream and riparian habitat, an adequate and diverse food supply, access to spawning and rearing habitat, and barrier-free migration corridors. Degradation or elimination of any of these habitat elements will alter the viability of salmonid populations. As described in McElhaney et al. (2000), a population's viability is entirely determined by its unique combination of abundance, productivity, spatial structure, and diversity.

Until Euro-American settlers arrived, the streams and rivers of the SEWMU were essentially relatively untouched.[7] Salmonids are assumed to have been able to exploit all suitable habitats below natural barriers. The streams and creeks within the SEWMU were probably fairly similar to one another. According to the subbasin plans, a typical stream arose in the high elevations of the Blue Mountains and flowed through the semi-arid lower elevations to the Grande Ronde, Snake, or the Columbia rivers, or one of its tributaries. In general, stream banks in the lower elevations were likely heavily covered by cottonwood groves and brushy vegetation. Creek channels were fragmented into intricate networks of side channels and sloughs by beaver dams and log jams. Scour pools, dammed pools, and pools on the outside of meanders are thought to have constituted at least 50 percent or more of the channels. Following the streams upriver, the number of beaver dams would probably have decreased as the elevation increased, although riparian areas would still have supported cottonwood thickets, which would have gradually given way to mixed conifers at the higher elevations. The presence of cottonwoods and conifers along the length of the creek would have assured a steady supply of woody debris to the stream course.

At the higher elevations, streams flowed through meadows interspersed throughout the mixed conifer forest. The meadows retained snow-melt and rain water, gradually releasing it to the stream through the warmer months. Peak stream flows would have been moderated by this gradual release. The stream structure in the higher elevations was likely quite complex due to the abundance of large woody debris. Fallen logs would have created step pools and temperatures would have remained relatively cool during the summer months due to relatively narrow channels and shading by the forest canopy. In steeper areas of the mountains, the stream structure would have been predominately pool/riffle with cobble/gravel substrates.

Although, in general, the soils in the SEWMU are prone to erosion, the periods of high suspended sediment and turbidity were believed to have been less numerous and shorter in duration, allowing fines to be flushed from the system before harming eggs, juveniles, or food organisms.

In addition to the freshwater environment, Columbia River Basin salmon and steelhead must pass through the estuary at the mouth of the Columbia River on their way to the ocean. The estuary represents key habitat for juveniles who must make the critical physiological shift from a freshwater to a marine existence. Environmental conditions in the ocean are also critical during the first year of residency there. A significant portion (steelhead may spend up to 7 years in freshwater and only 1 or 2 in salt) of a

---

[7] Impacts from Native Americans inhabiting the area are considered to have been negligible because they lived pre-industrial, subsistence lifestyles and because the human population was a fraction of what it is today.

salmon's life is spent in the ocean and they accumulate most of their body mass in the marine environment. It is assumed that the Columbia River estuary was also unimpaired and in equilibrium with hydrologic and geologic processes prior to Euro-American settlement of the area.

Snake River salmon range across a vast area of the Northeast Pacific Ocean from the Columbia River to southeast Alaska (Healey 1991). Salmon and steelhead feed on zooplankton, herring, and sardines in the ocean. Salmon and steelhead populations in the ocean were subject to the same natural climatological, oceanographic, and geologic processes that occur today. However, prior to settlement of the west coast of North America by Euro-Americans, it is assumed that harvest of marine species and impairment of the marine environment by man was minimal.

The Columbia River Basin stream systems, prior to human development, probably carried the largest number of salmonids they could naturally support. Various estimates exist for the number of salmon and steelhead present in the Columbia River system prior to human development. The Pacific Fishery Management Council estimated historical abundance based on the extent of salmon habitat loss in the Columbia Basin (PFMC 1979). Using an assumed current abundance of between 2.5 to 3 million fish annually, PFMC estimated the pre-development abundance of salmon (excluding steelhead) to be around 6 million fish.

The Northwest Power and Conservation Council used a variety of methods to estimate salmon and steelhead abundance including catch records and estimates of aboriginal consumption of salmon (FPC 1986). They arrived at a range of 10 to 16 million fish annually. Chapman (1986), using records of early harvests and assumed harvest rates, estimated that the size of pre-development salmon and steelhead runs was between 7.5 and 8.8 million fish. What caused the decline of the salmonid populations within the recovery region? To put it as simply as possible, the cause was development by Euro-American settlers. Native Americans had inhabited the region for thousands of years and engaged in salmon and steelhead harvest. However, because the viability factors were still essentially intact, the effect of this harvest was likely minimal.

Since the mid-19th century, however, salmon, and steelhead numbers have dropped to their current low levels (e.g., average Bonneville Dam counts for all salmonids from 2005-2010 = 1,256,063 (DART)) despite attempts to bolster them through use of artificial production. Bull trout numbers have also decreased. The primary causes of this decline are the four "Hs": habitat degradation within the subbasins and the Columbia River estuary, harvest, direct and indirect mortalities associated with the mainstem hydroelectric system, and various unintended impacts associated with the construction and operation of hatcheries.

It is important to understand that the factors limiting population viability rarely occur in isolation. Salmonids and their habitats have been, and continue to be, subjected to many of these factors, sometimes several at any one time. Some factors can produce lethal results on their own. For example, excessive stream temperatures can kill salmon or salmon eggs in the absence of any other negative factor. However, in many cases, salmon that have returned to their spawning grounds to discover excessive water temperatures may have already experienced impediments to migration, presence of pollutants and fines in the water, and low water levels, among other impacts. Each factor, if excessive, can result in mortalities; together at lower levels, they produce an accumulation of weakening effects and increase the effects of disease, which can reduce the strength of individuals and eventually, populations. Although this chapter discusses the factors affecting viability individually, it must be understood that Walla Walla and Lower Snake River salmonids are most likely to experience many of these factors, sometimes simultaneously.

Because natural events can reduce abundance, productivity, spatial structure and life history diversity enough to threaten the long-term survival of a population, the impact of natural variation must be reflected in VSP criteria (McElhaney et al. 2000). This Plan will describe strategies leading to protection and restoration actions that are likely to increase the performance of a population to the point at which viability criteria are met.

5.2 GENERAL CAUSES OF SALMONID POPULATION DECLINE IN THE SEWMU

The SEWMU has experienced a variety of impacts to salmonids and salmonid habitat since the arrival of Euro-American settlers in the 19th century. Fur trappers were some of the first Euro-Americans to enter the area. The subsequent decimation of the beaver population in the 1830s and 1840s reduced an important source of large woody debris and pools in streams. The settlers, who began arriving in the late 1840s and 1850s, were attracted by the agricultural possibilities and agriculture remains an important land use today. Logging and urbanization have also affected salmonids and their habitat, as have construction and operation of hydroelectric dams on the Snake and Columbia rivers or their tributaries. Harvest, which occurs primarily outside the SEWMU, has also affected the abundance of salmon and steelhead.

General causes of salmonid population declines include irrigation diversion dams (especially during historical times), hydroelectric generation, hatcheries, agriculture, logging, urbanization (including residential and industrial development), recreation, and harvest. Activities associated with these endeavors have removed riparian vegetation, increased stream water temperatures and effects of parasites and diseases, altered and/or dewatered stream courses, introduced pollutants into streams and wetlands, and blocked or impeded fish passage both up- and downstream. Fish populations have been depleted by over-harvest in the late 19th and early 20th centuries. Hatcheries have introduced fish with different run timing and fish that prey upon or compete with non-hatchery fish. Diseases carried by hatchery fish are also a concern.

Although impacts from all of the factors discussed can be difficult to effectively mitigate, the SRSRB believes that fixing urban-induced problems is the most difficult. This is because of the large number of people that are affected by proposed actions and the costs associated with the actions. Throughout the term of the SRSRP, the SRSRB will continue to work with and encourage land use planners to develop policies to protect riparian and stream habitat from effects of urban and rural development.

5.2.1 Agriculture

Agriculture can negatively affect salmonid habitat in a variety of ways. Water needed for irrigating crops was historically diverted from streams by dams or other structures that often present partial or total passage barriers to adults and/or entrainment hazards to emigrating juveniles. In some cases, historic irrigation diversions were so large as to totally dewater downstream stream reaches; in others, the small quantity of water that was left in the natural stream channel is easily heated to unhealthy or near-lethal levels by the sun. Cropping practices in upland areas, the roads, stream crossings, and drainage systems that serve these areas have increased erosion rates and contributed large quantities of fine sediment to spawning riffles. Chemicals and pesticides used to increase crop production can enter the stream as pollutants harmful to fish.

Historically, grazing by livestock can negatively affect salmonid habitat in a variety of ways, such as by removing riparian vegetation and eliminating natural shade. The lack of shade frequently results in increased water temperatures. The reduced input of leaves, insects, and other organic material limits the amount of food available to fish and their prey. Trampling of stream banks by grazing livestock can cause the banks to collapse, increasing the input of fine sediment. Fecal material from livestock can introduce excessive concentrations of nutrients which, in warm, slow-moving streams, can result in low levels of dissolved oxygen (eutrophication). Grazing encourages channel incision as grasses and shrubs are removed from the riparian zone. Channel incision causes the riparian corridor to narrow and the water table to recede. However, recent grazing practices have eliminated these negative effects to a large degree in most areas.

Conversion of bunch grass prairie to production of annual crops has led to erosion of fine sediments into streams and increased intensity of runoff events, and increased channel bank erosion because of the abrasive nature of the runoff. The sediment is deposited primarily in the lower reaches of streams. Recent changes in agricultural practices, such as no till/direct seed farming, are aimed at reducing soil erosion and improvement of precipitation filtration into the soil.

Historic construction of dikes and levees to protect cities and cropland from flooding alter stream conditions and remove riparian habitats (see Section 5.2.3 for more effects of dikes and levees). Lowering the water table negatively affects riparian vegetation because it reduces natural revegetation because seedling roots cannot grow deep enough to reach water and prevent the plant from dying of dehydration. Established trees and shrubs also can be killed by lack of water due to a lowered water table.

5.2.2 Logging

Logging can involve a number of practices harmful to salmonids and their habitats. Historically, when trees along stream courses are removed, the forest canopy no longer adequately shades the entire stream, resulting in higher water temperatures. Trees can be removed by logging or by removal for road construction. Logging access roads often parallel or cross streams. Improperly sized and placed stream crossings can fail and dramatically increase the introduction of sediment into streams as well as block fish passage. Runoff from roads that parallel streams may allow sediment and road oils to enter the stream. Removal of riparian vegetation also reduces plant and animal inputs into the stream as food sources, root structure that maintains bank stability, and reduces the source of large woody debris important to maintenance of suitable in-stream conditions. Harvest of trees can affect hydrology and stream discharge dynamics.

In the past, logging in the Pacific Northwest involved practices that were devastating to salmonid streams. For example, in some cases, streams were used to transport logs to larger rivers. Streams were dammed and filled with logs from bank to bank awaiting the winter or spring floods. When the water rose, the dams were blasted and great rafts of logs were washed down the stream removing gravels, salmonid eggs, insects, riparian vegetation, and anything else in their way. Large boulders and logs were removed downstream to improve transportation of the stored logs. Though these types of practices have been discontinued, logging legacy effects are still evident in many areas and logging still can be a source of serious impact to salmon habitats. Current logging practices have been changed to allow for protection of sensitive fish and wildlife habitat.

5.2.3 Urban and Rural Development

Although heavy urban development has been confined to a relatively small portion of the salmon recovery region, it has had a disproportionately large impact. The growth of towns and cities can affect streams in numerous ways. As with logging roads, urban and rural roads built across or along streams can introduce fines and toxic substances such as motor oil into the water. Improperly designed and constructed stream crossings can block or impede fish passage. Paving of parking lots and roads increases the amount of impervious surface and reduces the infiltration of precipitation into the aquifer. As a consequence, streams draining watersheds with a high proportion of impervious surface area tend to be flashy, unstable and embedded with fine sediments. Pollutants can also enter streams as a result of lawn and garden fertilization or cultivation, or from factories or other businesses.[8]

Stream areas that attract concentrations of people can lead to harassment of fish and illegal fishing (poaching). Fish on spawning beds are particularly susceptible to intentional harassment as well as to unintentional disturbances from human activities such as boating and swimming. Continued disturbance can cause spawning adults to abandon a good spawning area and to either spawn in poor habitat or to die before spawning.

All of the preceding development-related impacts occur to one degree or another in various portions of the recovery region. Flood control projects and associated structures, however, have had a much greater impact on salmonids. Large portions of the Tucannon, Touchet and Walla Walla rivers have been channelized and confined by levees and dikes to protect nearby roads, buildings and fields and farms that have been repeatedly damaged by floods. The cumulative impact of these projects destabilize the rivers by increasing their erosive power (Hecht et al. 1982). As a consequence, the Tucannon River is now actively degrading its banks and bed and causing serious problems with regard to fine sediment deposition and habitat complexity.

The Walla Walla River, and especially its Mill Creek tributary, has also been severely impacted by flood control projects. On June 28, 1938, the Flood Control Act was passed in Congress, which called for two projects to be built in the Walla Walla Valley: the Mill Creek Flood Control Plan and the Mill Creek Channel. The purpose of the flood control plan was to divert water from Mill Creek away from the City of Walla Walla, while the purpose of the channel project was to reinforce the channel of Mill Creek where it flowed through the downtown area. The Mill Creek Flood Control Plan was completed in 1943 and included two dams: Bennington Dam and the Yellowhawk Diversion Dam. Bennington Dam, built across Mill Creek east of the City of Walla Walla, is capable of diverting up to 4,000 cubic feet per second (cfs) into a nearby flood storage reservoir. A return canal drains water from the reservoir back into Mill Creek when flooding danger subsides. Fish passage facilities were not constructed for Bennington Dam until the mid-1980s, but these facilities have proven insufficient to adequately pass salmonids (Glen Mendel, WDFW, personal communication). The Yellowhawk Diversion Dam is located approximately half a mile downstream from Bennington Dam where Yellowhawk Creek splits off from Mill Creek. The purpose of the Yellowhawk dam is to divert water from Mill Creek into Garrison and Yellowhawk creeks, re-routing these flows to the Walla Walla River south of the city, primarily to provide irrigation water for Gardena Farms Irrigation District (at Burlingame Dam on the Walla Walla River).

The USACE completed the Mill Creek Channel project in 1943. This project channelized about 9.7 miles of Mill Creek though the heart of the city, beginning at Gose Street Bridge on the western outskirts and ending at Bennington Dam. Concrete barriers, walls, floors, and weirs were built throughout this reach, as

[8] This discussion does not include the following, which may also increase pollutants in streams: clearing for homes and yards that often extends to the water's edge, dumping of yard wastes, chemicals, ornamental objects, etc. within the stream and regulation of stream flows or channelizing the streams to prevent damage to homes, yards, roads, etc.

well as a long series of gabions intended to dissipate the energy of floodwaters on both ends of the flood control project.

Both of these projects have prevented flood damage to the City of Walla Walla, but at a considerable cost to the fisheries resources of Mill Creek and the subbasin as a whole. Passage is obstructed to varying degrees at numerous points from the beginning of the channel project to Bennington Dam, habitat complexity is virtually non-existent through the channelized section, and portions of Mill Creek are partially dewatered and subjected to excessive temperatures on an annual basis when flows are re-routed down Yellowhawk Creek.

5.2.4 Hydroelectric Generation

Construction of the mainstem dams on the Columbia and Snake rivers profoundly altered the Basin's ecosystem (Independent Scientific Group 2000). The dams blocked, to varying extents, both adult fish passage upstream to spawning areas and juvenile fish passage downstream to the estuary and the ocean. In addition, dams can cause mortalities to fish caught in the turbines and through introduction of nitrogen and other dissolved gases into the blood of salmon attempting to move through the turbulence created by the spill ways.

All dams below Hell's Canyon on the Snake River and the Chief Joseph Dam on the Columbia River were constructed with facilities to allow adult fish to pass upstream. None of the dams were built with facilities dedicated passing juvenile or adult fish downstream; however, all the lower Snake and Columbia River dams have since been retro-fitted with some juvenile fish passage facilities. The Hell's Canyon complex of dams has blocked access to spawning areas in the upper Snake River and altered water flow patterns and water temperature regimes, as well as the movement and replenishment of bedload that forms gravel bars and spawning gravels. Construction of dams on the Snake River also involved creation of reservoirs in the lower Snake River, mostly within southeast Washington. The reservoirs have altered instream habitat, changing it to a deep, slow water environment with potentially higher temperatures. The slowed waters release their sediment loads, burying natural gravels and cobbles. The changed environment has encouraged growth of populations of native and non-native species such as northern pikeminnow, walleye, and smallmouth bass, which prey upon juvenile salmonids. These reservoirs also have inundated significant fall Chinook spawning areas in the lower Snake River and the dams prevent or reduce downstream movements of adult salmon and steelhead that temporarily migrated upstream, or overwintered, or spawned upstream (e.g. steelhead kelts).

Completion of the Snake River dams in the mid-1970s and construction of upstream reservoirs shifted the focus of fish passage concerns. Estimates of mortality for downstream migrants during the mid-1970s were in excess of 90 percent in some years (NOAA 2000). These high mortalities coincided with reduced ocean survival conditions. Consequently, the abundance of Snake River salmon and steelhead plummeted to the point where initial petitions for listing the fish under the Endangered Species Act were filed. In response, the USACE devised various passage technologies including screens to collect juvenile fish for transport around the dams. These technologies have resulted in an increase of juvenile survival, estimated at 50 to 60 percent by the late 1990s in the area extending from Bonneville Dam to above Lower Granite Dam. Survival of some stocks of juvenile salmonids at some dams exceed 98%, but not all stocks and all dams have similar downstream passage survival for juveniles.

5.2.5 Hatcheries

As salmon numbers declined over time, managers looked for ways to increase fish abundance without affecting land use and development activities, while maintaining harvest in the Columbia and Snake River basins. The answer appeared to be artificial production. Hatchery facilities for salmon were first built in the Columbia River Basin in 1875. The 1940s and 1950s saw a great increase in hatchery construction in the Lower Columbia River as fish runs continued to decline. Another increase in hatchery programs occurred in the 1980's, primarily as mitigation for Idaho Power's Hell's Canyon dams, Dworshak Dam, and the lower Snake River dams (as part of the Lower Snake River Compensation Program). The primary purpose of these hatcheries was to provide fish for commercial harvest.

Hatcheries can have negative effects on wild fish populations from the ecological, biological, and genetic standpoints. The interactions of natural and artificially produced fish are complex and, in some cases, not well understood. However, recent studies have begun to shed some light onto the relationships of hatchery-bred fish to their environments.

There is little information available regarding the effects of in-region hatcheries and releases on the survival of SEWMU ESA-listed populations. What information is available indicates that the presence of hatchery adults on the spawning grounds may decrease naturally produced fish fitness and survival (e.g., Araki et al. 2008, Chilcote et al. 2011). Over the last 30 years, at least small numbers of hatchery adults and juveniles have been observed in virtually all stream reaches within the recovery area. Some streams such as Alpowa Creek have 40% or more hatchery steelhead on the spawning grounds annually. More information on the current number of hatchery fish present in the recovery area, as well as their impact upon naturally produced fish, will continue to be collected as part of present and future monitoring efforts.

5.2.6 Harvest

Salmon and steelhead have been harvested in the Columbia Basin as long as there have been people inhabiting the region. For thousands of years, Native Americans have fished for salmon and other species in the mainstem and tributaries of the Columbia River for ceremonial and subsistence use and for barter. A wide variety of gear and methods were used, ranging from hoop and dip nets at cascades such as Celilo and Willamette falls to spears, weirs, and traps in smaller streams and headwater areas.

Development of non-Indian fisheries began about 1830; by 1861, commercial fishing was an important economic activity. Salmon were harvested for the newly developing canning industry. The early commercial fisheries used gill nets, seines hauled from shore, traps, and fish wheels. Later, purse seines and troll (using hook and line) fisheries developed. Recreational fishing burgeoned in the late 1800s (ODFW and WDFW 1998).

Initially, non-Indian fisheries targeted spring and summer Chinook salmon; these runs dominated the commercial harvest during the 1800s. As technology improved, commercial fishers became more efficient at harvesting salmon. Eventually, the combined ocean and freshwater harvest rates for Columbia River spring and summer Chinook salmon exceeded 80 percent and sometimes 90 percent of the run – accelerating the species' decline. From 1938 to 1955, the average harvest rate dropped to about 60 percent of the total spring/summer Chinook salmon run and appeared to have a minimal effect on subsequent returns (NMFS 1991). Until the spring of 2000, when a relatively large run of hatchery spring/summer Chinook salmon returned and provided a small commercial tribal fishery, no commercial season for spring/summer Chinook salmon had taken place since 1977. As fish populations declined throughout the Columbia Basin, harvest reduction was one of the first actions taken (also includes hatchery production). Today, most fisheries have been reduced to a small percentage of their historical magnitude.

Historically, illegal harvest (poaching) was a problem (e.g., in the Tucannon and Walla Walla subbasins). This was particularly true for fall spawning spring Chinook salmon and bull trout. Current outreach programs are aimed at reducing the impacts of potential illegal harvest.

Within the Snake River Washington Recovery Unit, over-fishing has reduced bull trout populations in some southeast Washington streams, including the Tucannon River, as some anglers targeted bull trout when the fish were concentrated below stream barriers or on spawning grounds and were vulnerable just prior to, or during, spawning. In addition, bull trout may have been historically considered an unfavorable species by anglers, as occurred in other areas, and been specifically targeted for removal. Current angler-related threats to bull trout in the Snake River Washington Recovery Unit could occur through misidentification and accidental harvest, intentional poaching, or hooking mortality (USFWS 2002a).

It should be noted that most harvest occurs outside the recovery region, primarily in the Pacific Ocean, Columbia River estuary, and in the lower Columbia River (below McNary Dam). The average harvest rate on upriver spring Chinook salmon from 1938-1973 was 55% (NMFS 2008b). As the stocks declined it became apparent that these harvest rates were not sustainable. By the mid-1970s, the spring season fisheries that targeted upriver stocks were largely eliminated by the state and tribal managers. Harvest rates in all mainstem commercial, recreational, and ceremonial and subsistence (C&S) fisheries have averaged just over 8% since then (NMFS 2008a). Harvest of Chinook within the SRWRU was generally closed from the 1970's until 2001.

Snake River (SR) fall Chinook are caught in ocean and in-river fisheries. SR fall Chinook are broadly distributed and caught in fisheries from Alaska to California, but the center of their distribution and the majority of impacts occur in fisheries from the west Coast of Vancouver Island to central Oregon. The total ocean fishery exploitation rate averaged 46% from 1986 to 1991, and 31% from 1992 to 2006 (NMFS 2008b). Ocean fisheries have been required since 1996, through ESA consultation, to achieve a 30% reduction in the average exploitation rate observed during the 1988 to 1993 base period (NMFS 2008c). In the early to mid 1990's, downriver and ocean harvest often exceeded 70% or the adult returns of Snake River fall Chinook (Glen Mendel, WDFW, personal communication).

SR fall Chinook are also caught in fall season fisheries in the Columbia River with most impacts occurring in Non-Tribal and treaty Tribal fisheries from the river mouth to McNary Dam. Since 1996, fisheries have been subject to a total harvest rate limit of 31.29%. This represents a 30% reduction from the 1988 to 1993 base period harvest rate. Ocean and in-river standards are separate, and the fisheries are managed independently subject to their respective own standard.

Commercial harvest of steelhead in non-Treaty fisheries has been prohibited since 1975. From 1938 through the mid-1960s, the commercial catch of steelhead ranged from 100,000 to nearly 300,000 steelhead per year. From the mid-1960s until the non-Treaty commercial fisheries were closed, the catch of steelhead was approximately 50,000 fish per year (WDFW and ODFW 2002). These essentially were all wild fish since hatchery production of steelhead was still relatively limited at the time.

Since 1986, recreational anglers in the Columbia Basin have been required to release unmarked, wild steelhead. Wild steelhead are still subject to mortality associated with catch-and-release, but implementation of mark-selective fisheries has greatly reduced the impact to wild steelhead from recreational fisheries.

Beginning in 1988, the CRFMP provided a framework for managing the mainstem fisheries that impacted steelhead. The Plan limited tribal fishery impacts during the fall season management period to 15% for A-run steelhead, and 32% for B-run steelhead. Although the CRFMP was not formally completed until 1988, fisheries were managed subject to these harvest rate limits as of 1986.

After the ESA listing of SR fall Chinook in 1992, fall fisheries, where most of the steelhead impacts occur, were subject to further constraints in order to reduce the impacts to SR fall Chinook salmon. While the CRFMP limited tribal fishery impacts during the fall season management period to 15% for A-run and 32% for B-run steelhead, the constraints to reduce impacts to SR fall Chinook resulted in reductions in the incidental catch of steelhead.

Snake River steelhead and Upper Columbia River steelhead were ESA listed in August 1997. Fall fisheries managed under *U.S. v. Oregon* were reviewed first through ESA consultation in late 1997 and in more detail in 1998. These consultations addressed the incidental impacts on listed steelhead. Beginning in 1998, non-Treaty fall season fisheries were subject to a specific harvest rate limit of 2%, a provision that applied to the SR steelhead DPS and the MCR steelhead DPS that were later listed in 1999. Similarly, beginning in 1998, treaty-Indian fall season fisheries were subject to a harvest rate limit of 15% for B-run steelhead; a reduction from the prior 32% limit in the CRFMP. This further limitation on B-run steelhead indirectly reduced the impacts to A-run steelhead as well.

5.3 SPECIFIC CAUSES OF DECLINE DUE TO HABITAT ALTERATIONS FOR POPULATIONS WITHIN THE SEWMU

A primary focus of this recovery plan is on actions to restore fish production by improving habitat conditions within the subbasins. The focus, established by the SRSRB, does not mean that the dominant limiting factors are confined to the subbasins within the SEWMU. In fact, the subbasin plans for all of the populations in the SEWMU concluded that 45 percent of the abundance restoration potential for Walla Walla steelhead, 54 percent of the abundance restoration potential for Tucannon steelhead, and 72 percent of the abundance restoration potential for Asotin steelhead lies outside the subbasins.

Discussion of specific causes of decline in populations for all species due to factors outside the SEWMU subbasins are well covered (and basically up to date) in the FCRPS Biological Opinion (NMFS 2008c). Further information on the specific factors related to hydro, harvest, and hatcheries can be found in that document.

In the following section, the specific information for habitat factors is illustrated through local knowledge and EDT modeling. The section begins with general factors identified through the EDT modeling[9] process, which relate to all geographic areas within the SEWMU. Then, each geographic area is discussed in terms of three subtopics:

- Historical Causes for Decline (summarized from SRSRB 2006),
- Actions and Improvements That Have Taken Place to Address Original Causes for Decline, and
- Current Impacts and Limiting Factors.

It is important to understand that some of the limiting factors that occur today are "legacy effects" from past actions and natural events that still affect SEWMU salmonid population viability. Land use actions, such as grazing (effects to riparian habitat), mining (leaching of pollutants, removal of gravel, etc.), forestry practices (increase in sediment load from harvest and road building), channelization and diking as flood control measures (loss of stream connectivity to floodplain) are examples of actions taken by man, primarily in the past but no longer occur or to a much lower extent, that potentially have lasting impacts. Natural events, such as flooding and fires can have impacts that potentially affect salmonid viability for decades. Some examples of natural events and human responses that persist include, 1) the 1930s flood in Walla Walla prompted flood control measures that included a flood control dam, artificial lake for diverted flood waters, and a highly modified and channelized waterway for Mill Creek and 2) a straightened, simplified river channel and many miles of levees along the Tucannon River as a response to the 1964 flood.

Current impacts can also be caused by human actions and natural events. Continuing to remove water for agriculture, additional urban or rural development, as well as many other land use activities are actions that can potentially negatively affect viability, while draught, fire, or other natural events can limit salmonid productivity too.

5.4 FACTORS AFFECTING HABITAT

The EDT model provides a way to systematically summarize empirical data and expert opinion on habitat condition using sixteen habitat factors related to the restoration of salmonid habitat (Table 5-1). Each of these habitat factors is related to the suite of conditions comprising suitable salmon habitat.

Table 5-1. EDT Habitat Factors.

Factor	Description
Channel Stability	Stability of the reach with respect to its streambed, banks, and its channel shape and location. The more unstable the channel, the lower the survival of eggs and juvenile fish.
Stream Flow	The amount, pattern, or extent of stream flow fluctuations. Both too much and too little flow in the stream channel can reduce salmon performance. High flows may cause juveniles to leave a stream; low flows may eliminate all production from the stream.

[9] The EDT modeling was performed in the mid 2000s, and was originally presented in the 2006 draft Plan. It was not updated for this revised plan.

Factor	Description
Habitat Diversity	The extent of habitat complexity within a stream reach. Complexity is the opposite of uniformity; greater complexity increases survival. Streams with large amounts of wood, boulders, undercut banks, and pools provide better habitat than those that do not.
Sediment Load	The amount of sediment present in, or passing through, the stream reach. Fine sediment can smother incubating eggs and reduce the quality of juvenile rearing habitat.
Stream Temperature	Water that is too cold or hot can reduce salmon survival at all life stages. In general, fish sensitivity to temperature decreases as fish move from egg to smolt to adult.
Predation	The relative abundance of predators that feed upon fish. Predators can be fish, mammals, or birds.
Chemicals	Concentrations of toxic chemicals and conditions (such as pH) from point and non-point sources.
Competition With Other Species	The relative abundance of other species that compete with salmon for food and space in the same stream reach.
Competition with Hatchery Fish	The relative abundance of hatchery fish that compete with salmon for food and space in the same stream reach.
Obstructions	Physical structures, such as dams, weirs, or waterfalls, that impede the use of a stream reach by fish.
Water Withdrawals	Water removed from stream channels for irrigation, city water supply, or other uses. Water removal can affect fish by entraining juveniles on pump intakes or lowering water levels. Low water levels can impede fish passage, reduce available habitat, and result in high water temperatures.
Food	The amount, diversity, and availability of food available to the fish community. Food sources include macro invertebrates, salmon carcasses, and terrestrial insects.
Oxygen	Mean concentration of dissolved oxygen in the stream reach. Low oxygen levels reduce fish survival at all life stages.
Pathogens	The abundance, concentration, or effects of pathogens on fish in the stream reach. For example, the presence of a fish hatchery or large numbers of livestock along the reach could cause unusually high concentrations of pathogens.
Key Habitat	The amount of the key habitat present in the stream for each life stage. An example of key habitat would be riffles in which salmonids spawn. If key habitats are limited, the stream can support fewer salmonids.
Harassment/Poaching	Humans may reduce the survival of salmonids though such activities as swimming, boating, and poaching, i.e., catching fish illegally. The effects of legal harvest on salmonids are not considered in this factor.

The Asotin Creek, Tucannon River, Walla Walla River, Grande Ronde and Lower Snake Mainstem subbasin plans present detailed discussions of stream habitat conditions limiting salmonid populations (ACCD 2004, PCD 2004, CCD 2004, WWWPU & WWWC 2004, Nowak 2004). The analyses contained in the plans are based on the results of habitat modeling using the EDT Model (Appendix F) (Lestelle et al. 1996). The EDT analysis looked at the relationships between habitat and fish production for spring/summer Chinook, fall Chinook salmon, and summer steelhead. Impacts to bull trout habitat were derived from the Washington bull trout management plan (WDFW 2000a) and the draft federal bull trout recovery plan (USFWS 2002a). The subbasin plans can be viewed on the web at www.nwcouncil.org.

The results of EDT analyses are presented in figures throughout this section. It must be noted that EDT was conducted in 2004 and was based off information prior to that year; the EDT assessment warrants updating as considerable improvements have been made to many of the rivers/streams in the last decade. The figures show the geographic area under consideration, the factors limiting viability and their relative importance, and the relative importance of each geographic area. The Protection/Restoration columns represent the relative importance of specific geographic areas to production if the area were fully restored to assumed historical conditions. The relative importance is presented as "scaled" and "unscaled" benefits. Scaled benefits are the mean benefit per kilometer of habitat; unscaled benefits are an absolute measure of mean benefit. Benefits and negative or adverse factors are represented by circles of graduated size; the larger the circle, the greater the effect.

5.5 SEWMU DPS/ESU

5.5.1 Snake River DPS/ESU Asotin Creek Steelhead and Asotin Creek Spring/Summer Chinook Populations

The Asotin Creek spring/summer Chinook salmon and steelhead populations were analyzed independently, but are similar enough that they are presented together in this section. However, spring Chinook salmon probably never were produced in George Creek and upper SF Asotin, Upper NF Asotin and Charley creeks. This is consistent with the Asotin Creek Subbasin Plan which also presents the two species together. Limiting factors and specific impacts on viability parameters will be described for the major sub-watersheds supporting these populations. The subbasins are all quite different from one another and will be described individually.

5.5.1.1 Asotin Creek Mainstem and George Creek

In the 2006 Plan (SRSRB 2006), sediment load, channel stability, key habitat quantity, and habitat diversity were identified as the primary factors limiting the abundance and productivity of steelhead and spring/summer Chinook in the Asotin Creek mainstem and the George Creek watershed (Figure 5-1 and Figure 5-2). Flow and temperature were identified as secondary factors, although temperature is believed to be significant only in the upper reaches of the Asotin mainstem and in the George Creek mainstem. It should be noted that temperature was not considered a limiting factor in the EDT analysis because the assessment team (in the mid 2000s) considered it to be a natural condition in this stream reach. However, high temperatures were considered to continue to limit production to some degree even after full restoration. EDT does not identify conditions as "priority restoration factors" if they are considered to depress production even under historical/normative conditions and are thus "inevitable".[10]

[10] EDT identifies factors which would most benefit production if they were to be restored to *normative* conditions, rather than strictly identifying limiting factors. Because temperature in the lower Asotin mainstem was assumed to remain excessive even after full restoration although historic temperatures were not based on empirical data, it was not flagged as a priority attribute for restoration, even though it clearly is a "limiting factor".

Most of the limiting factors appear to decrease with distance upstream. Temperature and channel stability were identified in the 2006 Plan to be the exceptions to this correlation.

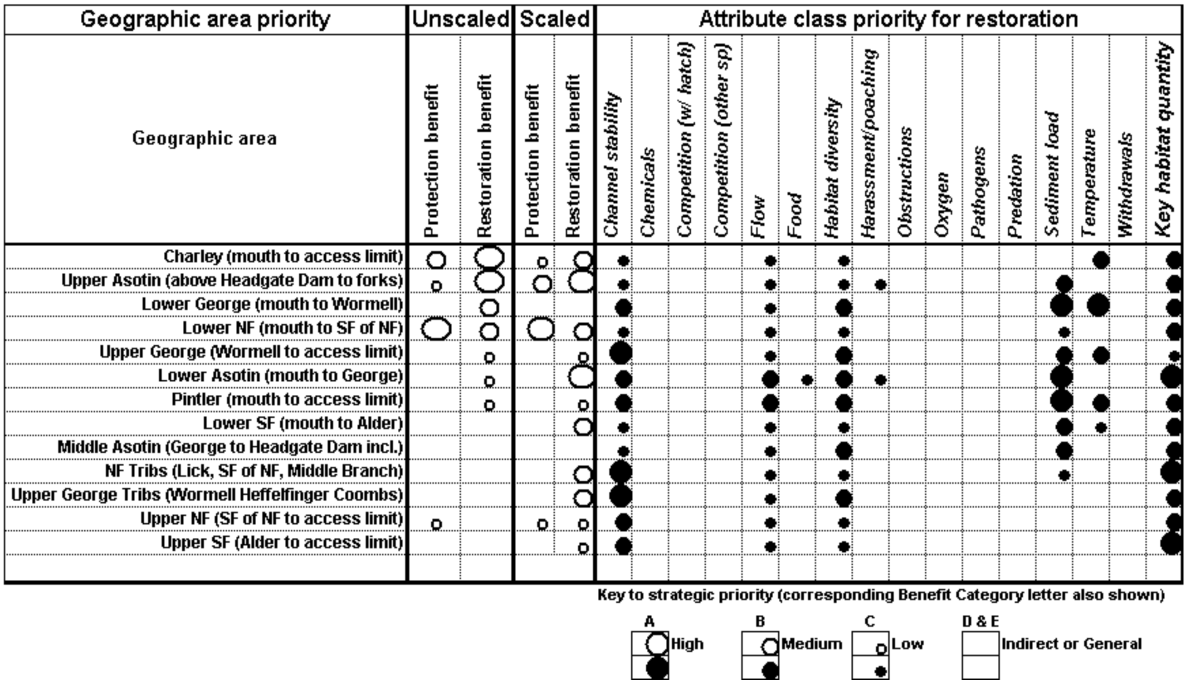


Figure 5-1. Factors Affecting Viability of Asotin Steelhead.

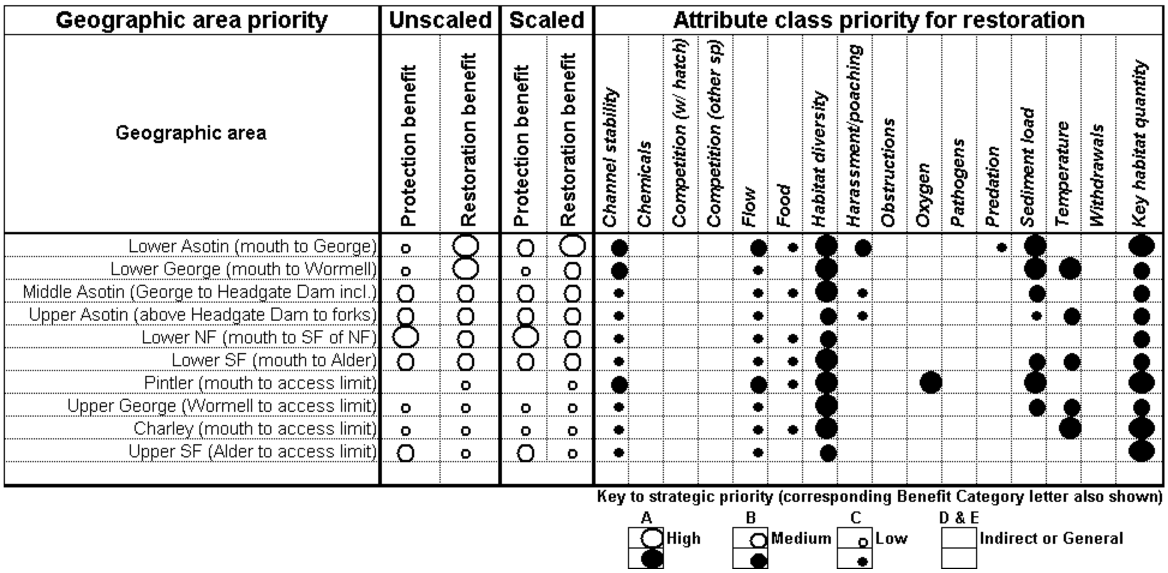


Figure 5-2. Factors Affecting Viability of Asotin Spring/Summer Chinook (2004).

In the mainstems of Asotin and George creeks, inadequate key habitat conditions are believed to affect primarily fry and holding adults; impacts are most likely more severe for spring/summer Chinook salmon than steelhead. Both species probably experience similar effects with regard to habitat diversity. Lack of habitat diversity is believed to suppress the survival of all juvenile life stages, especially fry and overwintering pre-smolts. The effect of low habitat diversity on holding adults is potentially much more substantial for spring/summer Chinook salmon than steelhead because of the time of year that they are staging prior to spawning. For both species, the severity of the impact of sedimentation and the number of life stages affected most likely decreases with increasing distance from the mouth.

It is likely that steelhead incubation, fry, and overwintering as well as spring/summer Chinook salmon spawning, overwintering, and incubation are substantially impaired by sedimentation near the mouth of Asotin Creek. For both species, incubation is the only life stage that can be significantly impaired by sedimentation in the upper portions of Asotin and George creeks. Channel instability most likely has an extreme impact on incubation for both species in the lower mainstem of Asotin and George creeks. The EDT model predicted that a strong impact on incubation persists in upper George Creek for steelhead, but not for spring/summer Chinook salmon, and the impact of channel stability probably diminishes for both species in the upper Asotin mainstem. It is likely that increased peak flows significantly depress survival of fry and overwintering pre-smolts for both species in the lower reaches, but this effect decreases considerably in the upper portion of the mainstem. High temperature is believed to have a relatively small impact on spring/summer Chinook salmon spawners in the middle reaches of the mainstem, but could have a significant impact on steelhead spawners and/or incubation throughout all of the mainstem except for upper George Creek.

Historical Causes for Decline (summarized from SRSRB 2006)

From the late 19th century to about the middle of the 1960s, Headgate Dam had severe impacts on adult access and juvenile emigration, and is still in need of improvement... Historically, grazing, crop production, and residential development were believed to be primarily responsible for the limiting factors in this portion of the subbasin.

Pasture and rangelands cover 43 percent (36,582 hectares, or 90,393 acres) of the entire Asotin Creek watershed. In some locations, the stream has been used as a watering station for livestock for nearly a century; severe overgrazing has been documented in the past. Historically, the lack of riparian canopy cover greatly increased stream temperatures in all of these streams, especially in the summer.

In 2001, the Asotin County Conservation District (2001) estimated 44,420 tons of sediment was being delivered annually to Asotin Creek from all sources. More than 50 percent of this sediment came from agricultural and grazing practices in George and Pintler creeks and from croplands adjacent to lower reaches of the mainstem of Asotin Creek (Asotin County Conservation District 2001).

Loess soils predominate in this watershed and can be highly susceptible to erosion with any kind of soil disturbance. Increased sediment delivery historically caused filling and scouring in the stream bed, which in turn suffocated or physically destroyed incubating eggs and pre-emergent juveniles.

Residential development has historically been identified as a significant limiting factor in the lower portion of the Asotin Creek watershed. Much of the stream channel within the residential areas has been confined by riprap and dikes to protect property from floods. Flood control structures, bank protection measures, and heavy animal and human use of the streambanks historically caused extensive damage to riparian cover, wood recruitment, pool habitat, and stream attributes necessary for successful fish migration (ACMWP 1995; USFS 1998b).

Development of the transportation system and rural residences in the Asotin subbasin has affected habitat complexity, sedimentation and embeddedness, riparian function, and fish passage. The Asotin Creek mainstem has been diked, straightened, and relocated in numerous locations in order to protect Asotin Creek Road and nearby structures. In the upper watershed, the road network crosses the stream many times, each requiring the use of culverts and each having potential impacts on fish passage.

Grazing, crop production, residential development, and road construction historically all contributed to the loss of habitat diversity and key habitat quantity. Grazing, crop production in or adjacent to riparian areas, and residential development, especially diking and channelization to protect roads and property, historically all reduced the production of large woody debris. These same factors reduced riparian function and increased confinement, reducing habitat diversity and increasing channel instability. Finally, increased sediment supply, reduced woody debris, and channel straightening appear to have eliminated pools of various types, resulting in a lack of key habitat for both juveniles and pre-spawning adults.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in Asotin and George Creek have worked proactively with local landowners over the past fifteen years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Currently, obstructions in the basin have been largely removed with only one partial barrier currently being addressed.   Farmers and ranchers have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. To address high stream temperatures project implementers and landowners have planted riparian areas, conducted irrigation efficiency projects and conducted in-stream work to reduce channel width. Increased flow and channel depth/width ratios in conjunction with riparian trees have reduced high summer water temperatures extending salmon rearing habitat further downstream into lower elevations than at the time of listing. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.

Current Impacts and Limiting Factors

Asotin and George Creek salmon and steelhead continue to be suppressed by reduced habitat diversity, key habitat, elevated sediment load, and obstructions. Encroachment on the floodplain caused by the construction of dikes (historically), roads, single family dwellings and the activities that are associated the encroachment continues to threaten Asotin Creek. Reduced stream channel complexity and floodplain function caused by channel straightening, incision and loss of historic riparian forests/large wood debris source has reduced key habitats such as rearing and wintering habitat. Fine sediments originating on steep valley slopes remain a concern and have potential to have continued impacts on salmon habitat. Much of the Asotin and George Creek drainage have high potential for increasing fine sediment loads, so protection of existing conditions will remain high priority.

5.5.1.2 Charley Creek

In the Charley Creek drainage, the aquatic assessment in the mid 2000s, identified habitat diversity, key habitat quantity, channel stability, flow and temperature as the major limiting factors for both steelhead and spring/summer Chinook salmon. A lack of key habitat for adult migrants and adults holding prior to spawning depressed production in the lower two reaches. It appears that sediment and low flow limits production and juvenile life stages in the uppermost reach. In the analysis, temperature had high impacts on spring/summer Chinook salmon spawners and steelhead incubation in the lower reaches of Charley Creek, but minimal effects in the upper watershed.

Historical Causes for Decline (summarized from SRSRB 2006),

Historically, factors limiting viability of salmonids in Charley Creek were somewhat different from those affecting the Asotin mainstem and George Creek because of a relatively greater impact associated with logging in the Charley Creek watershed. Between 1970 and 1995, approximately 4,520 acres of forest were clear-cut in the entire Asotin Creek watershed within the Charley Creek, South Fork Asotin Creek, and Cougar Creek drainages.

Historical impacts from logging within Charley Creek include increased delivery of sediment to the stream channel due to the construction of logging roads. Some estimates indicate that historically, more than 50 percent of the sediment delivered into Asotin Creek from timber-harvest activities was attributable to roads. Some of the forested drainages in the Charley Creek drainage had road densities as high as 4.1 to 5.0 miles per square mile, whereas the average for forested lands within the Asotin watershed is less than 2.0 miles per square mile.

The U.S. Forest Service, as part of the Asotin Creek Technical Advisory Committee in the mid 2000s, summarized the primary limiting factors to fish production in Charley Creek as follows:

1. High stream temperatures (even though stream temperatures are generally much cooler on National Forest lands than in privately held lands lower in the watershed);
2. Low numbers of large pools; and
3. Sediment deposition in spawning areas (ACMWP 1995).

Even with these historical limiting factors, the U.S. Forest Service believed that fish habitat conditions on Umatilla National Forest lands in Asotin Creek are still good to excellent.

Charley Creek was also affected by two small impoundments constructed for a put-and-take recreational trout fishery. In 1948, Charley Creek was impounded at RM 4.0 by two small earthen dams. The dams were 15 feet high and completely blocked access to upper Charley Creek for 16 years until a flood in 1964 destroyed them and sent a plume of sediment down Charley Creek and into Asotin Creek. Fish passage to upper Charley Creek is now possible.

Agriculture has historically impacted Charley Creek to a certain extent. The lower four to five miles of the creek were severely damaged by cattle which were allowed direct access to the stream channel.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Salmon habitat restoration implementers have worked to reduce the impacts of past land management activities in Charley Creek by conducting restoration actions which address the following limiting factors for salmon recovery, sediment load, habitat diversity, stream temperature, and key habitat features. Fine sediments have been reduced through riparian restoration/protection, livestock exclusions, forest road removal, construction of sediment basin and changes in forest management practices. As riparian habitat continues to mature benefits to sediment, stream temperature, and habitat complexity will continue to improve as large wood recruit into the channel and reestablish natural function.

Note: Charley Creek has been identified as the treatment stream for the Asotin Creek Intensively Monitored Watershed (IMW) which is scheduled for extensive riparian, floodplain, and complexity restoration and monitoring activities through 2018.

Current Impacts and Limiting Factors

Charley Creek salmon and steelhead numbers continue to be suppressed by reduced habitat diversity, and key habitat largely as related to large wood debris and floodplain function. Rearing habitat including pools and winter habitat remain limiting in the drainage. Though fine sediments have been reduced through land management actions elevated sediment loads remain a concern in the drainage.

5.5.1.3 North Fork and South Fork Asotin Creek

Asotin Creek's lower South Fork was historically impacted by sediment load and key habitat quantity, and secondarily by habitat diversity, channel stability, low flow, and excessive temperature. The upper South Fork experienced similar impacts, except that temperature and sedimentation are no longer limiting.

Many reaches in the North Fork mainstem were moderately limited by a lack of key habitat quantity and channel stability (upper North Fork only) or experienced low impacts from flow, habitat diversity, and sedimentation (lower North Fork only). Steelhead production in the upper North Fork tributaries, on the other hand, was believed to be strongly limited by channel stability and a lack of key habitat quantity and secondarily limited by low habitat diversity, altered flow, and introduction of sediment.

Historically, the primary limiting factors for spring/summer Chinook in the both the South and North forks of Asotin Creek was believed to be key habitat quantity and habitat diversity which impacted all life stages at moderate to extreme levels. Sediment load was believed to be secondary in the lowermost reaches of the forks, possibly impacting incubation and most other life stages at low to moderate levels.

Historical Causes for Decline (summarized from SRSRB 2006)

The human actions that were likely most responsible for habitat degradation in the North and South forks of Asotin Creek watershed are historical logging operations, roads, farming, and ranching (cattle grazing) on the tops of ridges in the South Fork drainage. Road construction produced negative impacts to riparian zones including increases in sedimentation. A natural factor that has the potential to significantly impact fish production, especially in the headwaters area of the forks, is the very high gradient of many reaches (4 percent or greater).

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the North and South Fork of Asotin Creek have worked proactively with local landowners over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. Elevated stream temperatures have been addressed by planting riparian areas, conducted irrigation efficiency projects and in-stream work to reduce channel width. Increased flow and channel depth/width ratios in conjunction with riparian trees have reduced high summer water temperatures and contributed to extending salmon rearing habitat further downstream in the mainstem. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.

Note: 8km reaches of both the North and South Fork of Asotin Creek have been identified as the control streams for the Asotin Creek Intensively Monitored Watershed (IMW) which will restrict restoration activities in these reaches to passive actions such as upland actions and maturation of existing riparian through 2018.

Current Impacts and Limiting Factors

The North and South Forks of Asotin Creek salmon and steelhead continue to be suppressed by reduced habitat diversity, key habitat, and elevated sediment load. Reduced stream channel complexity and floodplain function caused by channel straightening, incision and loss of historic riparian forests/large wood debris source has reduced habitat diversity and key habitats such as rearing and wintering habitat. Fine sediments originating on seep valley slopes remain a concern and have potential to have continued impacts on salmon habitat.

5.5.1.4 Asotin Creek Steelhead Tributary Populations

The Asotin steelhead population contains fish located in seven different subbasins (the Almota, Alpowa, Couse, George, Steptoe, Tenmile, and Wawawai creeks subbasins) as well as a "core population" in the Asotin Creek MaSA.

EDT habitat assessments were completed for Almota Creek, Tenmile Creek, and Deadman Creek (considered part of the Tucannon steelhead population) during subbasin planning in the Lower Snake Subbasin Plan (PCD 2004). It was assumed that the habitat conditions in these three streams were similar to conditions in six other small tributaries that were not analyzed (Alkali Flat, Alpowa, Couse, Penawawa, Steptoe, and Wawawai creeks). The Lower Snake Subbasin Plan addressed all nine of these tributaries, directly or by inference from the three tributaries analyzed.

Based on the assessments, it was thought that the habitat factors most impacting abundance and productivity in the three Asotin tributaries analyzed were sediment, low flow, a lack of pool habitat, poor habitat diversity associated with scarce large woody debris and anthropogenic confinement, poor riparian function, excessive temperature, and obstructions.

Historical Causes for Decline (summarized from SRSRB 2006)

Historically, most of the limiting factors for Almota and Tenmile creeks were believed to be the direct or indirect result of the impacts of roads and agricultural practices, including grazing and cropping, on the riparian zone and associated uplands. Sedimentation and low flows were believed to be attributed to crop production and grazing near the riparian corridor and in the uplands. Lack of pools was attributed to the scarcity of woody debris due to riparian degradation caused by crop production, grazing, and roads.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Asotin Creek Steelhead Tributary Populations watersheds have worked proactively with local landowners over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. All major obstructions have been addressed and many irrigation diversions have been screened. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. Elevated stream temperatures have been addressed by planting riparian areas. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.

Current Impacts and Limiting Factors

The Asotin Creek Steelhead Tributary Population watersheds continue to be suppressed by reduced habitat diversity, key habitat, stream temperature, and elevated sediment load. Reduced stream channel complexity and floodplain function caused by channel straightening, incision and loss of historic riparian forests/large wood debris source has reduced habitat diversity and key habitats such as rearing and wintering habitat. Fine sediments originating on seep valley slopes remain a concern and have potential to have continued impacts on salmon habitat.

Note: The Asotin Creek Steelhead Tributary Population watersheds are all considered priority protection watersheds with the exception of Alpowa Creek.

Bull Trout

It is assumed that actions designed to improve habitat conditions for steelhead and spring/summer Chinook salmon will provide benefits to bull trout as well.

5.5.2 Mid-Columbia DPS: Walla Walla River Summer Steelhead

The Walla Walla Subbasin Plan (WWWPU & WWWC 2004) concluded that sediment load, habitat diversity, and obstructions were the most common and severe limiting habitat factors in the SEWMU. High water temperatures, channel stability, instream flow, and a lack of key habitat were also significant limiting factors. The relative magnitude of these and other habitat factors are summarized by geographic area in Figure 5-3.

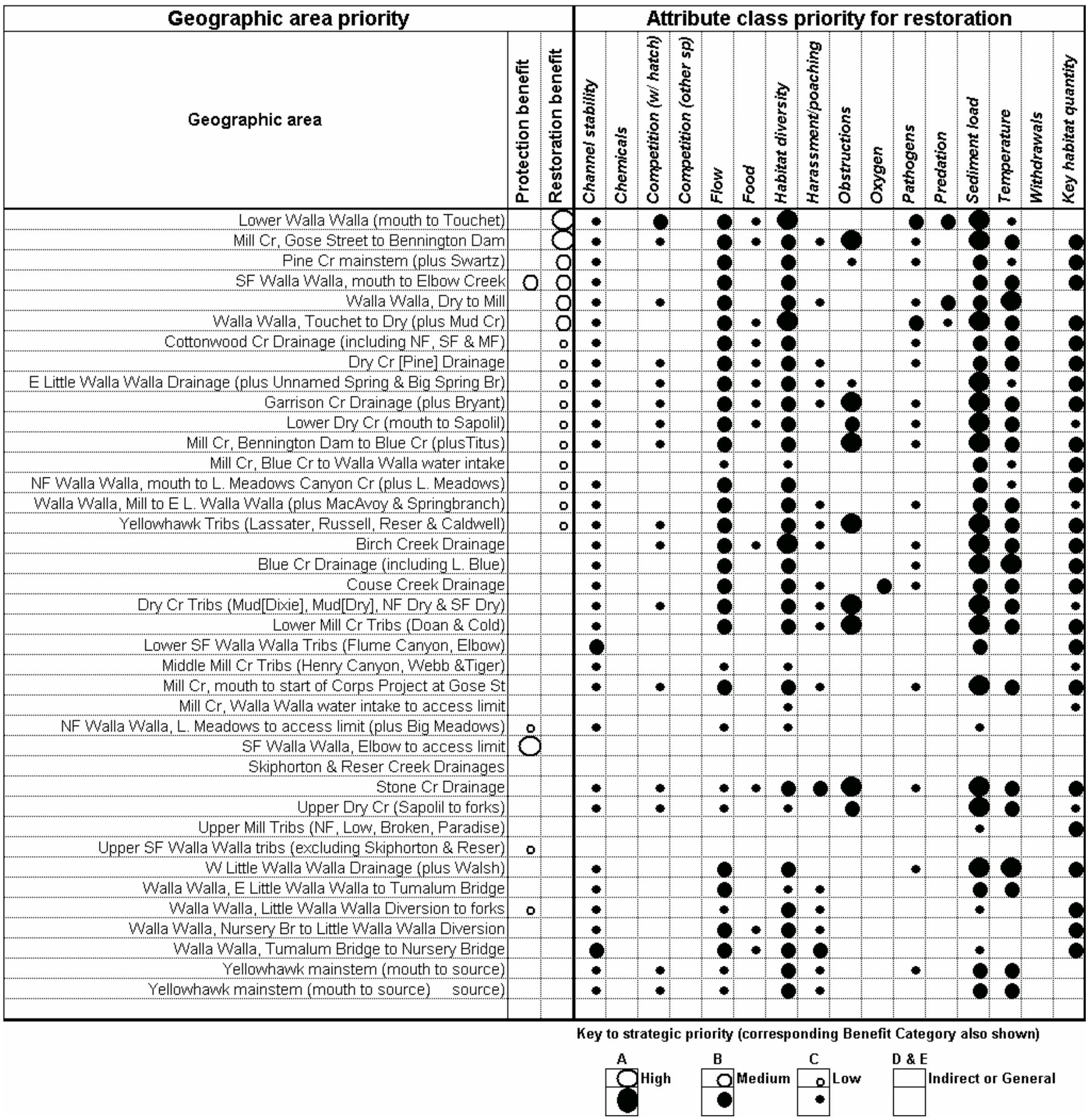


Figure 5-3. Factors Limiting the Viability of the Walla Walla Steelhead Population.

5.5.2.1 Lower Walla Walla Mainstem (Mouth to Dry Creek)

Low flow, temperature, sedimentation, a lack of pool habitat, and habitat diversity were identified in the Walla Walla Subbasin Plan as the major factors limiting steelhead production in the lower Walla Walla mainstem. Secondary limiting factors identified in the EDT analysis included competition with hatchery fish, pathogens, food, predation, and channel stability.

Historical Causes for Decline (summarized from SRSRB 2006)

The subbasin plan attributed sedimentation problems to historical residential and agricultural land uses, poor riparian condition, increased width-to-depth ratio,[11] road drainage systems, and overgrazing. Historically, hydropower and irrigation diversion dams on the lower mainstem Walla Walla (Nine Mile Dam), the upper Walla Walla (Nursery Bridge Dam) and the lower Touchet River (Hofer and Maiden Diversions) played a much larger role than they do at present. Although Nine Mile and Maiden Dams no longer exist, both were instrumental in the precipitous decline of salmon and steelhead populations in the early 20th century. Although the impact of Nine Mile Dam was thought to be large, cumulative impacts of other diversions on the middle and upper mainstem Walla Walla River were also believed to be significant.

This part of the SEWMU was historically, and continues to be heavily used for agriculture. Agricultural activities originally consisted almost wholly of sheep and cattle ranching which began as early as the 1860s. After the success of initial attempts at dry-land wheat farming, ranching was less dominant.

Historically, practices related to crop production were ranked (in the EDT modeling process) as among the top contributors to sedimentation problems throughout the subbasin. Past agriculture practices resulted in removal of riparian vegetation, which can contribute to erosion and decreases the filtering effect riparian buffers have on streams. Although the earliest agricultural activities focused on the mid-section of the Walla Walla River near the first settlements, agricultural land use today extends from the mouth to the forested headwaters.

Roads and railroads have also historically affected sedimentation in the subbasin. The construction of roads increases the total amount of impervious surfaces present, which in turn increases the quantity of water during storm runoff as well as the rate at which sedimentation is delivered to nearby streams. Bank erosion and sedimentation can be exacerbated by increased storm flows.

The reduction in the number and size of pools was also historically a key limiting factor in the entire Walla Walla subbasin as well as the lower mainstem. The subbasin plan estimates that cumulative pool area was reduced by approximately 75 percent as a result of stream channel straightening, unstable banks, high width-to-depth ratios, poor riparian conditions leading to lack of woody debris in the stream channels, removal of woody debris in stream channels in developed areas, and decreased base flows which decrease the area of all habitat types.

---

[11] The term "width-to-depth ratio" refers to the ratio of channel width to mean depth. Typically, natural undisturbed channels have relatively low width-to-depth ratios, whereas channels with unstable banks have ratios that are considerably higher, indicating a reach that is unnaturally wide and shallow.

Residential/urban impacts have historically occurred primarily in the Walla Walla/College Place, Waitsburg, and Dayton areas within the recovery region.

Grazing has also historically been identified as a factor that has degraded riparian zones in the SEWMU. Historically, grazing occurred primarily near the early settlements in the river valleys, but has subsequently occurred throughout the Walla Walla watershed.

Over the past 150 years, water appropriation and inadequate fish passage conditions have heavily impacted salmon, steelhead, and bull trout in the Walla Walla subbasin. HIstorically, many reaches of the Walla Walla River and some of its tributaries went dry on an annual basis, often leaving fish stranded in pools.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Lower Walla Walla River downstream from Dry Creek have worked proactively with local landowners over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity.   All major obstructions have been addressed and many irrigation diversions have been screened. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. Elevated stream temperatures have been addressed by planting riparian areas. Stream flows have been improved through better coordination efforts among state planners and irrigators, in addition to irrigation efficiency and aquifer recharge. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.

Note: This reach of the Walla Walla has not been prioritized for salmon restoration actions outside of improving passage for migrating salmonids.

Current Impacts and Limiting Factors

The Lower Walla Walla River downstream from Dry Creek continues to be suppressed by low flow, habitat diversity, stream temperature, and elevated sediment load. Reduced stream channel complexity and floodplain function caused by channel straightening, incision and loss of historic riparian forests/large wood debris source has reduced habitat diversity and key habitats such as wintering rearing habitat. Fine sediments originate on surrounding agricultural land, in tributaries and on banks as the river channel continues to express its natural meander width.

5.5.2.2 Upper Walla Walla Mainstem and Forks

In the upper mainstem of the Walla Walla River, flow (decreased baseflow) and habitat diversity are believed to be the dominant limiting factors for steelhead. Secondary limiting factors include channel stability, harassment, obstructions, and, to a lesser degree, food and temperature.

Historical Causes for Decline (summarized from SRSRB 2006)

Habitat diversity in the upper Walla Walla mainstem was historically degraded by agricultural development and its impacts on water quantity, riparian function, large woody debris, and stream confinement. In the upper mainstem, urban development was also an important cause of degraded fish habitat.

The ultimate causes of the key habitat and sedimentation problems in the upper mainstem are essentially the same as for the lower mainstem. However, the reductions of base flows historically seen in the upper mainstem most likely played a relatively greater role in reducing key habitat because the low flows reduce the total area of stream habitat.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Upper Mainstem Walla Walla River and Forks have worked proactively with local landowners over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Currently, obstructions in the basin have been largely removed and many irrigation diversions have been screened. Farmers and ranchers have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas, removed and setback river levees (in limited sites) and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. To address high stream temperatures project implementers and landowner have planted riparian areas, conducted irrigation efficiency projects, conducted aquifer recharge, purchased and leased water rights and conducted in-stream work to reduce channel width. Increased flow and improved channel depth/width ratios in conjunction with riparian trees have reduced high summer water temperatures extending salmon rearing habitat further downstream and improved fish passage. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures. As an interim step to increase stream habitat diversity and key habitat features in-stream restoration actions such as channel reconfiguration and large wood debris placement actions have been implemented increasing complexity in limited sites.

Current Impacts and Limiting Factors

The Upper Mainstem Walla Walla River and Forks steelhead population continue to be suppressed by reduced habitat diversity, key habitat, elevated sediment load, low flow and stream temperature. Encroachment on the floodplain caused by the construction of single family dwelling and the activities that are associated the encroachment continues to threaten floodplain and riparian function. Reduced stream channel complexity and floodplain function caused by past channel straightening, incision and loss of historic riparian forests/large wood debris source has reduced key habitats such as rearing and wintering habitat. Fine sediments originating on steep agricultural lands and from damaged stream banks continue to impact salmon habitat. Stream flow, although improving, remains a factor limiting available habitat and stream temperature particularly in the low reaches of the drainage.

5.5.2.3 Mill Creek

Mill Creek is a special case relative to the Walla Walla steelhead population. A small fraction of the drainage, located above a series of physical obstructions, contains excellent habitat, but the majority of the drainage provides habitat ranging in quality from fair to very poor. Mill Creek has been a protected watershed since the early 1900s above the Walla Walla municipal water intake (RM 26.9). In this area (upstream of RM 26.9), it is in nearly pristine condition. This area, however, represents only 17 to 33 percent of the watershed in terms of miles, depending on whether the Yellowhawk/Garrison Creek complex is included. The quality of most of the rest of the drainage is relatively poor (SRSRC 2004).

Fish habitat in the 6.9 miles from Bennington Dam downstream to the beginning of the flood control project at Gose Street can be described as severely limited. Bennington Dam (which has inadequate fish passage facilities) is capable of diverting up to 4,000 cfs into a flood control channel that empties into Bennington Lake.

All of the reach between Gose Street and the Bennington Dam Geographic Area is confined between concrete walls or gabions, often with a concrete floor. Many velocity barriers and poorly designed ladders are present, as well as a long, unlighted subterranean section. It is believed to be extremely difficult for an adult salmon or steelhead under its own power to pass from Gose Street to Bennington Dam. In addition, the Yellowhawk Diversion Dam, about a mile below Bennington Dam, diverts nearly all of the flow in Mill Creek during the summer into the Yellowhawk Creek distributary system. This diversion eliminates any possibility of upstream passage between Gose Street and Bennington Dam and partially or totally dewaters a large portion of lower Mill Creek.

Finally, although it is possible for adult steelhead (and perhaps spring/summer Chinook salmon) to gain access to upper Mill Creek via Yellowhawk Creek, they have to swim about five miles up the mainstem Walla Walla River and then turn into Yellowhawk Creek, and then negotiate more than eight miles of confined and highly urbanized stream. However, in recent years, fish have been observed migrating upstream of Bennington Dam (Mahoney et al. 2009).

Much of the habitat between Bennington Dam and the municipal water intake is of marginal quality. This area experiences major sedimentation and temperature problems affecting both steelhead and spring/summer Chinook salmon as well as significant problems related to flow, habitat diversity, and key habitat quantity. However, there are currently assessments and designs underway for Mill Creek to provide adequate passage. In addition, the SR RTT reclassified Mill Creek upstream of Bennington Dam as a priority restoration reach with the vision that passage will get restored soon.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Mill Creek watershed have worked proactively with local landowners, irrigators and local governments over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Currently, obstructions in the basin are being addressed (6 mile section through Walla Walla) while several of the larger ones (Gose Street and Kooskooski) being removed and many irrigation diversions have been screened. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures. As an interim step to increase stream habitat diversity and key habitat features in-stream restoration actions such as channel reconfiguration and large wood debris placement actions have been implemented increasing complexity in limited sites.

Current Impacts and Limiting Factors

The Mill Creek steelhead population continues to be suppressed by reduced habitat diversity, key habitat, and obstructions. Encroachment on the floodplain caused by the construction of single family dwelling and the activities that are associated the encroachment continues to threaten floodplain and riparian function. Reduced stream channel complexity and floodplain function caused by past channel straightening, incision, loss of historic riparian forests and loss of large wood debris source has reduced key habitats such as rearing and wintering habitat. Stream temperature in the lower river is also impacted by poor riparian habitat, confinement and poor floodplain and channel function.

5.5.2.4 Walla Walla Headwaters (South and North Fork)

The Walla Walla Subbasin Plan lists habitat diversity and key habitat quantity as the primary factors limiting steelhead production in the lower South Fork of the Walla Walla River (mouth to Elbow Creek); channel stability, flow, sedimentation, and temperature were identified as secondary factors.

The potential impact of low habitat diversity is considered high on steelhead spawners and fry in the lower reaches of the South Fork, but low elsewhere. Increased peak flows most likely have high impacts on steelhead fry, while decreased base flows have small impacts on steelhead parr. Channel stability, sediment load, and temperature most likely affect steelhead incubation in the lower reaches.

The North Fork appears to be most heavily impacted by a lack of habitat diversity. The productivity of fry and overwintering pre-smolts is believed to be consistently depressed by a lack of habitat diversity. Flow (increased peak flow and decreased base flow), sedimentation, and channel stability are also limiting factors. Increased peak flows most likely depress the productivity of fry and overwintering pre-smolts in every reach of the North Fork, while decreased base flows probably impact subyearlings. Channel stability and sedimentation are believed to have low but consistent impacts on fry and overwintering pre-smolts. Temperature is probably a factor only in the lowermost reach of the North Fork where it has minor impacts on subyearlings.

Limiting factors are quite similar for the North and South forks of the Walla Walla River. In both forks, habitat diversity is believed to be the major limiting factor; flow, sedimentation, and channel stability play secondary roles. Temperature is most likely a minor issue in the lower reaches of both streams. The South Fork, especially the upper South Fork and its tributaries, appears to afford slightly better habitat than the North Fork.

Historical Causes for Decline (summarized from SRSRB 2006)

Historically, low woody debris recruitment associated with logging operations and sediment inputs associated with roads were responsible for current habitat conditions in the Walla Walla headwaters. These factors are believed to have depressed production throughout all of the upper reaches in the Walla

Walla subbasin (including the Touchet River). In addition, a number of dams that formerly existed on the mainstem Walla Walla (e.g., Marie Dorian, Cemetery, Nine Mile dams) had a profound impact on salmon production.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Please see the NE Oregon portion of the Snake River Comprehensive Recovery Plan for information concerning this section.

Current Impacts and Limiting Factors

Please see the NE Oregon portion of the Snake River Comprehensive Recovery Plan for information concerning this section.

5.5.2.5 Touchet River Mainstem

In the Touchet River Mainstem, the major current limiting factors for steelhead are believed to be sedimentation, habitat diversity, flow, channel stability, and temperature. Secondary limiting factors include predation and a lack of key habitat (primarily pools). The major environmental limiting factors identified in the EDT modeling process, and their relative degree of impact, are shown by geographic area in Figure 5-4.

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Lower Touche (mouth to Coppei)		◯	●		●		●	•	●				●	●	⬤	●		•
NF Touche Mainstem	○	○	•		•		•		•						●	●		●
Coppei Drainage		∘	●				●		●				•		●	●		●
Wolf Fork, Coates to access limit (plus Whitney)	◯	∘	•				•		•						•			●
Wolf Fork, mouth to Coates (plus Robinson & Coates)		∘	●				●		●						●	●		●
Lower Walla Walla (mouth to Touche)			•		•		●	•	⬤				●	●	⬤	•		
NF Touche Tribs (excluding Wolf Fork)			•				•		•						•			●
Pattit Drainage			●		•		●		●						●	●		●
SF Touche Mainstem	∘		●		•		•	•	•				•		●	●		●
SF Touche Tribs			●				●		●						●			●
Touche, Coppei to forks (plus Whiskey)			●		•		●	•	●	•			•	•	●	●		

Key to strategic priority (corresponding Benefit Category letter also shown)

A: ◯ / ⬤ High; B: ○ / ● Medium; C: ∘ / • Low; D & E: (blank) Indirect or General

Figure 5-4. Factors Limiting the Viability of the Touchet River Steelhead Population.

The impacts of sedimentation to all life stages of steelhead are believed to be high or extreme below Coppei Creek; sediment impacts to incubation remain high throughout the mainstem and in Whiskey Creek. Inadequate habitat diversity most likely affects all steelhead life stages to some degree, but the impacts on spawners, fry, and parr are greater than for other life stages. Excessive stream temperatures probably cause a large loss in productivity for steelhead spawners, incubating eggs, and fry in the lower mainstem and possibly continue to have strong impacts on incubation through the length of the stream to the forks. Prominent among limiting factors is flow. Increased peak flows have the potential to have high impacts on steelhead fry in virtually every reach, whereas decreased base flows adversely impact subyearling steelhead in most reaches.

The EDT analysis identified competition with hatchery fish, pathogens, and food as minor limiting factors.

Historical Causes for Decline (summarized from SRSRB 2006)

Historically, adult passage, juvenile entrainment, dewatering and temperature problems associated with Hofer Dam and the former Maiden Dam diversions, as well as the generalized impact of Nine Mile Dam on the lower Walla Walla, were the major limiting factors. However, currently, adequate passage has been restored at Hofer Dam and Nine Mile Dam no longer exists.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Touchet River from the mouth to the confluence with Coppei Creek have worked proactively with local landowners, irrigators and local governments over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Obstructions in the reach have been addressed and many irrigation diversions have been screened. The result of a barrier free mainstem has been steelhead moving upriver earlier in the fall/winter than at the time of listing. Farmers and ranchers have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, and installed off channel water sources to livestock. These actions have reduced sediment loads in the mainstem improving rearing habitats. The majority of the river reach has experienced increased riparian forests due to high levels of riparian restoration. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.   As an interim step to increase stream habitat diversity and key habitat features in-stream restoration actions such as channel reconfiguration and large wood debris placement actions have been implemented increasing complexity at limited sites.

Note: Downstream from the confluence of the Whetstone drainage the primary restoration action has been to remove obstructions, screen irrigation diversions, improve riparian conditions and reduce fine sediments.

Current Impacts and Limiting Factors

The Touchet River from the mouth to the confluence with Coppei Creek habitat continues to be suppressed by channel stability, reduced habitat diversity, key habitat, flow, stream temperature and sediment load. Encroachment on the floodplain caused by the construction of single family dwelling and the activities that are associated the encroachment continues to threaten floodplain and riparian function. Reduced stream channel complexity, confinement and floodplain function caused by past channel straightening, incision, loss of historic riparian forests and loss of large wood debris source has reduced key habitats such as rearing and wintering habitat. Stream temperature in the lower mainstem are also be elevated due to reduced riparian, confinement and poor floodplain and channel function

5.5.2.6 Touchet River Headwaters

The Touchet headwaters include the North Fork, South Fork, and Wolf Fork. The Walla Walla Subbasin Plan identified habitat diversity, sedimentation, temperature, and flow as the major limiting factors for steelhead in the North Fork Touchet River. Although not mentioned in the subbasin plan, the EDT analysis indicated that various combinations of these same factors, plus channel stability, are also primary limiting factors for steelhead in the South Fork and the Wolf Fork. Habitat diversity is a primary limiting factor in almost all reaches of the North Fork and Wolf Fork, where it significantly decreases the survival of spawners (lower North Fork), fry (North and Wolf Forks), and subyearlings (Wolf Fork).

Sedimentation, temperature, and flow have similar and significant impacts in all three forks. Sedimentation has a substantial negative impact on incubation and smaller impacts on subyearlings. Temperature, increased peak flow, and decreased base flow also have the same general impacts in all three forks: temperature strongly depresses incubation in the lower reaches; increased peak flows impact fry negatively, and decreased base flow impact subyearlings in virtually every reach of all three forks. Channel stability strongly impacts egg survival in the lower South Fork and most reaches of the Wolf Fork, but has comparatively little impact in the North Fork.

Excessive peak flows and a lack of key habitat depress fry productivity in virtually every reach of the Wolf Fork. Similarly, a lack of key habitat (pools) and inadequate habitat diversity depresses the productivity of holding adults throughout the Wolf Creek watershed. Increased sedimentation significantly depresses incubation productivity in most reaches of the Wolf Fork.

Historical Causes for Decline (summarized from SRSRB 2006)

Historically, agricultural, residential development, blockages, and dewatering associated with diversion dams were responsible for the initial decline in production of salmonids in the Touchet River. However, the primary causes of habitat degradation in the Touchet headwaters were historical logging operations and the impacts of roads and dikes.

Historical logging operations resulted in a lack of large trees in the riparian corridor, decreased recruitment of woody debris, and ultimately, a lack of large woody debris in stream channels. Past logging operations have also resulted in increased water temperatures in basin streams due to the removal or alteration of riparian habitat. Historical timber harvests in the Touchet headwaters may have altered stream flow by increasing peak flows and reducing summer base flows.

The EDT analysis assumed slight to moderate increases in peak flows and flow flashiness because of historical watershed disturbances in the Touchet headwaters, as well as slight to moderate decreases in base flows.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Touchet River headwaters from Coppei Creek upriver have worked proactively with local landowners, irrigators and local to improve factors limiting salmon habitat quality and salmon/steelhead productivity. Obstructions in the reach have been addressed with only one remaining in the upper-most watershed, and many irrigation diversions have been screened. The result of a barrier free mainstem and upper watershed has been increased spawning and rearing habitat for steelhead compared to the time of listing. Farmers and ranchers have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, and installed off channel water sources to livestock. These actions have reduced sediment loads originating in the upper watershed improving spawning and rearing habitats. The majority of the river reach has experienced increased riparian forests due to high levels of riparian restoration resulting in decreased summer high temperatures and over the last few years the reach has experienced preferred temperatures above Dayton. Damaged stream banks, low habitat diversity, and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures. One critical factor limiting river channel and floodplain function in this reach is channel confinement caused by formal and informal river levees and channel training. As an interim step to increase stream habitat diversity and key habitat features in-stream restoration actions such as channel reconfiguration and large wood debris placement actions have been implemented increasing complexity at localized sites.

Current Impacts and Limiting Factors

The Touchet River headwaters habitat continues to be suppressed by channel stability, reduced habitat diversity, key habitat, and sediment load. Encroachment on the floodplain caused by the construction of single family dwelling and the activities that are associated the encroachment continues to threaten floodplain and riparian function. Reduced stream channel complexity, confinement and floodplain function caused by past channel straightening, incision, loss of historic riparian forests and loss of large wood debris source has reduced key habitats such as rearing and wintering habitat. Stream temperature in the lower mainstem downstream from Dayton may also be elevated due to reduced riparian cover, confinement and poor floodplain and channel function.

Bull Trout

It is assumed that actions taken to improve habitat conditions for spring/summer Chinook salmon and steelhead will benefit bull trout.

5.5.3 Snake River DPS/ESU: Tucannon River Steelhead and Spring/Summer Chinook Salmon Populations

The major factors limiting the viability of the Tucannon River steelhead and spring/summer Chinook salmon populations are believed to be sediment, large woody debris, anthropogenic confinement and riparian function and their impacts on habitat diversity and channel stability, key habitat (pools and pool tail-outs), summer water temperature, and flow.

5.5.3.1 Lower Tucannon (Mouth to Pataha) and Pataha Creek

As shown in Figure 5-5, key habitat quantity and sedimentation are believed to be the primary limiting factors for summer steelhead in the Lower Tucannon mainstem (mouth to Pataha Creek) and in the Pataha Creek mainstem, according to the Tucannon River Subbasin Plan (CCD 2004). Habitat diversity, flow, channel stability, predation, pathogens, and temperature are listed as strong secondary limiting factors. Figure 5-6 shows limiting factors for spring/summer Chinook salmon. The EDT analysis attributes the largest proportion of the impact to spring/summer Chinook salmon populations to temperature, a lack of key habitat quantity, and sedimentation, and a lesser proportion to a lack of habitat diversity. Channel stability, flow, food, pathogens, and predation account for the smallest proportions.

An EDT analysis of the production potential of spring/summer Chinook salmon in the Pataha Creek mainstem indicated that habitat diversity, key habitat quantity, and sedimentation are most likely the dominant limiting factors for Chinook salmon in the mainstem of Pataha Creek, while flow and temperature are secondary factors. The impact of temperature is most pronounced below the town of Pomeroy.

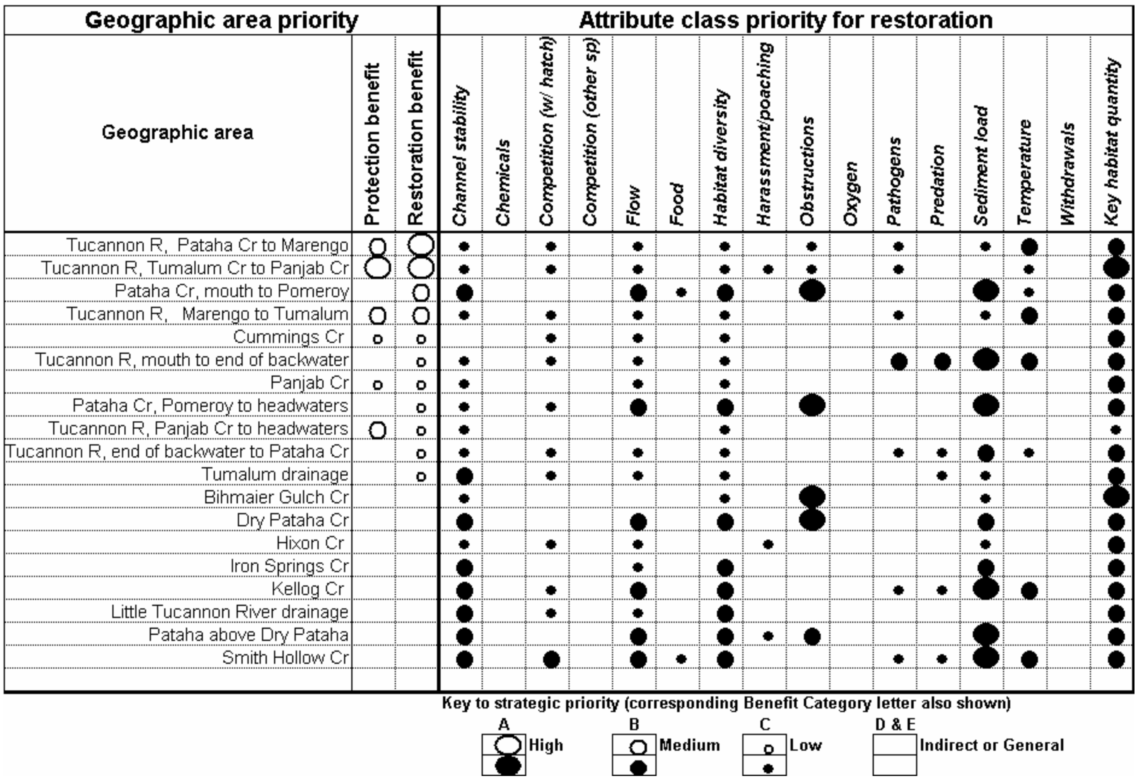


Figure 5-5. Factors Limiting the Viability of the Tucannon River Steelhead Population.

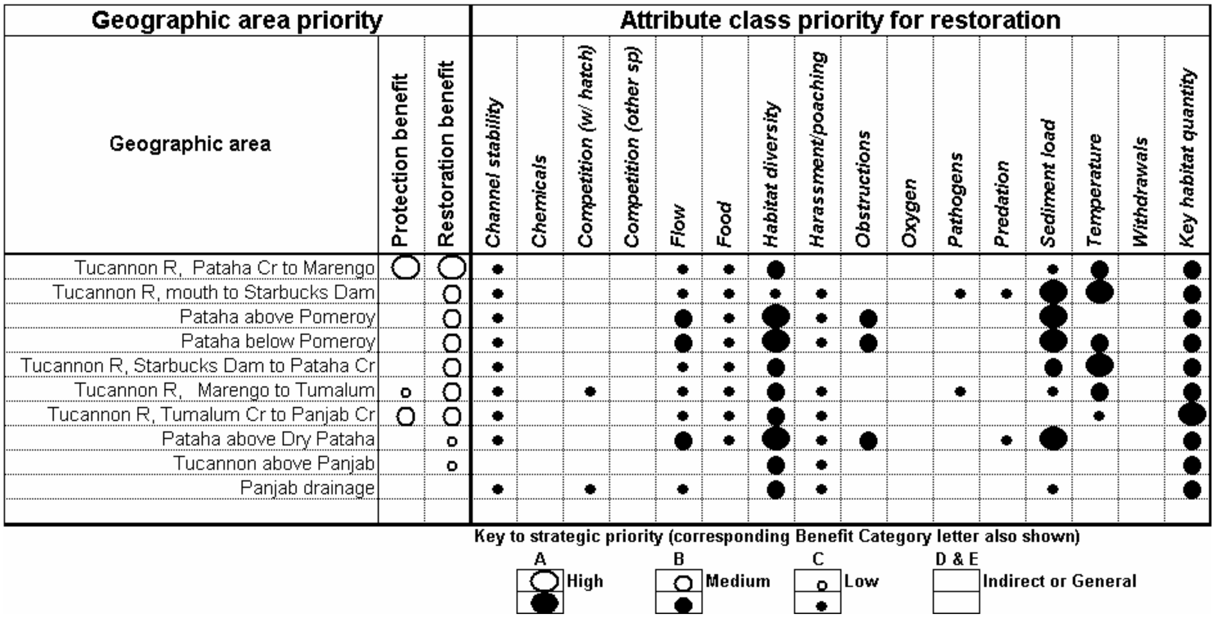


Figure 5-6. Factors Limiting the Viability of Tucannon River Spring/Summer Chinook.

The EDT analysis indicated that high impacts to steelhead fry and holding adults are attributed to the loss of key habitat quantity (pools) which also depresses the productivity of subyearling and overwintering spring/summer Chinook salmon juveniles. Sedimentation probably impacts virtually all life stages of both species, but has very high impacts on fry and overwintering pre-smolts. Although reduced habitat diversity impacts most life stages of both species according to the EDT analysis, it affects spring/summer Chinook salmon somewhat more than steelhead, potentially depressing fry production. Decreased stream flows likely reduce the productivity of subyearlings for both species, but relatively more so for steelhead. Analysis suggests that temperature has an impact on spring/summer Chinook salmon in the Tucannon mainstem below the Pataha confluence, potentially limiting the survival of holding adults and spawners. The same impacts are identified in the Pataha mainstem, although the impact lessens above Pomeroy. For steelhead, excessive temperature in the lower Tucannon mainstem and in Pataha Creek most likely affects primarily incubating eggs, fry, and subyearlings. Predation appears to also be a problem near the stream's confluence with the Snake River because exotic species (e.g., smallmouth bass) invading the Tucannon from the Snake River feed on fry or subyearlings of both species.

Historical Causes for Decline (summarized from SRSRB 2006)

Historical impacts to the lower Tucannon River were largely attributable to dams and, to a lesser degree, the poaching that was made easier by dams, and barriers to passage (G. Mendel, personal communication,). Starbuck Dam (RM 5.5) and De Ruwe Dam (RM 16) were both built between 1900 and 1910, and both played major roles in the early decline of anadromous salmonids in the Tucannon River. These dams dewatered a mile or more of the mainstem during the summer and fall, were ineffectively laddered, and probably entrained or killed by impingement a high proportion of juveniles during times of peak diversion (USFWS 2002d).

Historical grazing practices added to the sedimentation problem by eliminating riparian vegetation and causing bank sloughing, channel widening, and gully erosion in the lower Tucannon and Pataha drainages.

Historically, two dams restricted adult access and reduced the survival of outmigrating smolts and fluvial bull trout. Starbuck Dam was constructed at RM 5.5 in 1907 and De Ruwe Dam was constructed in 1900 at RM 16. Both dams were originally hydropower projects, and both diverted all or most of the flow in the river during the summer months (Bryant and Parkhurst 1950). Starbuck Dam was equipped with a ladder, but the entrance was immediately below the dam and fish were unable to find it. The De Ruwe Dam also had a ladder which was apparently not properly maintained. By 1935, the ladder was choked with mud and gravel, overgrown with willows, and was probably impassable.

Besides blocking adult salmonid passage, both dams represented major smolt entrainment hazards. An unscreened irrigation diversion withdrawing 11 cfs was operated in the pool above Starbuck Dam. Though the penstock at Starbuck Dam was screened, the mesh size was probably too wide to exclude smaller juveniles and impingement was almost certainly a problem for juveniles of all sizes. In 1935, De Ruwe Dam had been converted to an irrigation diversion (Bryant and Parkhurst 1950). At that time, virtually all stream flow and any migrating fish were diverted into an unscreened ditch during the summer months. The De Ruwe Dam was washed out by the 1964 flood, but Starbuck Dam, although modified, is still in place. In 1992, the Washington Department of Fish and Wildlife built a new fish ladder at Starbuck Dam.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Lower Tucannon River downstream from Pataha Creek have worked proactively with local landowners to improve factors limiting salmon habitat quality and salmon/steelhead productivity. All major obstructions have been addressed and many irrigation diversions have been screened. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. Elevated stream temperatures have been addressed by planting riparian areas. Stream flows have been improved irrigation efficiency and trusting of saved water. As a direct result of increased flows and maturing riparian trees salmonids spawning and rearing has been observed farther downstream than at the time of listing. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures. The CCD has completed seven irrigation efficiency contracts, "Trusted" a total of 11.104 cfs and 951.38 af with 1134.6 acres served. Pataha Creek portion is .635 cfs, 63.5 af and 64 acres served.

Note: This reach of the Tucannon River was changed to a priority restoration reach in the Snake River Salmon Recovery Plan beginning in 2010. It is anticipated this change will increase restoration actions in the lower river in future years.

Current Impacts and Limiting Factors

Currently, much of the sedimentation problem in the lower Tucannon mainstem is attributable to agricultural practices along the lower Tucannon mainstem and in the Pataha Valley upstream. This situation is exacerbated by a poorly designed road system and extremely unstable and incised (~20 feet) stream banks in the Pataha watershed. The lack of habitat diversity is primarily caused by a lack of large woody debris, channel confinement and/or channelization, and poor riparian function. In turn, these factors are attributable to current and historical crop production and grazing practices, historical decimation of beaver populations, and to the elimination of many riparian trees by past logging operations and a series of catastrophic floods. Temperature problems are attributable to riparian damage within the reach and upstream (reduced shading), to low flows caused by hydrological disruption of the upper watershed, and to upstream irrigation diversions. The lack of pools and pool tail-outs is caused by very low quantities of large woody debris and the filling of pools with transported sediment. Finally, pathogens are believed to be a minor problem because of elevated water temperatures, generally stressful conditions, and the presence of a hatchery complex upstream.

Elevated water temperatures throughout the Tucannon drainage are primarily attributable to a widespread lack of shading associated with riparian degradation, loss of stream channel and floodplain function (loss of subsurface flow) but are exacerbated by irrigation withdrawals. The proportion of the natural river flow that is diverted for irrigation is higher in dry years when the river is already low and needs to retain volume to remain within temperature tolerance levels for fish. Unfortunately, natural summer base flows are well below the volume allocated in combined irrigation permits. A cursory review of irrigation system data indicates that the overall conveyance efficiency of the irrigation system is only 65 percent (TRMWP 1997). By 1995, the Washington Department of Ecology had issued 68 surface water rights for the Tucannon River, for a total diversion of 60 cubic feet per second to irrigate 1,147 acres (Covert et al. 1995; TRMWP 1997). All new applications for surface water rights since 1995 have been denied.

Sedimentation problems in the Pataha watershed are exacerbated by the existing road system (USFWS 2002d). The road network in the watershed is largely a non-engineered system more than a century old. Most of the 361 miles of roads run parallel to Pataha Creek and cross many smaller tributaries. Few of these roads are equipped with settlement basins and sediment in runoff from adjacent lands is funneled directly into Pataha Creek. Some of the sediment delivered to Pataha Creek via road drainage is attributable to poor construction and/or maintenance, but most of the sediment originates from upland agricultural operations.

The natural hydrological regime represents a constraint on fish production in Pataha Creek that has not yet been fully documented. The Tucannon Subbasin Summary (Columbia Conservation District 2001) reports that flows in Pataha Creek are the result of melting snow in the Blue Mountains. This is in marked contrast to the Tucannon mainstem, which is totally sustained by groundwater at baseflow. During years when the mountain snowpack is subnormal, Bihmaier Springs can provide as much as half of the flow in Pataha Creek during the summer. During droughts, some sections of Pataha Creek have been known to go dry. Due to the low flows, adult fish passage in the lower Pataha is impaired at the Delaney culvert (30 percent maximum blockage in May and August), Dodge Bridge (20 percent maximum in August), and the 20th Street sewer line (30 percent maximum in May and August). Davis Shelf was considered a minor barrier to adult fish passage in the upper Pataha mainstem (10 percent blockage in August). In addition, stream temperatures increase significantly when flows fall below 9 cfs.

Residential development also affects fish habitat in the Pataha drainage. The City of Pomeroy is located along Pataha Creek; city roads and infrastructure are located in the creek’s floodplain. Within Pomeroy, significant portions of the streambank on both sides have been converted to vertical walls reinforced with concrete or riprap. The stream has been straightened and there is no floodplain function in this reach. Large trees and other riparian vegetation are largely missing because of channel modification within the city limits and because of upstream land use activities, resulting in severe headcutting and erosion. In

1998, canopy cover in Pataha Creek ranged from 5 to 15 percent from Pomeroy downstream to its confluence with the Tucannon River (Kuttel Jr. 2002). Abandoned concrete slabs covered with mud and vegetation are blocking the stream channel downstream of the Pomeroy well site, and the 20th Street sewer line partially blocks adult passage. Finally, historical illegal harvest (poaching) activities were also likely to have reduced adult production dramatically since European development.

5.5.3.2 Tucannon River, Pataha Confluence to Marengo

For the Tucannon mainstem from Pataha Creek to Marengo, the Tucannon Subbasin Plan identified key habitat quantity as the primary factor limiting steelhead production. Habitat diversity, flow, channel stability, sediment, and temperature were identified as secondary limiting factors. Primary limiting factors for spring/summer Chinook are temperature, key habitat quantity, and habitat diversity; secondary factors are flow, channel stability, sediment, and food.

The loss of key habitat impacts steelhead fry and holding spring/summer Chinook adults, resulting in depressed survival of most steelhead and spring/summer Chinook salmon life stages. Inadequate habitat diversity also impacts the productivity of almost all life stages of both species, with especially large impacts on spring/summer Chinook salmon fry in the reach from Tucannon Falls to the steelhead release facility at Einrich. Temperature has large impacts on spring/summer Chinook salmon migrant adults and spawners and on incubating steelhead eggs in this geographic area. Increased peak flows have moderate impacts on both spring/summer Chinook salmon and steelhead fry; decreased base flows have moderate impacts on steelhead subyearlings and holding spring/summer Chinook salmon adults. Sedimentation affects spring/summer Chinook salmon and steelhead similarly, moderately reducing the survival of fry and overwintering pre-smolts in all reaches and strongly impacting incubation in the lowermost reach.

For steelhead, the EDT analysis identified minor limiting factors, including competition with hatchery fish and pathogens that were not discussed in the subbasin plan. For spring/summer Chinook salmon, the plan noted that reduced food availability was not a major factor in any one reach, but might be cumulatively significant as a minor factor throughout the watershed.

Historical Causes for Decline (summarized from SRSRB 2006)

The initial decline of salmon and steelhead production through the subbasin is attributable to the problems associated with historical diversion dams and poaching. During the past several decades, the Tucannon River has undergone fundamental changes in flow regime, bed conditions, water quality, and habitat values. It was estimated that 33 to 55 percent of the riparian woodland present in 1937 had been lost by 1978, much of it to floods and the installation of protective dikes in the basin after the 1964 flood. Some of the woodland loss was attributed to encroachment of other land use practices, principally irrigated fields and pastures. As wooded riparian zones were replaced with open areas, shade was diminished and the riverbanks became less stable.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Tucannon River upstream from the Pataha Creek confluence to Marengo have worked proactively with local landowners over the past nineteen years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. All major obstructions have been addressed and many irrigation diversions have been screened. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. The reduction of sediment load in this reach has been drastic in that sediment basins constructed to capture fines routing from upslope agriculture are no longer needed. Elevated stream temperatures have been addressed by planting riparian areas. Stream flows have been improved irrigation efficiency and trusting of saved water. As a direct result of increased flows, reduce with to depth ratios and maturing riparian trees salmonids spawning and rearing has been observed farther downstream than at the time of listing. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures. Noteworthy is that water temperature in the Tucannon River at Marengo exceeded 72 farenhiet on average 24 days per year from 1982 through 2002. Since 2005, the water temperature has not reached 72 farenheit at any time at Marengo.

Current Impacts and Limiting Factors

Currently, floodplain connectivity and function is restricted by diking or levees along an estimated 34 percent of the reach from the mouth to Cummings Creek (RM 34.5) (Columbia Conservation District 2001). In this reach, the river has been significantly straightened and has lost about 30 percent of its pre-1960s flood length, which has resulted in higher water velocities and fewer pools. To maximize land use, agriculture, development, and transportation, the floodplain has been isolated from the river by the construction of dikes and levees.

5.5.3.3 Tucannon River: Marengo to Little Tucannon River

In the mainstem Tucannon River reaches between Marengo and the Little Tucannon River, habitat diversity and key habitat quantity are considered by the subbasin plan to be the primary limiting factors for summer steelhead. Flow and channel stability are secondary limiting factors. Moderate losses of productivity attributable to habitat diversity were apparent across most life stages, with high losses to fry in the uppermost reach. The poor habitat diversity in these areas is the result of poor riparian condition and a lack of large woody debris. Loss of key habitat quantity has had large impacts on all steelhead life stages, with extreme impacts on holding adults. Much of the key habitat impact is attributed to a lack of pools, which, in turn, is the result of channel straightening and the scarcity of large woody debris.

Several minor limiting factors for steelhead identified by the EDT analysis that were not discussed in the subbasin plan include competition with hatchery fish, pathogens, maximum temperature, and harassment/poaching.

The dominant limiting factors identified by EDT for spring/summer Chinook salmon in this portion of the Tucannon River are a lack of habitat diversity and key habitat (pools). Secondary limiting factors include temperature (the impact of which decreases substantially in the upstream reaches) and minor impacts attributable to channel stability, flow, and food.

Historical Causes for Decline (summarized from SRSRB 2006)

Historically, agricultural, residential development, blockages, and dewatering associated with diversion dams were responsible for the initial decline in production of salmonids in the Tucannon River. However, the primary causes of habitat degradation in the Tucannon headwaters were historical logging operations, grazing, and the impacts of roads and dikes.

Historical logging operations resulted in a lack of large trees in the riparian corridor, decreased recruitment of woody debris, and ultimately, a lack of large woody debris in stream channels. Past logging operations have also resulted in increased water temperatures in basin streams due to the removal or alteration of riparian habitat. Historical timber harvests in the Tucannon headwaters may have altered stream flow by increasing peak flows and reducing summer base flows.

The EDT analysis assumed slight to moderate increases in peak flows and flow flashiness because of historical watershed disturbances in the Tucannon headwaters, as well as slight to moderate decreases in base flows.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

Habitat restoration project implementers in the Tucannon River upstream from the Marengo to the Little Tucannon confluence have worked proactively with local landowners and state agencies over the past seven years to improve factors limiting salmon habitat quality and salmon/steelhead productivity. All major obstructions and irrigation diversions screens have been addressed. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness. The reduction of sediment load in tis reach has been drastic in that sediment basins constructed to capture fines routing from upslope agriculture are no longer needed. Elevated stream temperatures have been addressed by planting riparian areas although forest fires in 2005 have reduce riparian forests in the upper middle reaches of the drainage particularly on state and federal lands. The loss of riparian cover has had one large benefit in that a large increase in large woody debris has been recruited in the stream channel on levels not seen since land management practices began. Additional wood augmentation restoration actions have begun to dramatically improve wood retention in the upper drainage driving the formation of floodplain connectivity and side channels in some reaches. Stream flows have been improved through irrigation efficiency and trusting of saved water. As a direct result of increased flows, reduce with to depth ratios and maturing riparian trees salmonids spawning and rearing has been observed farther downstream than at the time of listing. Damaged stream banks, low habitat diversity and key habitats although improved through restoration actions will continue to produce fine sediment and elevate stream temperatures until floodplains and riparian cover matures.

Current Impacts and Limiting Factors

Limiting factors for this reach include reduced channel stability, low habitat diversity, reduced key habitat quantity, and temperature. The river is inhibited by legacy effects of intense land management which has straightened and confined the river into a single channel reducing floodplain connectivity, riparian forests and minimizing complexity. River levees currently confine the channel minimizing side channels and transporting large wood debris from the reach inhibiting recovery.

Forest lands in this area receive a high level of recreational use; in fact, recreation may be the dominant land use, particularly in the National Forest's Wenaha Wilderness area and on WDFW lands. Because the uplands are dominated by steep slopes, most recreational use is concentrated in riparian areas. Nearly 400,000 visitors per year enjoy camping, fishing, hunting, wildlife viewing, and hiking in the WDFW wildlife area or nearby wilderness area. During major holidays, between 3,000 and 5,000 people visit each day. WDFW currently manages seven campgrounds in the area and the Forest Service manages five. Federal planners are considering an additional campground near the Tucannon guard station.

Camp Wooten, a 160-acre environmental learning center, is located within the 16,728-acre W.T. Wooten Wildlife Area, owned by WDFW and managed by Washington State Parks. Camp Wooten is leased and operated by the Washington State Parks Department. Thousands of school and 4-H children visit the camp every year to learn about natural resource conservation topics.

Above RM 34.5, on public land owned by WDFW and USFS, floodplain connectivity and function are restricted by dikes or levees. The floodplain has been isolated from the river to protect infrastructure, including Camp Wooten Environmental Learning Center (Washington State Parks), man-made fishing ponds, the Tucannon Fish Hatchery and acclimation facility, roads, and campgrounds. Isolating the floodplain has resulted in a poor and narrow riparian zone and lack of shade. It is believed that elevated water temperature is an unnatural condition which began with the reduction of shade from riparian vegetation during the flood of 1964-1965. It is also assumed that subsequent floods and channelization have exacerbated the problem.

5.5.3.4 Tucannon River: Little Tucannon to Bear Creek ("Mountain Tucannon")

The EDT analysis of the Tucannon subbasin identified a lack of key habitat (primarily pools) as the dominant limiting factor for steelhead and spring/summer Chinook salmon in the headwaters of the Tucannon River, with minor impacts attributable to channel stability and habitat diversity. This area was referred to as the "Mountain Tucannon" in the Tucannon Subbasin Plan as it includes the uppermost reaches of the mainstem in the foothills of the Blue Mountains. The impact of all limiting factors in this area was minimal, affecting primarily subyearling steelhead and fry and overwintering spring/summer Chinook salmon. The impacts of limiting factors in the Panjab Creek watershed were also minimal in the EDT analysis. For both steelhead and spring/summer Chinook salmon, the dominant limiting factor was a lack of key habitat attributable to a decrease from historical levels in the quantity of pools of various types. Inadequate habitat diversity and channel instability had very minor impacts, as did a minimal increase in peak flows. Fry and incubating eggs were the primary steelhead life stages affected, while spring/summer Chinook salmon fry and holding adults were most affected.

Historical Causes for Decline (summarized from SRSRB 2006)

Habitat degradation in the Tucannon River headwaters is primarily attributed to inadequate quantities of large woody debris which are the result of past logging and flood control operations. Stream and riparian damage occurred because logs were often moved downhill in stream channels and floodplains.

Agriculture has had a minimal effect on this area. Cattle grazing has been excluded from upper reaches of the Tucannon since the early 1990s. Recreational activities such as camping, hunting, and "four-wheeling" have also impacted stream habitat in this area.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

With the exception of one privately owned in-holding, this reach is owned by the USFS. Channel restoration including in-stream structures and riparian planting have occurred on both USFS and private lands in this reach to improve factors limiting salmon habitat quality and salmon/steelhead productivity. All major obstructions have been addressed (Little Tucannon culvert replaced with a bridge). Grazing allotments have been fenced out of sensitive habitats, and forest roads contributing fine sediments are benign modified or removed. The result has been reduced fine sediment loads and reduced streambed embeddedness.

Note: This reach of the Tucannon River is primarily on USFS lands and much is located in the Wenaha Wilderness area.

Current Impacts and Limiting Factors

Factors currently limiting salmon recovery in the Tucannon River headwaters include habitat diversity and key habitat quantity. These limiting factors are largely legacy effects of past stream channel and riparian management practices where riparian forests were logged, grazed and snags were removed from the water course

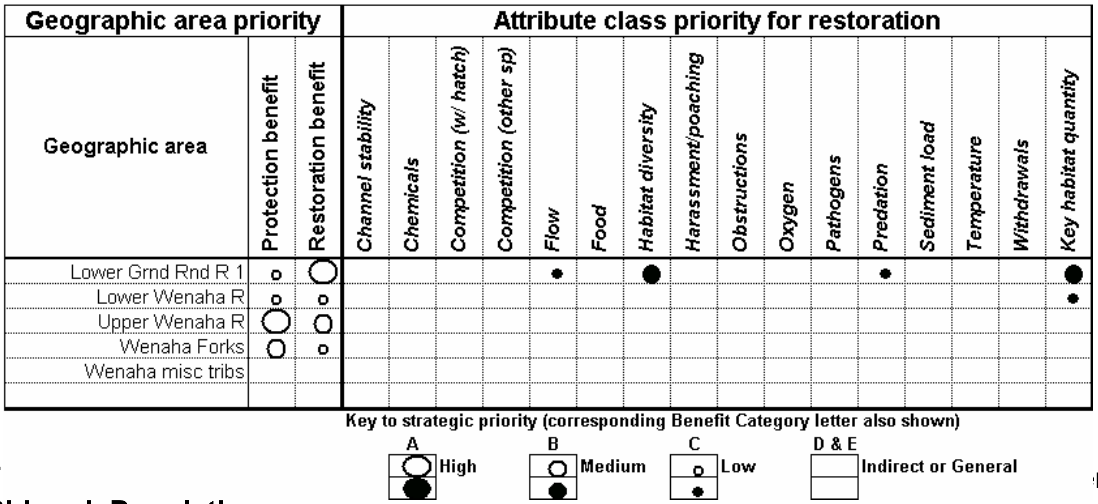
Bull Trout

Bull trout spawn and rear in the headwaters of the Tucannon River and most of its tributaries, but some fish migrate downstream as far as the Snake River. It is assumed that actions taken to improve habitat conditions for spring/summer Chinook salmon and steelhead will benefit bull trout.

5.5.4 Snake River ESU/DPS

5.5.4.1 Wenaha Spring/Summer Chinook and Lower Grande Ronde Steelhead Populations

Except for its lowermost portions, the Wenaha watershed is relatively pristine (it has only been a wilderness area since the 1960s and had cattle grazing until 1990s). Accordingly, the Grande Ronde Subbasin Plan (Nowak 2004) reported very few limiting factors for the drainage, all of which are confined to the lowermost reaches in the Wenaha mainstem. For spring/summer Chinook salmon, the EDT analysis suggested that key habitat quantity is a very minor limiting factor, affecting overwintering pre-smolts, subyearlings, and smolts. Production of spring/summer Chinook salmon in the lower Grande Ronde below the Wenaha confluence is moderately impacted by a lack of habitat diversity and key habitat quantity (pools). Very slight impacts due to predation and flow are also noted. The results of the EDT analysis for the Wenaha spring/summer Chinook salmon population are presented in Figure 5-7.



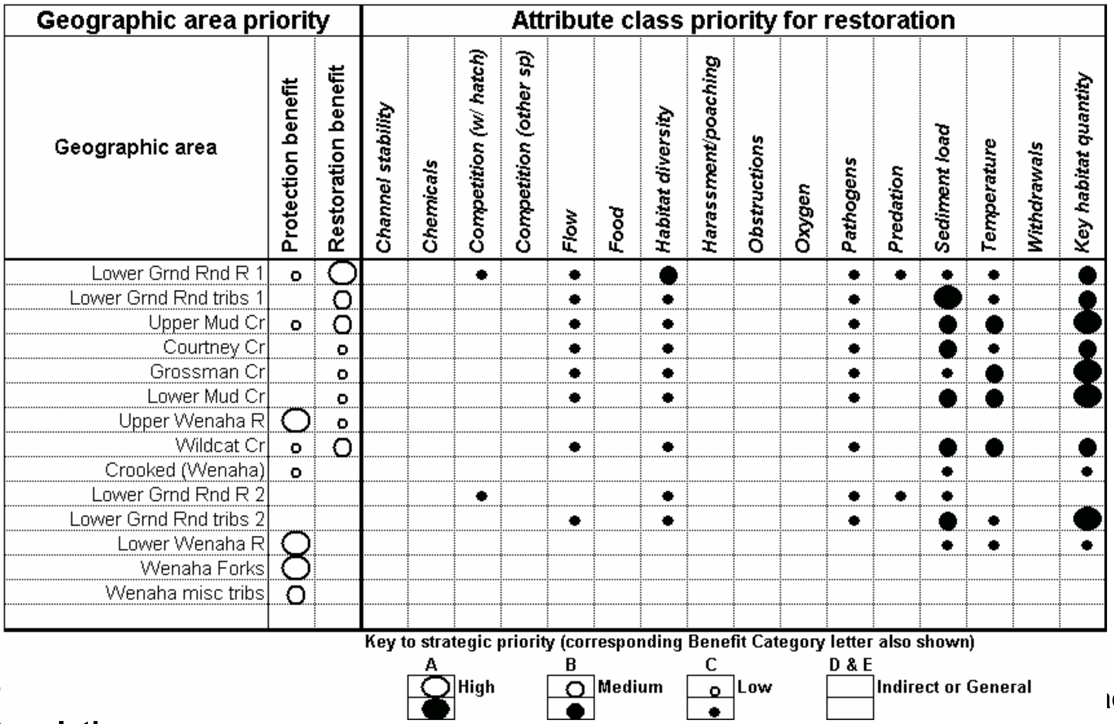
Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Lower Grnd Rnd R 1	∘	◯					•		⬤					•				⬤
Lower Wenaha R	∘	∘																•
Upper Wenaha R	◯	○																
Wenaha Forks	○	∘																
Wenaha misc tribs																		

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	∘ / • Low	Indirect or General

F **r**
Chinook Population.

The Lower Grande Ronde steelhead population includes the Wenaha River drainage and lower Grande Ronde River as well as a number of tributaries to the lower Grande Ronde, the largest of which are Mud, Courtney, Grossman, and Wildcat creeks. EDT limiting factors analysis for this population indicates that there are very few habitat problems within the Wenaha drainage, but that there are significant impacts in the lower Grande Ronde mainstem and the lower Grande Ronde tributaries (Figure 5-8). Within the Wenaha drainage, steelhead subyearlings and incubating eggs are very slightly impacted by sedimentation and, to an even lower degree, by temperature and a lack of key habitat (pools). In the lower Grande Ronde River and its tributaries, the largest impacts are due to sedimentation and key habitat quantity (pools), with lesser impacts attributable to excessive temperature. Lesser impacts were attributed to habitat diversity, low flow, and fish pathogens. Within the lower Grande Ronde River mainstem, the largest impacts affect overwintering juveniles and are attributable to a lack of habitat diversity and key habitat (pools). Sedimentation, icing, bed scour, and occasional temperature effects on incubating eggs were almost always the major impacts identified in the lower Grande Ronde tributaries.



F ... d Population.

Historical Causes for Decline (summarized from SRSRB 2006)

It is speculated that historical logging and grazing may have impacted salmonid populations in the past.

The Grande Ronde Subbasin Plan (Nowak 2004) attributed the lack of habitat diversity in the lower Grande Ronde mainstem primarily to anthropogenic confinement, the importation of suspended sediment from upstream, and a lack of large woody debris. They also noted, however, that much of this area is a natural transport zone due to a high degree of natural confinement and that increasing woody debris loading would likely be difficult. The plan also attributed most of the sediment and temperature problems in the tributaries to riparian degradation associated with streamside roads and grazing.

Actions and Improvements That Have Taken Place to Address Original Causes for Decline

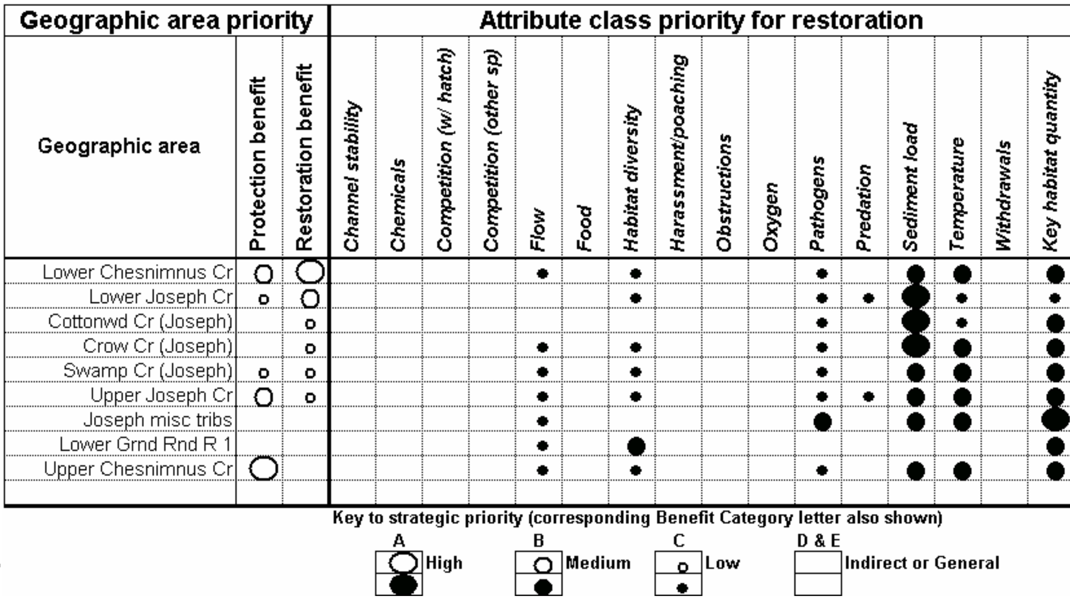
The lower Grande Ronde River has benefited from salmon habitat restoration actions performed in the drainage which reduced sediment load, removed obstructions, and improved riparian habitat in the tributaries. Farmers, ranchers and state agencies have participated in a number of federal and state programs to improve grazing practices, convert tilled lands to minimum till agriculture, fenced livestock out of sensitive habitats, constructed sediment retention basins in problem areas and installed off channel water sources to livestock. The result has been reduced fine sediment loads and reduced streambed embeddedness.

Current Impacts and Limiting Factors

Factors limiting in the Lower Grande Ronde and tributaries include habitat diversity including large wood debris caused by past land management and limited riparian, fine sediment, stream temperature and key habitat quantity.

5.5.4.2 Joseph Creek Steelhead Population

Figure 5-9 shows the results of the EDT limiting factors analysis for the entire Joseph Creek watershed, but only the "Lower Joseph Creek" geographic area, which includes the Washington portion of the drainage (as well as some of the lowermost Oregon reaches), is applicable to this analysis.



F pulation.

Figure 5-9 shows that sedimentation is the dominant limiting factor in the Lower Joseph Creek geographic area, with pathogens, predation, temperature and a lack of key habitat (pools) playing minor roles. Incubation and overwintering are the life stages most affected by sedimentation in these reaches.

The Grande Ronde Subbasin Plan (Nowak 2004) states that lower Joseph Creek flows through mostly private lands in a relatively confined canyon, and is partly paralleled by a road. They note some grazing, a reasonably intact riparian corridor, no logging, and isolated ranches. They conclude that the sediment and other impacts affecting this area likely are caused by activities upstream, and therefore that actions taken strictly within lower Joseph Creek are unlikely to improve conditions appreciably.

5.6 SUMMARY OF KEY LIMITING FACTORS

The key factors limiting the viability of salmonid populations in the recovery area are summarized for each of the four "Hs." Chapter 6 will present strategies to address, as appropriate, each factor. Note that NMFS has developed more detailed analyses of impacts from the hydroelectric system, hatcheries, harvest, and Columbia River estuary habitat (NOAA Fisheries 2008). The strategies and actions described in the FCRPS BiOp are currently being implemented, or planned for implementation.

5.6.1 Key Factors Related to Habitat

5.6.1.1 Habitat within the SEWMU

The watersheds in the SEWMU have similar salmonid habitat limitations due to similarities in topography, geology, vegetation, and land use. Agriculture (including grazing), logging, and urbanization have increased sediment and water temperatures, decreased riparian condition, and caused major changes in channel form and function. The key habitat factors affecting the recovery region are lack of large woody debris, stream confinement, reduction or elimination of riparian functions, increased sediment, reduction in quality habitat (lack of pools and reduced habitat diversity), alterations to stream flows, and high water temperatures. Table 5-2 shows the key factors for the major streams and stream reaches in the recovery region.

Table 5-2. Key Limiting Habitat Factors in SEWMU Subbasins.

Geographic Area	Limiting Habitat Attributes								
	Large Wood	Confinement	Riparian Function	Sediment	Key Habitat (Pools)	Flow	Bed Scour	Temperature[a]	Other
Upper Asotin (Headgate Dam to Forks)	X	X	X	X	X			X	
Lower George Creek	X	X	X	X	X	X	X	X	
Lower NF Asotin	X	X	X	X	X		X		
Charley Creek	X	X	X	X	X		X		
Lower SF Asotin	X	X	X	X	X			X	
Tucannon, Pataha Creek to Marengo	X	X	X	X	X	X		X	
Tucannon, Marengo to Tumalum Creek	X	X	X		X	X		X	
Tucannon Tumalum Creek to Hatchery Dam	X	X	X		X	X		X	
Tucannon, Hatchery Dam to Little Tucannon	X	X	X		X				
Tucannon, Little Tucannon to Bear Creek	X	X	X		X				
Walla Walla, Mill to E Little Walla Walla	X	X	X	X	X	X	X	X	
Walla Walla, E. Little Walla Walla to Tumalum Bridge	X	X	X	X	X	X	X	X	
Walla Walla, Tumalum Bridge to Nursery Bridge	X	X	X		X	X	X		
Walla Walla, Nursery Bridge to Little Walla Walla Diversion	X	X	X		X	X	X		
Walla Walla, Little Walla Walla Diversion to forks	X	X	X		X	X		X	
SF Walla Walla, mouth to Elbow Creek	X	X	X	X	X	X	X	X	
NF Walla Walla, mouth to L. Meadows Canyon Creek (plus L. Meadows)	X	X	X	X	X	X	X	X	
Coppei Drainage	X	X	X	X	X	X	X	X	
Touchet, Coppei to forks (plus Whiskey	X	X	X	X	X	X	X	X	
SF Touchet Mainstem	X	X	X	X	X	X	X	X	

Geographic Area	Limiting Habitat Attributes								
	Large Wood	Confinement	Riparian Function	Sediment	Key Habitat (Pools)	Flow	Bed Scour	Temperature[a]	Other
SF Touchet Tributaries	X	X	X	X	X				
NF Touchet Mainstem	X	X	X	X	X				
NF Touchet Tributaries (excluding Wolf fork)	X				X				
Wolf Fork, mouth to Coates (plus Robinson & Coates)	X	X	X	X	X				
Wolf Fork, Coates to access limit (plus Whitney)	X	X	X		X		X		
Almota Creek			X	X	X	X		X	
Deadman Creek			X	X	X	X		X	
Grande Ronde, below Wenaha Wilderness			X	X	X	X		X	Predation

[a]Temperature "problems" as identified by EDT represent a negative impact *relative to historical conditions*, not necessarily an existing negative impact. Thus, if historical conditions were assumed to include a negative impact due to a particular environmental factor, and if the same degree of impact were present currently, EDT would not indicate a "problem". This situation arises relatively frequently with regard to high temperatures in Snake River tributaries. Specifically, negative impacts attributable to high water temperatures are recognized in many areas (e.g., the lower Walla Walla mainstem, lower Touchet River, Deadman Creek, etc.), but are not emphasized as a problem because impacts nearly as severe were assumed to occur historically.

5.6.1.2 Habitat Outside the Recovery Region

The Columbia River Estuary has been extensively modified by man. Key factors affecting salmonid habitat are the following.

- The annual hydrograph in the Columbia River has been significantly altered; winter and spring high flows have been moderated and summer-fall flow has increased. These changes have impacted the estuary food web upon which salmon depend for food.
- The size of the Columbia River estuary has been reduced by 24 percent as a result of diking and elimination of back and side channels. This has likely reduced the carrying capacity of the estuary to support large numbers of juvenile salmonids.
- Alteration of flow and upriver dams has significantly altered the input of sediment and organic matter, including large wood, to the estuary. These actions have reduced habitat complexity and food abundance.
- Although water quality has improved, the Columbia River estuary does have increased levels of most metals as well as DDT and PCBs. These chemicals may reduce juvenile survival and other species these fish rely on as a food source.

The ocean environment has a significant effect on salmonids. Among factors affecting salmonid survival are the following:

- Abundance of Snake River salmon and steelhead is highly dependent on conditions in the ocean.
- Ocean conditions cycle at 15 to 30 year periods producing long-term cycles in salmon abundance. These cycles must be accounted for in determining the success or failure of actions designed to increase salmon abundance.

- Shorter term oscillations such as El Niño result in significant variation in returns from year-to-year.

5.6.2 Key Factors Related to Hydroelectric Installations

Salmon and steelhead populations addressed in this recovery plan are directly impacted by four to eight hydroelectric dams depending on the location of the subbasin from which they originate. Some of the key impacts from hydro include the following.[12]

- Stocks are negatively impacted by flow regulation from dams in the upper Columbia and Snake Rivers. Spring flows are lower and summer flows are generally higher.
- The major loss of spawning and rearing habitat above Hells' Canyon Dam, and the loss or alteration of habitat for spawning and rearing in the lower Snake River (for Snake River fall Chinook primarily)
- Flow impacts attributable to Dworshak and Hells Canyon Dams[13].
- Juvenile bypass systems at the Snake River dams collect the majority of juvenile migrants and divert them into transport barges or trucks which transport and release the fish below Bonneville Dam. This activity may result in increased stress, descaling, and mortality.
- Some dams may prevent fish that have "overshot" their natal tributary from returning to that tributary.
- Recent survival of adult fish from Bonneville Dam to above Lower Granite Dam is estimated between 65 to 96 percent, for an estimate of per project survival between 95 and 99 percent.

5.6.3 Key Factors Related to Hatcheries

Populations of the key species addressed in this recovery plan are impacted by releases of juvenile fish from hatcheries throughout the Snake River below Hells Canyon Dam. Approximately 33 hatcheries release over 29 million juvenile salmon and steelhead into the Snake River annually. Hatcheries can cause a number of potentially negative impacts to wild fish, most of which can be mitigated through proper fish husbandry practices. Potential negative impacts are:

- Competition for limited space and resources in streams and estuary
- Predation of wild fish by hatchery fish or an increase in predation as a result of predators being attracted to hatchery release points
- Disease transmission from hatchery fish to wild fish
- Ecological effects in streams as a result of segregation of hatchery populations from the stream including the loss of salmon carcasses containing marine-derived nutrients
- Genetic effects resulting from hybridization of domesticated hatchery fish and wild fish leading to the loss of local adaptations in wild populations or reduced productivity or reduced survival

5.6.4 Key Factors Related to Harvest

Impacts to the key species as a result of harvest occur mostly outside the recovery region. Factors affecting SEWMU populations include the following.

---

[12] Additional detailed information can be found in the Hydro Module.

[13] Additional releases from these dams of cool water during critical periods have increased the

- Salmon and steelhead are impacted by commercial, sport, and tribal ceremonial and subsistence fisheries in the Lower Columbia River. Spring Chinook salmon are linked to the lower Columbia for ESA impacts and terminal harvest opportunities.
- All fisheries are currently managed to reduce or minimize impacts to listed Upper Columbia or Snake River populations.
- Outside the SEWMU, fisheries impacting one or more of the populations addressed in this recovery plan occur in the ocean and in the Columbia River.
- Within the recovery region, fisheries appear to have minimal impacts on populations addressed by this recovery plan.
- There are no directed recreational fisheries on ESA listed fish within the SEWMU. Recreational fisheries target non-listed hatchery fish; others must be released.
- No fisheries for bull trout currently are authorized in the SEWMU.
- Columbia River harvest of Snake River steelhead has declined over the past several years.
- Columbia River spring/summer Chinook salmon harvests are minimal and vary with the projected run size.

5.7 CURRENT THREATS

The previous sections identified factors that led to the decline of SEWMU spring/summer Chinook salmon, steelhead, and bull trout. In this section the plan summarizes current threats to the continued existence of the three species. These threats are organized according to the five categories as set forth in Section 4(a)(1) of the ESA and all apply to this recovery plan:

1. The present or threatened destruction, modification, or curtailment of its habitat or range.
2. Overutilization for commercial, recreational, scientific, or educational purposes.
3. Disease or predation.
4. Inadequacy of existing regulatory mechanisms.
5. Other natural or human-made factors affecting its continued existence.

The information outlined in this section comes from the Federal Register Rules and Regulations, subbasin plans, and discussion through the SR RTT (Table 5-3).

Table 5-3. Summary of current threats by listing factor and category (from SR RTT).

Listing Factor	Status of Threats Associated with:	Threat	Comment
Present or threatened destruction, modification or curtailment of the species' habitat or range	Habitat	Prior allocation of ground and surface water	
		Catastrophic wildfire	
		Improperly designed, installed and maintained roads and road right-of-ways as it pertains to sediment	
		Impervious surface and storm water runoff	
		Invasive riparian weeds and competition	

Listing Factor	Status of Threats Associated with:	Threat	Comment
		Inadequate or future loss of refuge watersheds/sanctuaries	
		Current and future channel confinement	
	Hydropower	Loss of mainstem Snake River habitat and water quality including fall back impacts and passage survival	
Over-utilization for commercial, recreational, scientific or educational purposes	Harvest	Ocean and Lower Columbia River overharvest	
Disease or predation	Disease and Predation	Predation by avian species Predation from native and exotic fish species.	
Inadequacy of existing regulatory mechanisms	Regulatory mechanisms	Inadequate land use regulations and enforcement necessary to protect the floodplain and channel migration zone	
Other natural or manmade factors affecting its continued existence	Hatchery programs		
	Natural	Catastrophic wildfire	
	Manmade		

In addition to the threats listed above (Table 5-3), additional concerns are noted in Table 5-4 concerning various factors that could be affecting the viability of SEWMU populations.

Table 5-4. Additional concerns that could affect the viability of SEWMU populations.

<table>
<tr><th>Concerns</th><th>Comment</th></tr>
<tr><td>Balancing habitat needs with cooperative landowners and local governments.

Tilled field edges, lack of grass waterways/cut-slopes, public road right-of–way damage</td><td>There has been much progress with working with individual land owners, local governments and state governments in the SEWMU, but this will be a continuing challenge. Public road “shoulders” and right of ways are a significant contributor and/or routing network of fine sediment.</td></tr>
<tr><td>Out-of-region overharvest (elevated/over-estimated pre-season run forecasts result in “premature” harvest levels in lower Columbia and consumption of ESA impact rate followed by continued non-sport harvest upriver)</td><td>While harvest managers attempt to refine their forecasting methods, it is important that additional take is not allowed to occur of SEWMU populations in the areas open to harvest downstream of the SEWMU; the more terminal the harvest the more precise the management.</td></tr>
<tr><td>ecological impact of exotic mussels</td><td>Diligence to ensure that exotic mussels are not introduced into the Columbia basin is of prime importance.</td></tr>
<tr><td>Loss of federal farm conservation programs , primarily CREP and CRP</td><td rowspan="5">These five concerns are very important and whatever can be done to ensure that they are taken care of will be supported by the SRSRB and SR RTT.</td></tr>
<tr><td>Funding certainty, level and societal support</td></tr>
<tr><td>Public frustration with bureaucratic process /permitting and contradictory agency mission</td></tr>
<tr><td>Reduction in recreational sport fisheries may result in the loss of public and landowner support for salmon recovery</td></tr>
<tr><td>Monitoring – in the absence of monitoring we do not know pHOS in wilderness areas, for example; spatial structure and abundance in remote or unsampled tributaries, and productivity in these same tributaries is largely unknown. De-listing could be met but data is not available to reach that conclusion.</td></tr>
</table>

5.7.1 Spring Chinook Salmon

5.7.1.1 The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture (including livestock grazing), residential development, and historic forest management continue to threaten spring Chinook salmon and their habitat in some locations in the SEWMU.

- While most water diversions without proper passage routes have been fixed, they could disrupt migrations of adult spring/summer Chinook salmon.

- While most unscreened diversions have been fixed, they could trap or divert juvenile spring/summer Chinook salmon resulting in reduced survival.

- Hydroelectric passage mortality has been reduced substantially in the last 15 years; it still can reduce abundance of migrant spring/summer Chinook salmon.

- Sedimentation from land and water management activities is a cause of habitat degradation in some salmon streams.

- Confinement and loss of floodplain function has lead to loss of habitat complexity, off-channel habitat, and large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large woody debris threatens spring/summer Chinook salmon and their habitat in some locations in the SEWMU.

5.7.1.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- The effects of recreational fishing on naturally produced spring/summer Chinook salmon may be heightened during fisheries for hatchery produced Chinook salmon in the Lower Columbia River.

- Incidental harvest mortality in mixed-stock fisheries and commercial fisheries in the Lower Columbia River contributes to the loss of naturally produced spring/summer Chinook salmon.

- Illegal harvest (poaching) continues to threaten spring/summer Chinook salmon.

5.7.1.3 Disease or Predation

- The presence of non-native (exotic) species (e.g., walleye and smallmouth bass) has resulted in increased predator populations that prey on spring/summer Chinook salmon.

- Increased predation by northern pikeminnow affects the survival of downstream migrating spring/summer Chinook salmon.

- Avian predation is a threat to spring/summer Chinook salmon populations.

- Predation by pinnipeds is also a major concern in the Lower Columbia River.

- Disease transmission from hatchery fish to wild fish in unknown, but may be detrimental.

- Hatchery-reared smolts can prey directly on wild salmon.

- Releases of hatchery fish can help to support an increased predator population, thereby increasing predation rates on wild fish.

5.7.1.4 Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.

- Although the Washington State Growth Management Act (GMA) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.

- The “base” State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of spring/summer Chinook salmon.

- Implementation of the Federal Clean Water Act has not been completely successful in protecting spring/summer Chinook salmon, particularly with respect to non-point sources of pollution.

- Current Washington State fishing regulations are geared towards managing exotic walleye and smallmouth bass for trophy, or conservation purposes. More liberal management of these two species has the potential to reduce predation impacts on juvenile salmonids, primarily in the mainstem Snake and Columbia Rivers.

- Existing federal regulations are occasionally at odds (e.g. The USACE dike vegetation management policy vs ESA and Clean Water policies).

5.7.1.5 Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.)[14] can exacerbate the problems associated with degraded and altered riverine and estuarine habitats.

- Drought conditions reduce already limited spawning, rearing, and migration habitat.

- Poor ocean conditions (e.g., less upwelling, warm surface waters, etc.) negatively affect spring/summer Chinook salmon production.

- The collection of naturally produced spring/summer Chinook salmon for hatchery broodstock may harm small or dwindling natural populations if not done with best management practices (see HSRG 2004)[15].

- Competition, genetic introgression, and disease transmission resulting from hatchery introductions may reduce the productivity and survival of naturally produced spring/summer Chinook salmon[16].

- The use of non-localy derived broodstock for hatchery programs may negatively affect genetic integrity of natural stocks.

- Collection of naturaly produced spring Chinook salmon for hatchery broodstock may harm small or dwindling natural populations; conversely a safety net program may be required in some instances.

- Competition and genetic introgression resulting from hatchery introductions may reduce the productivity and survival of naturally produced salmon.

---

[14] Natural disturbance is not necessarily a bad thing. Indeed, species richness and diversity are higher in areas with some disturbance ("Intermediate Disturbance Hypothesis"; Connell 1978). However, when disturbances occur too often (resulting from the cumulative effects of both natural and un-natural disturbances), species richness and diversity decrease because some species go extinct.

[15] Using natural broodstock can also reserve genetic resources when population status is low.

[16] Competition, genetic introgression, and disease transmission are critical uncertainties and further information (research) is needed.

5.7.2 Steelhead

5.7.2.1 The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture, residential development, and historic forest management continue to threaten steelhead and their habitat in some locations in the SEWMU.
- While most water diversions without proper passage routes have been fixed, they could disrupt migrations of adult steelhead.
- While most unscreened diversions have been fixed, they could trap or divert juvenile steelhead resulting in reduced survival.
- Hydroelectric passage mortality has been reduced substantially in the last 15 years; it still can reduce abundance of migrant steelhead.
- Sedimentation from land and water management activities is a cause of habitat degradation in some steelhead streams.
- Confinement and loss of floodplain function has lead to loss of habitat complexity, off-channel habitat, and large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large woody debris threatens steelhead and their habitat in some locations in the SEWMU.

5.7.2.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- The effects of recreational fishing on naturally produced steelhead may be heightened during fisheries for hatchery produced steelhead in the Lower Columbia River.
- Incidental harvest mortality in mixed-stock fisheries and commercial fisheries in the Lower Columbia River contributes to the loss of naturally produced steelhead.
- Illegal harvest (poaching) continues to threaten steelhead.

5.7.2.3 Disease or Predation

- The presence of non-native species (e.g., walleye and smallmouth bass) has resulted in increased predator populations that prey on steelhead.
- Increased predation by northern pikeminnow affects the survival of downstream migrating steelhead.

- Avian predation is a threat to steelhead populations.

- Predation by pinnipeds is also a concern.

- Disease transmission from hatchery to wild fish is unknown, but may be detrimental.

- Hatchery released smolts can prey on wild juveniles.

- Releases of hatchery fish can help to support an increased predator population, thereby increasing predation rates on wild fish.

5.7.2.4 Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.

- Although the Washington State Growth Management Act (GMS) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.

- The “base” State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of steelhead.

- Implementation of the Federal Clean Water Act has not been completely successful in protecting steelhead, particularly with respect to non-point sources of pollution.

- Current Washington State fishing regulations are geared towards managing exotic walleye and smallmouth bass for trophy, or conservation purposes. More liberal management of these two species has the potential to reduce predation impacts on juvenile salmonids, primarily in the mainstem Snake and Columbia Rivers.

- Existing federal regulations are occasionally at odds (e.g. USACOE dike vegetation management policy vs. ESA and Clean Water policies).

5.7.2.5 Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.) can exacerbate the problems associated with degraded and altered riverine and estuarine habitats.

- Drought conditions reduce already limited spawning, rearing, and migration habitat.

- Poor ocean conditions (e.g., less upwelling, warm surface waters, etc.) negatively affect steelhead production.

- The use of non-locally derived broodstock for hatchery programs may negatively affect genetic integrity.

- The collection of naturally produced steelhead for hatchery broodstock may harm small or dwindling natural populations if not done with best management practices (see HSRG 2004).

- Competition, genetic introgression, and disease transmission resulting from hatchery introductions may reduce the productivity and survival of naturally produced steelhead.

- The use of non-localy derived broodstock for hatchery programs may negatively affect genetic integrity of natural stocks.

- Collection of naturaly produced steelhead for hatchery broodstock may harm small or dwindling natural populations; conversely a safety net program may be required in some instances.

- Competition and genetic introgression resulting from hatchery introductions may reduce the productivity and survival of naturally produced salmon.

5.7.3 Bull Trout

5.7.3.1 The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture, residential development, and historic forest management continue to threaten bull trout and their habitat in some locations in the SEWMU.

- While most water diversions without proper passage routes have been fixed, they could disrupt migrations of adult bull trout.

- While most unscreened diversions have been fixed, they could trap or divert juvenile bull trout resulting in reduced survival.

- Passage through hydroelectric projects may reduce abundance of migrant bull trout.

- Sedimentation from land and water management activities is a cause of habitat degradation in some bull trout streams.

- Loss of habitat complexity, connectivity, channel stability, decreased in-stream flow, and increased water temperatures due to land and water management activities threatens bull trout in some locations in the SEWMU.

5.7.3.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- Illegal and incidental harvest may reduce the abundance of bull trout in the SEWMU.

- Harvest as a result of misidentification continues under existing fishing regulations.

- Poaching can be especially detrimental to small, isolated, local populations of migratory bull trout.

5.7.3.3 Disease or Predation

- The presence of non-native species (e.g., bass, walleye, etc.) has resulted in increased predator populations that prey on juvenile bull trout.

5.7.3.4 Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.

- Although the Washington State Growth Management Act (GMS) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.

- The "base" State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of bull trout.

- Implementation of the Federal Clean Water Act has not been completely successful in protecting bull trout, particularly with respect to non-point sources of pollution and water temperature.

- Current Washington State fishing regulations are geared towards managing exotic walleye and smallmouth bass for trophy, or conservation purposes. More liberal management of these two species has the potential to reduce predation impacts on juvenile salmonids, primarily in the mainstem Snake and Columbia Rivers.

5.7.3.5 Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.) can exacerbate the problems associated with degraded and altered riverine habitat.

- Drought conditions can reduce already limited spawning, rearing, and migration habitat.

- Introduction of non-native species for recreational fisheries may increase incidental catch and illegal harvest of bull trout.

Recent activities to address threats and reverse the long-term decline of spring/summer Chinook salmon, steelhead, and bull trout in the SEWMU are being initiated at Federal, State, and local levels (e.g., restrictive harvest regulations, adoption of various land management rules, and development of conservation strategies and plans). While these efforts are important to the conservation and recovery of ESA-listed species, additional work is needed to minimize threats to recovery.

5.8 UNCERTAINTIES

The preceding sections described many of the important factors that have, and continue to, reduce the abundance, productivity, spatial structure, and diversity of spring/summer Chinook salmon, steelhead, and bull trout in the SEWMU. It is clear that actions must be taken in all Hs (not just habitat) in order to recover listed populations. However, there are "key" areas of uncertainty[17] identified in FCRPS BiOp, USFWS Bull Trout Draft Recovery Plan, and Northwest Power and Conservation Council documents that can affect the success of actions implemented within each of the Hs. Resolution of uncertainties will greatly improve chances of attaining recovery goals outlined in this plan. These "key" uncertainties are highlighted below.

5.8.1 Ocean Productivity and Natural Variation

Global-scale processes in the ocean and atmosphere can regulate the productivity of marine, estuarine, and freshwater habitats of Chinook salmon and steelhead. Although managers cannot control these processes, natural variability must be understood to correctly interpret the response of salmon to management actions. For example, assessing needed survival improvements based on spawner returns from 1980-1999, during periods of below average climatic and other background conditions (Coronado and Hilborn 1998), has the effect of projecting these generally poor ocean conditions into the future. Additional research is needed to help understand the mechanisms of ocean and climatic survival conditions, and to help improve forecasting and relating fisheries management capabilities and ensure that SEWMU populations persist over the full range of environmental conditions they are likely to encounter.

[17] Key uncertainties identify important gaps in our knowledge about the resources and functional relationships that determine fish viability.

5.8.2 Global Climate Change

The potential impacts of global climate change are recognized at national and international levels (Beamish 1995). Many climate models project changes in regional snowpack and stream flows with global climate change. The effects of these changes could have significant effects on the success of recovery actions and the status of listed fish populations in the SEWMU. The risks of global climate change are potentially great for SEWMU stocks because of the sensitivity of salmon stocks to climate-related shifts in the position of the sub-arctic boundary, the strength of the California Current, the intensity of coastal upwelling, and the frequency and intensity of El Nino events (NPCC 2004). Bull trout are particularly sensitive to water temperatures and it is uncertain how global climate change will affect their habitat. More research is needed to address the effects of climate change on ocean circulation patterns, freshwater habitat, and salmon and trout productivity.

5.8.3 Hatchery Effectiveness

Uncertainties exist regarding the potential for both benefits and harm of hatchery-produced fish on naturally spawning populations. A major uncertainty is whether it is possible to integrate natural and artificial production systems in the same subbasin to achieve sustainable long-term productivity. There is also uncertainty about the reproductive success of hatchery fish spawning in the wild. NOAA Fisheries evaluated survival requirements using a broad range of 20 to 80% historical effectiveness of hatchery-origin spawners to cover this uncertainty. It is difficult to address the uncertainties and potential risks associated with hatcheries, because experimental methods for obtaining this information will take several years to get initial results and much longer before conclusions can be inferred from the empirical information. Although supplementation is considered a potential benefit to recovery, it carries risks as noted here.

5.8.4 Invasive Species

Another critical uncertainty is the effect of invasive species on the viability of listed populations in the SEWMU. One such species, American shad, may affect the abundance and survival of spring Chinook and steelhead in the lower Columbia River. It is possible that the growing population of shad is competing directly with juvenile Chinook and steelhead by cropping food sources important to salmonids in the lower Columbia River. It is also possible that the large numbers of shad in the lower river contribute to the growth of northern pikeminnow, smallmouth bass, and walleye, which are important predators of salmon and steelhead. Shad may be sustaining large populations of predators during periods when salmon and steelhead are not available to the predators, and, as a result, more and larger predators are present during periods when salmon and steelhead are moving through the lower Columbia River.

Research is needed to assess the direct and indirect effects of invasive species (including invasive plants) on the abundance and survival of spring/summer Chinook salmon, steelhead, and bull trout in the SEWMU.

5.8.5 Effects of Dams on Bull Trout

The Bull Trout Draft Recovery Plan (USFWS 2002a) has identified dams as an important factor for the decline of bull trout in the SEWMU. Although it is true that dams can affect salmonids by delaying or impeding migration of adults and by injuring or killing juveniles that pass downstream, there is currently little information on the effects of dams on bull trout in the SEWMU.

5.8.6 Interaction between Resident and Migrant Bull Trout Life-History Types

The Bull Trout Draft Recovery Plan (USFWS 2002a) proposes recovery criteria for bull trout based on connectivity, abundance, productivity, and spatial structure of migrant (fluvial and adfluvial) life-history types. A critical uncertainty is the role of resident life-history types in maintaining viable populations of bull trout. Little is known about the abundance and spatial structure of resident forms in the SEWMU, and even less is known about their contribution to migrant life-history types. Research is needed to assess the spatial structure and importance of resident types in maintaining viable populations of bull trout in the SEWMU.

5.8.7 Interaction between Resident and Anadromous Rainbow (steelhead) Trout Life-History Types

Understanding how resident rainbow trout contribute to anadromous steelhead populations is a key uncertainty throughout their range. Recent work in the Hood River, OR (Christie et al. 2011) suggests that approximately 20% of the anadromous genes' come from resident fish each generation. Obtaining information in other areas will assist managers with understanding the population dynamics and potential contribution of resident fish to anadromous fish viability.

5.8.8 Effects of Harvest, Hatchery, Hydropower, and Habitat Actions

A critical uncertainty associated with the implementation of this recovery plan will be the effect of management actions or strategies on the environment and on life-stage specific survival rate and population level responses. It is unclear how strategies implemented within each of the Hs (Harvest, Hatcheries, Hydropower, and Habitat) will interact and contribute to recovery. In particular, a high level of uncertainty exists for the magnitude and response time of habitat actions. Even if all habitat actions could be implemented immediately (which they cannot), there will be delays in the response to actions. Populations will likely respond more quickly to some actions (e.g., diversion screens and barrier removals) than they will to others (e.g., riparian plantings). Although the effects of interacting strategies on population VSP parameters remain unknown, monitoring will contribute substantially to resolving this uncertainty.

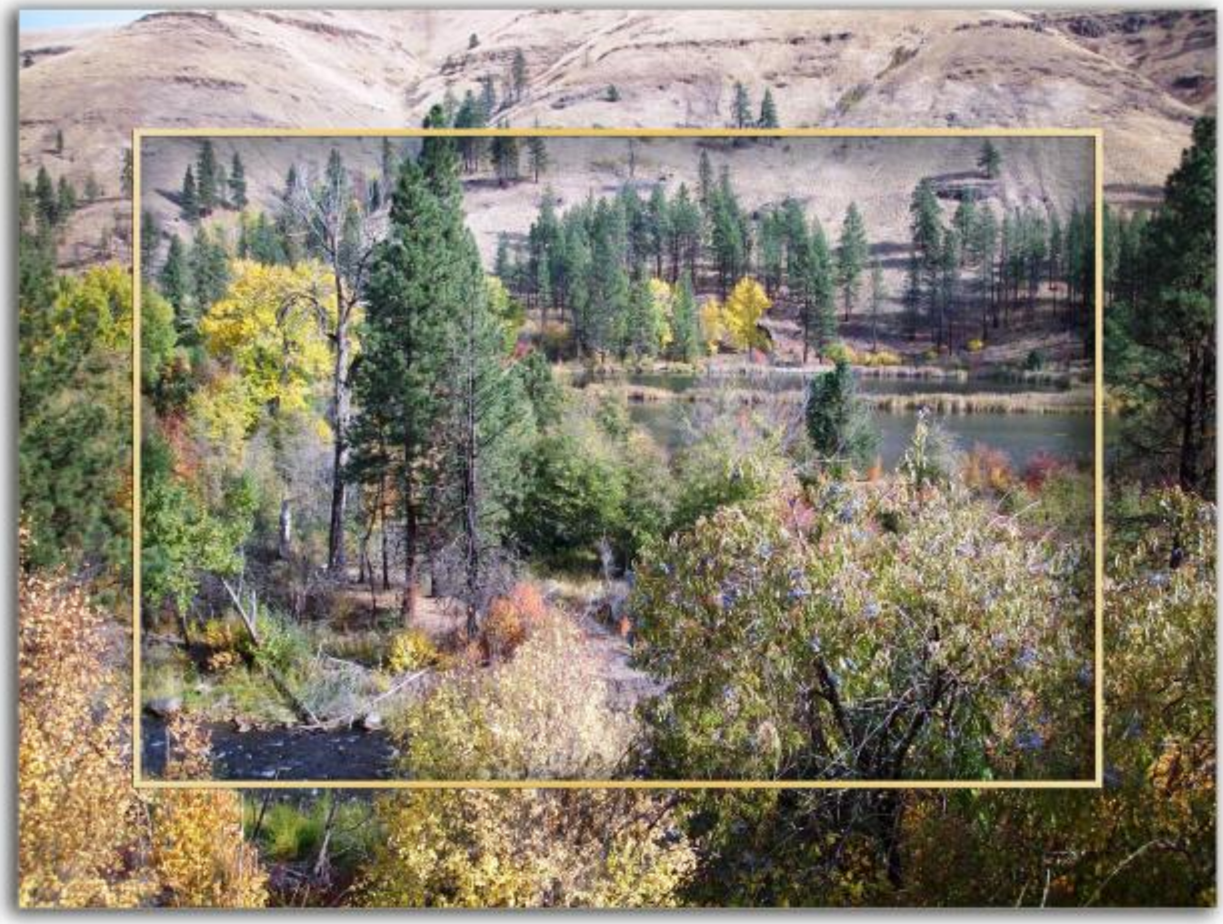
5.8.9 Effects of Human Population Growth

Human population growth in the SEWMU and its effects on recovery of listed species is a critical uncertainty. The size of the human population within the SEWMU region is expected to increase in the next two decades, with more most likely occurring in incorporated areas. [18] It is important to note that additional development along stream reaches has more direct potential to affect SEWMU salmonid populations. A high degree of coordination among agencies, tribes, and counties will be needed to maximize recovery efforts.

---

[18] See http://www.ofm.wa.gov/pop/gma/

6 RECOVERY STRATEGIES AND GENERAL ACTIONS



6.1 RECOVERY STRATEGY

The preceding chapters summarize recovery goals, biological criteria and threats criteria, current status assessment, the gap between current status and desired viability, and the major limiting factors and threats identified for the SEWMU steelhead and Chinook salmon populations. This information helps inform us how to formulate strategies to get to recovery and restoration.

The overall goal for recovery and restoration, as described in Chapter 4 of this plan, is to have all extant populations at either viable (low risk) or highly viable status, with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure and diversity attributes required for long-term persistence.

The ICTRT's current status assessment for most SEWMU populations is considered at high risk of extinction (Ford et al. 2010). One population, Joseph Creek steelhead, is currently at very low risk or "highly viable," and the Walla Walla steelhead population and possibly the Lower Grande Ronde steelhead populations are considered "maintained." As mentioned in Appendix B, long term data sets do not exist for most of the steelhead populations. For Asotin Creek steelhead population, which is managed natural production only, recent information suggests that abundance may be close to, or exceeding viability criteria, but additional years of monitoring are needed.

If, as discussed in Chapter 5, the decline of the SEWMU spring/summer Chinook salmon and summer steelhead populations is due to widespread habitat degradation, impaired mainstem passage, hatchery effects, mainstem fisheries, and predation/ competition/ disease, then actions taken to improve, change, mitigate, and reduce those factors will result in reduced risks and increased survival. Because of the species' complex life cycle, and the many changes that have taken place in their environment, the factors limiting their survival must be addressed in concert, and in an integrated way. The work needs to occur at a regional level, in terms of commitment to actions and funding, and at the local level, population by population. Each population and MPG contributes greatly to the wellbeing of the species. The intent for this plan is to build upon, help to coordinate, and add to the ongoing efforts.

NMFS' 2005 and 2006 listing decisions called upon Federal, state, and tribal entities to do their best to manage land, hydropower, hatchery, and harvest activities in a manner that would support salmonid recovery. This plan reaffirms those recommendations and adds to them the contributions of updated science, basinwide programs, and consensus building among stakeholders. While Federal, state, and tribal entities can make major contributions to the recovery of SEWMU populations, the actions of individuals on their land, as well as city and county codes and ordinances promoting conservation, are also essential.

The recovery strategies for SEWMU spring/summer Chinook salmon and summer steelhead populations addresses both the basin-wide issues that affect all populations, such as conditions in the migratory corridor, and the subbasin and site-specific issues that are addressed within this plan.. This SEWMU Plan describes the overall strategy, summarizes the MPG- and population level strategies, and refers to Appendix A for more site-specific, population level actions.

Achievement of the recovery and restoration goals will ultimately lead to the desired future condition as defined by the SRSRB's vision statement. The goals will be achieved through actions or sets of actions; the actions are selected by and consistent with the approach, or strategy, chosen by the local stakeholders. Strategies are rules and guidelines that are used to guide accomplishment of the "mission."

The strategic guidelines adopted by the SRSRB are as follows:

1. Emphasis will be placed on projects with long persistence time ("life span") and benefits distributed over the widest possible range of environmental attributes.
2. Recovery/restoration actions must include immediate measures in addition to long-term actions. Many actions that address the root causes of habitat degradation require a long time to achieve their goals. An example would be planting trees in riparian zones to a) reduce instream temperatures, b) add large woody debris, and c) increase habitat complexity. Immediate actions which can "jump start" recovery can include such things as manual addition of large woody debris to stream channels, and creation of meanders in channelized streams.
3. The management strategy will involve "adaptive management"; that is, it will be a feedback system where changes in information or data detected through monitoring and evaluation will be used to adjust and modify plans and actions.
4. Identification of important areas and proposed actions is based substantially on information contained in the applicable subbasin plans.

5. Actions necessary to accomplish the recovery goals will be considered within the context of the four "Hs" (habitat, harvest, hatcheries, and hydroelectric).
6. Actions implemented within the region will be focused primarily on restoration and protection of habitat; actions pertinent to the other "Hs" will be addressed primarily through other planning processes but the SRSRB may provide recommendations to these processes.
7. The EDT analysis tool, in combination with other analyses, empirical data, and professional opinion will be used to identify and prioritize habitat actions.
8. The final set of proposed actions will be subject to economic, social, and cultural constraints identified by the recovery region.
9. Priority actions are those that the SRSRB hopes to accomplish over the 10-year planning period of this plan.

6.2 ESU/DPS LEVEL RECOVERY STRATEGY

The recovery strategy for the SEWMU spring/summer Chinook salmon and summer steelhead populations is made up of the following elements:

- Affirm and address the 2005 and 2006 listing decisions recommendations regarding the limiting factors for the ESU/DPS and populations.
- Protect and restore tributary habitat and Columbia River mainstem habitat, through strategies and actions at both the Basin/programmatic level and at the local level as detailed in this plan.
- Address impaired fish passage through strategies and actions in the mainstem Columbia River, as detailed in the 2008 FCRPS Biological Opinion (as summarized in the Hydro Module) and in the tributaries as detailed in this plan.
- Implement hatchery reforms at the population and site-specific level through Hatchery and Genetic Management Plans (HGMPs) as required by the 2008 FCRPS Biological Opinion and as described in Appendix C of the Supplemental Comprehensive Analysis (NMFS 2008c).
- Address ecosystem imbalances in predation, competition, and disease through the strategies and actions in this plan, estuary module and FCRPS Biop.
- Maintain current low harvest levels, through fishery management planning for mainstem fisheries through the *U.S. v. Oregon* 10-year agreement, updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans for tributary fisheries, and Pacific Salmon Treaty and Pacific Fishery Management Council processes.
- Protect and restore the estuary and Columbia River plume as detailed in the Columbia River Estuary module.
- Respond to climate change threats with a strategy based on the principle of preserving biodiversity.
- Implement the Plan through effective coordination and governance.
- Research critical uncertainties, monitor and evaluate implementation and effectiveness and adjust course as appropriate through adaptive management.

The SRSRB believes that if this strategy is implemented and the biological response is as expected, the SEWMU spring/summer Chinook salmon and summer steelhead populations are likely to achieve viable status within 25 to 50 years.

The following sections describe the recovery strategy elements in more detail. The chapter concludes with summaries of the MPG-level strategies.

6.3 HABITAT

Actions to protect and improve habitat in the tributaries and the Snake and Columbia mainstems are essential to achieving recovery objectives for the SEWMU populations. Spring/summer Chinook and steelhead are "stream-type" salmonids; so they use mainstem tributary, upper tributary, and side channel habitats for spawning, juvenile rearing, and overwintering. Bull trout populations are particularly susceptible to the effects of degraded freshwater habitat because, like most steelhead, spend one or more years in their natal streams before migrating. While improving survival in the mainstem Snake and Columbia Rivers and estuary is also an important part of ESU/DPS-wide strategy, and will benefit all salmonid populations, protecting existing high quality or good quality tributary habitat and restoring degraded habitat will specifically benefit SEWMU populations in the spawning and rearing life stages. Improved spawning and rearing means that more fish will reproduce, more juveniles will survive to migrate, and consequently more adults will return, even if the other (outside of SEWMU) factors remain as they are today.

6.3.1 Columbia/Snake River

Relatively little information is available concerning SEWMU populations' use of mainstem Snake and Columbia River habitat upstream of Bonneville Dam, aside from passage through the dams. NMFS believes it is important to assess nearshore habitat and cold water refugia in the mainstem and to explore opportunities for, and potential benefits from, restoration and protection of these areas.

6.3.2 Tributary

The tributary habitat strategy proposed by the SRSRB is aimed at addressing habitat actions at the MaSA level, and are grouped under "Approach Categories." These categories define the approach to be taken to implementing overarching strategies (restoration or protection) discussed in Section 6.1 in order to achieve the desired future condition and recovery goals (Chapter 4). These approaches are designed to improve upland habitat, riparian conditions, floodplain functions, instream habitat, water quantity, and water quality. The selected approaches were prioritized using the following criteria:

- **Effectiveness**: What is the probability that implementing this strategy will achieve the objective?
- **Technical Feasibility**: How feasible is the strategy from a technical perspective?
- **Cost/benefit**: Are the benefits to fish habitat large relative to the cost of the strategy?

The approach categories were given priority values on a scale of 1 (lowest) to 5 (highest). Habitat factors (attribute) are correlated with sets of approaches, each of which is prioritized. On Table 6-1, it can be seen that the approach to improving embeddedness will rely on actions involving improvement of riparian areas (highest priority) to improving water quantity (lowest priority). Actions to achieve these improvements will be defined for each MaSA and each habitat factor in Appendix A.

Table 6-1. Prioritization of Approaches to Habitat Restoration.

Habitat Factor	Approach Categories				
	Improve riparian areas	Improve uplands	Improve channel and floodplain function	Improve instream habitat	Improve water quantity
Substrate Embeddedness	5	4	3	2	1
Large Woody Debris	4	0	5	3	0
Pools	4	0	5	3	2
Riparian Function	5	0	4	0	3
Confinement	4	0	5	0	0
Maximum Temperature	5	0	3	2	4
Bedscour	4	2	5	3	0
Summer Flow	3	4	2	0	5
TOTAL	34	10	32	13	15

The habitat factors were then arranged in order, from the most important to least important for each MaSA (Table 6-2). In most cases, attributes were combined to obtain a single value for a habitat factor. For example, the value for the habitat factor "embeddedness" is the total of the related attributes turbidity, percent fines, and embeddedness. Table 6-2 also contains restoration and protection objectives for habitat factors. For example, the restoration objective for temperature is to achieve a stream condition where the water temperature does not rise above 72ºF for more than four days per month. Protection objectives for each habitat factor are maintenance of existing conditions.

The actions proposed to improve stream conditions in each MaSA and MiSA are presented in Appendix A. The table includes information on action type, the number of units (acres, miles of stream etc.) affected by the action, annual costs, and the expected costs over the 10-year planning period. The tables in Appendix A detail the habitat factors and proposed actions for each population and MaSA. Table A-1 contains the habitat factors and general proposed actions for each population. Table A-2 contains the habitat factors and detailed action strategy for each MaSA.

Table 6-2. Summary of habitat factors, and associated objectives for each SEWMU MaSA.

MaSA	Priority	Habitat Factor and Objective
	I.	Increase Stream Flow
Mainstem Walla Walla River	II.	Temperature: not more than 4 days above 72ºF
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Embeddedness: less than 10% embeddedness
	V.	Riparian Function: 40 to 90% of maximum
	VI.	Channel Confinement: reduce to 40% to 60% of stream length
Mill Creek	I.	Embeddedness: < 10%
	II.	Temperature < 4 day > 72ºF
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Riparian: 40 to 90% of maximum
Middle Touchet River (mainstem from Coppei Creek to Patit Creek)	I.	Embeddedness: Less than 10%
	II.	Temperature: < 4 days > 72ºF
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Confinement: <15 to 40% of stream bank length
Upper Touchet River (Patit Creek Upstream to Touchet Headwaters)	I.	Temperature: < 4 days > 72ºF
	II.	Riparian: >62 to 82% of maximum
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Confinement: < 10 to 40% of streambank length
Upper Tucannon River (from Pataha Creek Upstream to Tucannon Headwaters)	I.	Riparian: > 40 to 75% of maximum
	II.	Large Woody Debris: > 1 piece per channel width
	III.	Confinement: < 25 to 50% of streambank length
	IV.	Temperature: < 4 days > 72ºF
Lower Tucannon River MiSA (from Pataha Creek downstream to Tucannon mouth)	I.	Temperature: < 4 days > 72ºF
	II.	Embeddedness: < 20%
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Riparian: >40 to 75% of maximum
	V.	Confinement: < 25 to 50% of stream bank length
Alpowa Creek	I.	Riparian: > 80% of maximum
	II.	Embeddedness: < 10%
	III.	Temperature: : < 4 day > 72ºF

MaSA	Priority	Habitat Factor and Objective
	IV.	Large Woody Debris: > 1 piece per channel width
Joseph Creek		Joseph Creek lies primarily in Oregon. Therefore, priority actions for the portion of Joseph Creek within Washington are to address imminent threats.
Lower Grande Ronde	Taken from draft NE OR recovery plan	Restore degraded habitat in the lower reaches of the system, primarily in the lower Grande Ronde River, to address water quantity and quality issues, as well as habitat structure and complexity factors affecting the Wenaha population during its migration to and from the ocean.
Wenaha River	Taken from draft NE OR recovery plan	The vast majority of the Wenaha River lies entirely within a wilderness area administered by the USFS. The proposed action for this river is to continue protective status.
Asotin Creek MSA (mouth to headwaters including all tributaries except George Creek)	I.	Large Woody Debris: >1 piece per channel width
	II.	Embeddedness: < 20%
	III.	Bed Scour: Reduce to < 10 cm
	IV.	Riparian: >75% to 90% of maximum
George Creek (tributary of Asotin Creek)	I.	Embeddedness: < 10%
	II.	Large Woody Debris: > 1 piece per channel width
	III.	Riparian: >75% of maximum
	IV.	Temperature: No more than 4 days above 72ºC
Pataha Creek MaSA (tributary of Tucannon River)	I.	Embeddedness: Protect existing condition
	II.	Temperature: Protect existing condition
	III.	Riparian: Protect existing condition
	IV.	Large Woody Debris: Protect existing condition
	V.	Confinement: Protect existing condition

6.4 IMPAIRED FISH PASSAGE

Problems in migratory corridors for juvenile and adult steelhead in the mainstem Snake and Columbia Rivers and tributaries are being addressed through the FCRPS (see below) to improve survival.

6.4.1 Impaired Fish Passage in Mainstem Columbia River

Although the Federal Columbia River Power System (FCRPS) is a major limiting factor for steelhead and salmon in the mainstem Columbia River, changing it is a complex process. Three U.S. government agencies – the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (COE) and the Bureau of Reclamation (Reclamation), also called, collectively, the “action agencies” – collaborate to run the FCRPS, under various congressional authorities, as a coordinated system for power production and flood control. The 31 federally owned multipurpose dams on the Columbia River and its tributaries that make up the FCRPS provide about 60 percent of the Northwest’s hydroelectric generating capacity. The dams supply irrigation water to more than a million acres of land in Washington, Oregon, Idaho and Montana. The river is used for barge navigation from the Pacific Ocean to Lewiston, Idaho, 465 miles inland.

NMFS has statutory responsibility under the ESA to consult with the FCRPS agencies and determine whether FCRPS effects on listed species are likely to jeopardize the continued existence of the species or cause adverse modification of critical habitat. NMFS summarizes its findings in a Biological Opinion, or BiOp. On May 26, 2005, the Federal District Court, in *National Wildlife Federation, et al., vs. National Marine Fisheries Service, et al.,* issued an opinion finding fault with the NMFS 2004 FCRPS BiOp (NMFS 2004). On October 7, 2005, the court ordered a “remand” of the BiOp, requiring NMFS and the action agencies to engage in a collaborative process, which included input from affected States and Tribes, to develop proposed operational measures for analysis in a new biological opinion. The court’s order, among other things, directed the action agencies to demonstrate how their proposed actions would contribute to recovery. A revised Biological Opinion was issued on May 5, 2008 (NMFS 2008c) and is available at http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm.

Current Snake/Columbia River hydropower programs and operations are the result of this and other completed or ongoing ESA section 7 consultation processes; habitat conservation plans (HCPs) pursuant to ESA section 10; FERC relicensing proceedings and other regulatory processes. In most cases, hydropower programs and operations are intended both to avoid jeopardy to listed species and to contribute to recovery.

The plan for current mainstem hydro operations, as summarized in the Hydro Module (NMFS 2008d), and any further improvements for fish survival that may result from the ongoing FCRPS collaborative process, represent the hydropower recovery strategy for all listed salmonids that migrate through the mainstem Snake and Columbia Rivers, including the SEWMU salmonid populations.

The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydro, habitat, hatchery, harvest and predation measures to address the biological needs of salmon and steelhead in every life stage. The RPA is the product of the collaboration between NMFS and the action agencies ordered by the court. It is based on a comprehensive analysis of the salmon life cycle conducted down to the level of the populations that make up the listed species. Section 8.8 and the “Reasonable and Prudent Alternative Table” in the 2008 FCRPS Biological Opinion describe actions that should positively affect SEWMU salmonid populations.

The current plan for operation of the FCRPS through 2018 (NMFS 2008c) contains the following actions intended to address the needs for survival and recovery of ESA-listed salmon and steelhead:

- Continue adult fish passage operations that have resulted in improved survival.
- Improve juvenile fish passage: install removable spillway weirs or similar surface bypass devices at John Day and McNary dams, an extended tailrace spill wall at The Dalles Dam, and various modifications at Bonneville Dam. Passage for steelhead smolts at each of the four Lower Columbia River mainstem projects must reach 96 percent survival.
- Continue and enhance spill for juvenile fish passage.
- Continue reservoir operations and river flows to benefit spring migrating juveniles.
- Develop dry water year operations to better protect migrating juveniles.
- Develop and implement a kelt management plan.

6.4.2 Impaired Fish Passage in Tributaries

The basic strategies to improve fish passage in tributaries and the prioritized areas can be found in Section 6.3 above.

6.5 HATCHERIES

The hatchery strategy proposed by the SRSRB is intended to be reflective of current plans and legally binding processes, and are ensured to assist in meeting overarching recovery objectives. The SRSRB hatchery strategy recognizes that, not only can hatcheries play an important role in recovering fish populations, but they can contribute to providing fish needed to meet tribal, commercial, and sport harvest, as well as recovery and restoration goals. The strategy attempts to balance risks to recovery of listed fish populations with the achievement of harvest objectives.

Two strategies for hatchery production are proposed: integrated hatcheries and segregated programs. Integrated programs, which use native broodstock to reduce genetic risk to a specific population, are proposed for most subbasins and populations. The exception is the Walla Walla subbasin summer steelhead program, which is proposed to be managed as both integrated and segregated (to provide harvest opportunities while maintaining genetic integrity). The Wenaha River and Joseph Creek, in the Grande Ronde River subbasin, as well as Asotin Creek are reserved for natural production only.

Hatchery Genetic Management Plans (HGMP's) will be developed for each hatchery program, and will define to a greater degree the detailed components, facilities, and other important information concerning these hatchery programs. HGMP's are coordinated by NOAA and developed by the operating entities to describe the hatchery impacts on listed species. NOAA uses the HGMP's as a basis for providing ESA coverage of hatchery operations through Section 7 consultations and Section 10 permits.

6.5.1 Adult management of hatchery-origin fish

It is important to understand that management of adult returning hatchery-origin fish is complicated and co-managers are not necessarily in agreement on all hatchery management actions listed within this Plan. Some studies have shown that excess hatchery-origin adults spawning in the wild may reduce natural population productivity (e.g., Araki et al. 2008). However, this issue is still considered a critical uncertainty, and as such, proper management actions are still in development until additional information is obtained.

Current management for the SEWMU will be to control the number of hatchery fish allowed to spawn in the wild to the extent possible in certain streams. For example, all hatchery-origin fish that are collected in trapping facilities at the Touchet, Tucannon and Asotin adult traps are removed from the spawning population, while adults from the endemic program are currently released to spawn naturally or collected as brood stock. The overall adult management strategy is designed to reduce potential negative effects of non-native hatchery fish on naturally produced fish populations. However, it is important to note that the percentage of hatchery-origin fish on the spawning grounds is not directly related to viability criteria. It is possible to have greater than, for example, 30% naturally spawning hatchery-origin fish (of endemic origin) on the spawning grounds and still meet viability criteria, ***IF*** it can be demonstrated that the population would meet viability criteria if the hatchery fish were removed.

To categorize population biological significance, the HSRG (2009) adopted the classification system developed by the Lower Columbia Fish Recovery Board (LCFRB), where salmonid populations were classified as either *Primary*, which are targeted for restoration to high productivity and abundance; *Contributing*, where small to medium improvements are needed; or *Stabilizing*, populations that may be maintained at current levels (Table 6-3). These criteria are broader and different than those used by the ICTRT. However, some linkages are inferred (Figure 6-1).

Table 6-3. HSRG recommendations for population categories of Primary, Contributing, and Stabilizing (HSRG 2009)[19].

Category	Hatchery Program Type	PNI	pHOS
Primary	Segregated	NA	≥ 0.05
	Integrated	≥ 0.67	< 0.30
Contributing	Segregated	NA	< 0.10
	Integrated	≥ 0.50	< 0.30
Stabilizing	Segregated	NA	Existing
	Integrated	Existing	Existing

[19] It is important to note that the criteria from this table are not agreed upon by the co-managers in the SEWMU. This table is shown for illustrative purposes only.

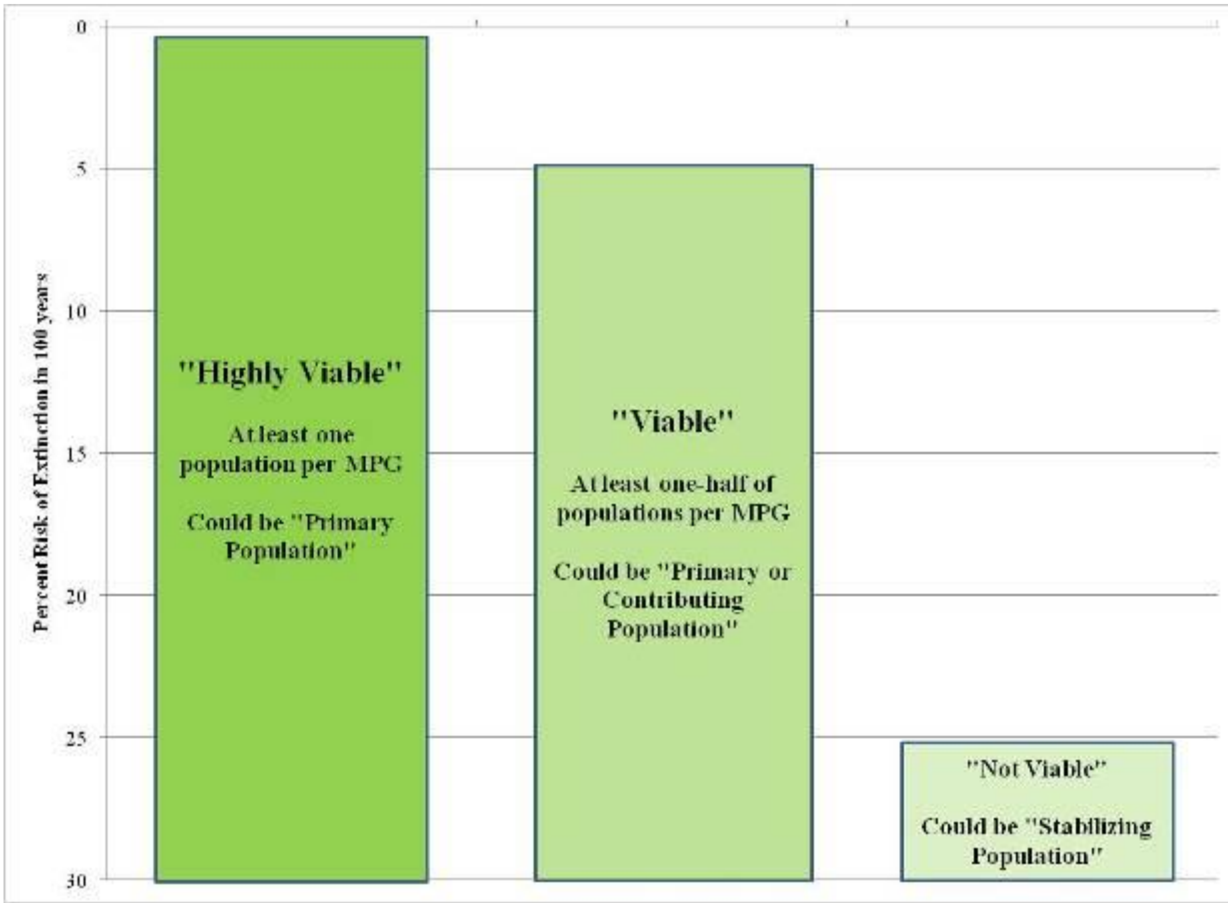


Figure 6-1. Comparison of the risk of extinction in 100 years, major population group viability criteria (ICTRT 2007a) and potential designation of populations as primary, contributing, and stabilizing (per HSRG 2009).

It is important to note that the population designations used by the HSRG are not as stringent as the ICTRT criteria, but designating populations as *Primary*, *Contributing*, or *Stabilizing* could be used to assist managers and policy makers in management of the populations.

It is important to note that one of the biggest uncertainties concerning hatchery fish is their affect on natural productivity when they spawn naturally in the wild, or interbreed with natural-origin fish on the spawning grounds. While most programs in the SEWMU use natural-origin broodstock to varying degrees (and are thus integrated with the natural population, as suggested by HSRG and HRT), uncertainty remains concerning their affect on natural populations. How the hatchery programs are implemented affects harvest strategies within the SEWMU and the SRSRB suggests that as further information is collected and analyzed concerning the affects of hatchery-origin natural spawners, that harvest is adaptively managed.

Specific short- and long-term hatchery strategies and actions for anadromous SEWMU fish species is presented in Appendix D. The proposed hatchery programs for each subbasin are based partly on the

HGMPs being developed by the resource agencies and NMFS. It should be noted that hatchery programs are not proposed for bull trout in the recovery area. In addition, strategies for Snake River fall Chinook salmon will not be captured in this section of the plan. Those strategies will be coordinated through the larger comprehensive roll up of the Snake River Basin Recovery Plan.

As previously stated, the proposed strategy attempts to balance risks to recovery of listed fish populations with the achievement of harvest objectives and mitigation goals. Because of these harvest objectives and mitigation goals it is unlikely that hatchery programs will be withdrawn even if populations in the recovery area increase to the point of recovery.

Noteworthy is that three of the populations in the SEWMU are currently managed as wild fish sanctuaries that have no direct supplementation with smolts or adults. The Joseph Creek and Asotin Creek steelhead populations and the Wenaha spring Chinook salmon populations will continue to be managed as wild fish sanctuaries. This management strategy, which was implemented by local co-managers in areas that don't negatively impact harvest and local economies, embraces the ICTRT recommendation to minimize or terminate hatchery production to assist meeting recovery goals.

6.6 PREDATION, COMPETITION AND DISEASE

Predation, competition and disease are grouped together as a category of concern because ultimately these factors relate to balance and imbalance in the ecosystem. Improving habitat for salmonids throughout the life cycle is the best strategy for addressing these potential limiting factors (ISAB 2007). Specific measures can also be taken; the following is a summary of ongoing efforts and research.

6.6.1 Predation

Extensive research on predation and efforts at predator control, including piscivorous fish, avian predators, and marine mammals have been undertaken in the Columbia Basin for decades, and will continue. The FCRPS BiOp and the Estuary Module (73 FR 161, January 2, 2008), both of which are part of this recovery plan, provide extensive evaluations of these issues as threats and limiting factors as well as specific strategies and actions for both monitoring and addressing them.

Piscivorous Fish

- Northern Pikeminnow Management Program - A multi-year, ongoing effort funded by BPA to reduce piscivorous predation on juvenile salmon through incentives to sports fishermen to remove predator-sized northern pikeminnow. From 1991 to 1996, three fisheries (sport-reward, dam angling, and gill net) harvested approximately 1.1 million northern pikeminnows greater than or equal to 250 mm fork length. Total exploitation averaged 12 percent (range, 8.1 to 15.5 percent) for 1991 to 1996 (Section 6.2.7.1 in NMFS 2000b). The annual harvest rate has averaged approximately 12 percent in the last few years.

- Non-native piscivores - Other sport fisheries target smallmouth bass, channel catfish, and walleye. However, the ISAB report states that state fisheries agencies in Washington, Oregon, and Idaho have simultaneously adopted management policies that in some cases are aimed at perpetuating or even enhancing populations of these introduced predators. The ISAB recommends that the state agencies relax (or eliminate) fishing regulations that may be enhancing populations of non-native species (both predators and competitors), especially those that directly or indirectly interact with juvenile and adult salmonids (ISAB 2007). The SRSRB supports strategies and actions that would result in reduced populations of non-indigenous predators on juvenile steelhead.

Avian predation

- Altering Rice Island to prevent tern and cormorant nesting was effective in reducing avian predation in the estuary, and the current FCRPS Biological Opinion (NMFS 2008c) recommends further reduction in bird habitat on East Sand Island.

- The Biological Opinion also recommends development of plans to control Caspian terns and double-crested cormorants that nest in islands upstream of Bonneville Dam. The Army Corps of Engineers takes various "avian deterrent actions" at the lower Snake and Columbia River dams, and will continue to do so.

Marine Mammals

A pinniped hazing program has been implemented at Bonneville Dam since 2005, but the efforts have largely been ineffective against California sea lions, which are not listed as threatened or endangered. The animals may leave the area temporarily but return as soon as hazing stops. Under section 120 of the Marine Mammal Protection Act, states can ask for permission to kill individually identifiable sea lions or seals that are having a "significant negative impact" on at-risk salmon and steelhead, and NMFS can grant that permission, if certain legal standards are met. In March 2008, NMFS granted the request of the states of Oregon, Washington, and Idaho to lethally remove problem California sea lions. Any animals that are captured may be euthanized if no permanent holding facility can be found for them. NMFS and representatives of zoos and aquariums are compiling a list of pre-approved permanent holding facilities interested in receiving a limited number of captured sea lions as an alternative to euthanasia. NOAA has authorized the states to remove as many as 85 animals annually, but estimates that only about 30 animals will be removed each year, given the conditions in its authorization.

In addition, non-lethal deterrence methods will be continued, including the following:

- Vessel chasing
- Cracker shells
- Aerial pyrotechnics (screamer rockets, banger rockets)
- Rubber projectiles
- Sea-lion exclusion devices
- Acoustic deterrents
- Underwater firecrackers
- Capture, marking, and relocation
- Temporary captive holding

Safety and training requirements for vessel use and deterrence measures (including firearms use) also would be continued.

Maintaining and restoring habitat

The ISAB report indicates that the methods of controlling non-native piscivores have not been sufficient, and that maintaining and restoring habitat is actually the better strategy. "When native species are provided with habitat for which they are best adapted, they have an improved chance of out-competing or persisting with non-native species."

Research and monitoring

The SRSRB supports research and monitoring to track trends in predator populations, understand their impacts on SEWMU populations, and development of appropriate management techniques to reduce predation.

6.6.2 Competition – Density Dependent Mortality

As described earlier, density-dependent mortality can occur at any stage in salmon or steelhead life cycle and may be exacerbated by the introduction of, and/or cumulative effects of, large numbers of hatchery fish released over a relatively short period of time. Consistent with this concern NMFS is planning to better define and describe the scientific uncertainty associated with ecological interactions of hatchery-origin and natural-origin salmonids.

See also Appendix C of the 2008 FCRPS Biological Opinion (NMFS 2008c).

6.6.3 Disease

Disease in salmonids is caused by multiple factors and probably cannot be directly addressed by recovery actions except in specific instances of known causal factors. It is more likely that nearly all of the recommended recovery actions that improve spawning, rearing, and passage conditions for steelhead and increase the survival, abundance, and productivity of naturally produced fish will result in decreasing incidence of disease.

6.7 HARVEST

Although the SRSRB has focused their planning efforts on habitat within the SEWMU, it is necessary also to consider harvest strategies, particularly those outside the SEWMU. Existing and proposed harvests management strategies within the SEWMU must be described insofar as they relate to habitat restoration at the subbasin level. This information can be found in Appendix E. Additional information on harvest outside of the SEWMU can be found in the Harvest Module. It is important to ensure that impacts from fisheries do not impede recovery, and to perform monitoring and evaluation to verify impacts and reduce existing uncertainties.

General strategies that relate to all management units are:

- The *U.S. v. Oregon* agreement for 2008-2018 will maintain current low impacts on SEWMU populations in the lower mainstem and treaty mainstem fisheries. (See Harvest Module)

- The Fisheries Management and Evaluation Plans (FMEPs) submitted by the States of Oregon and Washington and approved by NMFS under the 4(d) rule of the ESA provide a mechanism for developing, implementing, and adjusting recreational fisheries to achieve management and conservation objectives. Under the FMEPs, recreational fisheries in the tributaries are expected to maintain the currently estimated low impacts on steelhead. Furthermore, NMFS requires the states to implement, monitor, and evaluate the effects of these plans and to report annually, including an assessment of the annual catch of natural fish, fishery mortality, the abundance of hatchery and natural fish for each tributary fishery area, and angler compliance. A comprehensive evaluation is required every five years. The continuing and additional monitoring and evaluation under the FMEPs is expected to further reduce uncertainties concerning fisheries impacts.

- Tribal resource management plans (TRMPs) are also submitted by the SEWMU tribal interests and are approved by NMFS under the 4(d) rules of the ESA.

- Other increases in monitoring and evaluation will help to reduce uncertainties concerning fisheries impacts on SEWMU populations:
    - Creel surveys or other methods of quantifying impacts in the more popular fisheries
    - In-basin monitoring of escapement from ocean into tributaries and onto the spawning grounds
    - Monitoring to verify the applicability of aggregate impact rates of mainstem fisheries on specific populations

6.8 ESTUARY AND COLUMBIA RIVER PLUME

Although juvenile steelhead and spring Chinook salmon pass through the estuary on their way to the ocean, they tend to spend less residence time in the shallow parts of the estuary than other salmonids, and therefore the characteristics of the Columbia River plume and the deeper channels of the estuary are more important in determining their survival.

Flow changes in the estuary are primarily a result of dam operations, whereas habitat changes are a function of both hydropower operations and other, non-hydro issues, notably the construction of dikes and levees in the estuary. The main effects of flow on SEWMU populations are associated with changes in the plume. Thus, actions that affect the plume, decrease exposure to toxicants, and decrease predation (especially Caspian tern predation) should improve the abundance/productivity and diversity of the SEWMU populations.

NMFS' Estuary Module identifies 23 types of management actions that would improve estuary conditions for all salmonids. The following is a selection of these actions most beneficial to SEWMU populations:

- Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell.
- Manage pikeminnow, smallmouth bass, walleye, and channel catfish to prevent increases in abundance.
- Identify and implement actions to reduce salmonid predation by pinnipeds.
- Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island.
- Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.

- Implement pesticide and fertilizer best management practices to reduce estuary and upstream sources of toxic contaminants entering the estuary.
- Identify and reduce industrial, commercial, and public sources of pollutants.
- Monitor the estuary for contaminants and/or restore contaminated sites.
- Implement stormwater best management practices in cities and towns.

The module includes an evaluation of the “constraints” on implementation of these actions. Perhaps the most significant action would be to adjust the timing, magnitude and frequency of flows to return to a more natural hydrograph for the estuary; however, this is the least possible of the actions, given the constraints:

- Constraints on hydrosystem operations prevent the return to a natural hydrograph in the estuary. Implementation of this action would be limited by international treaties, the need for flood control, fish management objectives system-wide, and power management (NMFS 2007).

6.9 CLIMATE CHANGE

A strategy for addressing the effects of climate change on SEWMU populations needs to be based, broadly, on the principle of preserving biodiversity. Diversity in terms of both location and biological characteristics gives any species resilience in the face of environmental change. This principle underlies the viability criteria presented in Chapter 4 of this plan, as well as the strategies described in this chapter to address the factors limiting SEWMU population viability, as these are currently understood. NMFS supports the ISAB’s recommendations for mitigating the effects of climate change (ISAB 2007).

The ISAB notes, “As climate and streams warm, tributary habitats will become increasingly important because they usually provide the cool waters for salmonids and other cool-water species in a watershed” (ISAB 2007). It follows that water temperature and stream flow are factors that will remain important throughout salmonid freshwater habitat. All strategies and actions that help to lower water temperature or prevent further increase will help to mitigate climate change. Protecting and/or restoring riparian areas to increase shade, as recommended in Section 6.3, is an important strategy for minimizing water temperature increases. Additional actions include purchasing water rights to leave more water in streams and restoration actions to improve channel complexity and establish side-channel rearing (FCRPS BiOp, NMFS 2008a). Specific recommendations from the ISAB include:

- Protect or restore riparian buffers along streams – especially in headwater tributaries where shading is crucial for maintaining cool water temperatures.
- Expand efforts to protect riparian areas from grazing, logging, development, or other activities that could impact riparian vegetation.
- Protect potential thermal refugia. Remove barriers to fish passage into thermal refugia.

The ISAB emphasizes the importance of identifying areas that may be most affected by climate change and establishing adequate protective measures, including “reserve” areas or strongholds of high productivity and diversity.

The ISAB also offers possible actions that could be taken on the mainstem Columbia River to address climate change impacts on SEWMU populations:

- Flow augmentation from cool/cold water storage reservoirs to reduce water temperatures or create cool water refugia in mainstem reservoirs and the estuary. Effective implementation of this strategy may require increasing the number of storage reservoirs.

Existing FCRPS operations result in cold water releases from Dworshak reservoir in late summer. Temperature control towers at other headwater reservoirs are under consideration through other processes. These actions are likely to have an impact on SEWMU populations because these water sources are near enough to the species' migration corridor, while they are migrating in the Snake River mainstem.

- Use of removable surface weirs to reduce the time juvenile salmonids spend in the warm water of the forebay.

This Recovery Plan (through the FCRPS BiOp) includes operating all mainstem dams with removable surface weirs or other structures to quickly move juveniles downstream from dam forebays.

- Reduction of water temperatures in the ladders with water drawn from lower, cooler strata in the water column of the forebay.

Most mainstem reservoirs that SEWMU populations pass are isothermal during warm water periods, so pumping water from depth would not reduce ladder temperatures. However, stratification with warm surface water affecting fish ladders sometimes occurs at McNary Dam. A means of cooling fish ladder temperatures at this project should be investigated.

- Liberalization of harvest of introduced piscivorous species such as smallmouth bass, walleye, and channel catfish.
- There are opportunities to mitigate for some climate change impacts in the estuary and plume with changes to hydrosystem operations. Possible actions would include reducing the frequency and magnitude of winter flows, extending the period of spring runoff later in the year, and increasing late summer and autumn flows.

The recovery plan (through the FCRPS BiOp) calls for estuary habitat restoration projects that include dike breaching and restoring access and tidal influence to marshes.

The recovery plan (through the FCRPS BiOp) includes new analyses to incorporate climate change predictions into mainstem Columbia River hydrology models with improved forecasting capabilities. The goal is better long-term operations planning, including patterns of reservoir storage and release for flood control and other purposes.

Climate change responses require significant monitoring information and additional research regarding effects of climate on key habitat variables and effects of habitat variables on fish survival. Monitoring for Climate change is discussed in Appendix C.

6.10 COORDINATION/GOVERNANCE

Coordination of actions and information-sharing among fisheries biologists, Tribes, local governments, citizen groups, and state and Federal agencies based in both Oregon and Washington is a key component of recovery for SEWMU populations. Benefits of coordination include:

- Dealing with shared migration areas consistently.
- Developing coherent MPG-level strategies where populations are in two states (Grande Ronde MPGs; Umatilla/Walla Walla steelhead MPG), or the same population is in both states (Walla Walla steelhead population).
- Promoting consistent methods for setting recovery objectives, evaluating strategies, and monitoring progress across populations, MPGs, and the ESU/DPS.

This coordination is currently being implemented through the SRSRB, and associated subcommittees and teams. In addition, other processes, like the LSRCP also assist in regional coordination.

6.10.1 Research, Monitoring and Evaluation and Adaptive Management

An important part of the strategy for achieving recovery is the development of a monitoring plan that will support implementation of the recovery plan and long-term adaptive management in response to changes and trends in the data. Two keys to effective implementation are targeting actions to specific areas and monitoring the results of the actions. Appendix A of this Plan discusses specific areas and actions associated with those areas for preservation and restoration, and it is coordinated through the RTT. The monitoring plan is discussed in more detail in Appendix C.

In addition to the issue- and area-specific monitoring for adaptive management, research should be directed toward resolving the many uncertainties pertaining to ocean productivity, global climate change, hatchery effectiveness, effects of transportation, invasive species, effects of interacting strategies, and effects of human population growth on SEWMU spring Chinook salmon and steelhead recovery. These are described in greater detail in Appendix C of this Plan.

6.10.2 Summary of Recovery Strategies

The following sections summarize the recovery strategy for spring/summer Chinook and steelhead MPGs. Table 6-4 shows the SEWMU populations within each MPG and the overall MPG risk assessment from the ICTRT.

Table 6-4. Summary of ICTRT viability risk assessment for each MPG in the SEWMU.

MPG	SEWMU Population	ICTRT Risk Status
Lower Snake River spring/summer Chinook	Tucannon River	High risk
	Asotin Creek (functionally extinct)	
Grande Ronde/Imnaha spring/summer Chinook	Wenaha	High risk

MPG	SEWMU Population	ICTRT Risk Status
Umatilla / Walla Walla Rivers steelhead	Walla Walla R.	Moderate Risk
	Touchet R.	High risk
Lower Snake River steelhead	Tucannon R.	High risk[a]
	Asotin Cr.	
Grande Ronde steelhead	Lower Grande Ronde	Low-moderate risk (?)[b]
	Joseph Cr.	Very Low

[a] It is important to note that for Asotin Creek, abundance appears to meet TRT criteria for moderate to low risk, but information is lacking for productivity.

[b] The RTT disagrees that any risk category can be applied to the Lower Grande Ronde population since there is not enough information.

Only one population in the SEWMU meets the criteria for viable status (Joseph Creek); one (Walla Walla River) is assigned a moderate risk, and one is uncertain and may be either moderate or low risk (Lower Grande Ronde steelhead). One population is extirpated (Asotin Creek spring/summer Chinook salmon).

6.10.3 Delisting and Recovery Scenarios

Populations within an ESU or DPS are the units whose risk levels collectively determine MPG viability and the likely persistence of the ESU/DPS. The ICTRT recommended that all MPGs in an ESU/DPS should be viable before the ESU/DPS can be considered at low risk of extinction. However, it may not be necessary for all of the populations to attain low risk in order to provide sufficient viability for the ESU/DPS; the ESU/DPS-level viability criteria allow for some combination of risk status among the component populations. In other words, there is more than one way for an ESU/DPS to meet the viability criteria. The possible combinations of risk status for populations in each MPG that would allow the ESU/DPS to meet the viability criteria are called “delisting or recovery scenarios.”

The ICTRT offered a detailed discussion of possible scenarios for each MPG that would allow an ESU/DPS to meet the viability criteria (ICTRT 2007a). The ICTRT selected these combinations of risk status based on the populations’ unique characteristics, such as run timing, population size, or genetics; major production areas in the MPG; and spatial distribution of the populations. Although the ICTRT criteria provide that at least one population in each MPG should reach Highly Viable status, the team did not indicate which population that should be (except in the case of the Lower Snake River spring/summer Chinook salmon MPG), because of the uncertainties of any population’s response to recovery efforts. The ICTRT cautioned against closing off the options for any population prematurely.

Although not all populations in an MPG need to meet TRT viability criteria under most viable-MPG scenarios, it is strongly advisable to attempt to improve the status of more than the minimum number of populations to a low risk (viable) situation. There are two primary reasons for this: First, based on current population dynamic theory, the TRT has recommended that all extant populations be maintained with sufficient productivity that the overall MPG productivity does not fall below replacement (i.e. these areas should not serve as significant population sinks). Thus, it would be highly risky to allow the status of any population to degrade. In fact, many populations will need to be improved from their current status to be regarded as "maintained."

Second, although the possible population sets suggested in the ICTRT's memo would meet TRT viability criteria for the ESUs, achieving recovery will likely require attempting recovery in more than just those populations because of the uncertainty of success of recovery efforts. A low risk strategy will thus target more populations than the minimum for viability (ICTRT 2007a). The SR RTT agrees with this approach and suggests that meeting the Highly Viable status for each population within SEWMU would be needed to meet the restoration goals that the region desires.

Table 6-5 shows how the ICTRT applied their MPG-level criteria to the one extinct and eight extant populations of the SEWMU ESUs/DPSs.

Table 6-5. Recovery Scenarios: Application of ICTRT Viability Criteria to SEWMU MPGs: Options for Viability (all populations within each MPG are shown for context of how SEWMU populations aid recovery for each MPG) and comparison to recommendations of the SRSRB (RTT).

MPG & Population	Size Category	Role in Viability Scenario	Considerations	SRSRB (RTT) Recommendations
Lower Snake River spring/summer Chinook MPG: Applying ICTRT viability criteria, for this MPG to be viable, both populations should meet viability criteria, and one should be highly viable.				
Tucannon River	Intermediate	Need for Viable status	Only spring/summer population in MPG, needs to reach high viability	High viability
Asotin Creek (functionally extirpated)	Basic	Need for Viable status[a]	Initial recovery efforts should focus on improving the status of the extant Tucannon River population	The Asotin population ***is*** extirpated. Should be considered as an expansion of the Tucannon Population.
Grande Ronde/Imnaha spring/summer Chinook MPG: Applying ICTRT viability criteria, for this MPG to be viable, the Imnaha and two of three large, and one of two intermediate populations should meet viability criteria.				
Wenaha River	Intermediate	Option	One of two intermediate populations needed for Viable status.	Continue to manage as wild fish sanctuary. Required for viability (increase monitoring in WA tributaries)
Lostine/Wallowa Rivers (Oregon)	Large	Option	Two of the three Large size categories are needed for MPG	No recommendation on these populations because they are in

MPG & Population	Size Category	Role in Viability Scenario	Considerations	SRSRB (RTT) Recommendations
			recovery.	OR.
Minam River (Oregon)	Intermediate	Option	One of two intermediate populations needed for Viable status.	
Upper Grande Ronde River (Oregon)	Large	Option	Two of the three Large size categories are needed for MPG recovery.	
Catherine Creek (Oregon)	Large	Option	This population is treated as an "intermediate" population because the abundance/productivity analyses are conducted based only on spawners in Catherine Creek. The quantity of habitat within Catherine Creek, which excludes Indian Creek and the mainstem Grande Ronde River near Indian Creek, results in an intermediate size designation.	
Imnaha River (Oregon)	Intermediate	Need for Viable status	Only spring/summer type in MPG; the rest are considered spring.	
Lookingglass Creek (Oregon)	Basic		Extinct	
Big Sheep Creek (Oregon)	Basic		Extinct	
Umatilla/Walla Walla summer steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable, two populations should meet viability criteria, and one should be highly viable.				
Umatilla River (Oregon)	Large	Need for Viable status	Only Large population	Concur – needed for recovery
Walla Walla River (Wa and Oregon)	Intermediate	Option	Need one of two Intermediate populations – Walla Walla is now closer to meeting criteria than Touchet	Ensure coordination between OR and WA. Needs to be viable.
Touchet River	Intermediate	Option	Need one of two Intermediate populations	Needs to be viable.
Willow Creek (Oregon)	Intermediate		Extinct	Concur
Lower Snake River summer				

MPG & Population	Size Category	Role in Viability Scenario	Considerations	SRSRB (RTT) Recommendations
steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable, two populations should meet viability criteria, and one should be highly viable.				
Tucannon River	Intermediate	Need for Viable status	One of populations should reach Highly Viable status for MPG to be viable.	Needs to be viable.
Asotin Creek	Basic	Need for Viable status		Continue to manage as wild fish sanctuary. Needs to be highly viable.
Grande Ronde River summer steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable, one large and one intermediate population must meet or exceed population-level viability criteria, and one population in the MPG must meet highly viable criteria.				
Lower Grande Ronde River	Intermediate	Option	ICTRT considers this population as Maintained (but with question because of lack of specific data)	Needs to be viable (insufficient information for current designation – data gap).
Joseph Creek	Basic	Option	ICTRT considers this population as Highly Viable	Continue to manage as wild fish sanctuary. Needs to be highly viable.
Wallowa River (Oregon)	Intermediate	Option	ICTRT considers this population at High Risk (but with question because of lack of specific data)	No recommendation on these populations because they are in OR.
Upper Grande Ronde River (Oregon)	Large	Need for Viable status	ICTRT considers this population as Maintained	

[a] Note - the SR RTT disagrees that Asotin Creek should be needed for the MPG to be viable since they are extinct.

6.10.4 Spring/summer Chinook Salmon

6.10.4.1 Lower Snake River MPG

The overall goal set by the SRSRB for recovery and restoration of the Lower Snake spring/summer Chinook MPG is to have both the extant Tucannon population at highly viable status and a reintroduced Asotin Creek population at least viable (low risk), with representation of all the major life history strategies present historically.

Population	ICTRT Risk Level	Desired Status
Tucannon River	High	Very Low Risk
Asotin Creek	Functionally extirpated	Reintroduced and Moderate Risk

Recovery Scenario:

For the Lower Snake River spring/summer Chinook salmon MPG to be considered viable, the Tucannon population will need to achieve highly viable status (Ford et al. 2010). MPG viability could be further bolstered if reintroduction of spring/summer Chinook salmon into Asotin Creek succeeds. The ICTRT suggests focusing on achieving highly viable status of the Tucannon for MPG viability, and then introduction to Asotin Creek. However, the co-managers are interested in "jump-starting" the Asotin Creek population in the near term to begin reintroduction with appropriate stock of spring/summer Chinook salmon (most likely Tucannon River).

Restoration Scenario:

For restoration, as defined in Chapter 4, all populations within each MPG need to meet restoration criteria.

Gap:

The median survival gap (assuming recent ocean and base hydrosystem conditions and 5 percent risk) for the Tucannon River spring/summer Chinook salmon (Asotin Creek is functionally extinct) is 1.23 (meaning that a 123 percent increase in average life-cycle survival is required to achieve 5 percent risk in a 100-year time period). Exceeding the 1% risk curve for the Tucannon spring/summer Chinook salmon would require a 2.48 (248%) improvement in cumulative life cycle survival.

Threats and Limiting Factors

- Mainstem passage and the survival concerns described in Chapter 5 that apply to all species
- Habitat degradation in tributaries
- Possible effects of hatchery production/straying
- Harvest, depending on abundance

Summary of MPG Recovery Strategy:

The proposed actions for the spring/summer Chinook salmon populations in the lower Snake River MPG are based on restoring important tributary habitat functions in areas that likely supported historical production. The particular actions proposed for each population are predicated upon restoring natural conditions, to the extent possible, supporting summer rearing and overwintering in high potential reaches. For the Lower Snake River MPG, reducing embeddedness, increasing recruitment of large woody debris, reducing temperature and the restoring riparian habitats are common elements. For several populations, restoring sufficient flow, addressing high summer water temperatures, and other water quality issues are also key components (Table 6-6).

Table 6-6. Summary of habitat factors, and associated objectives for the Lower Snake River spring/summer Chinook salmon MPG.

MaSA	Priority	Habitat Factor and Objective
Upper Tucannon River (from Pataha Creek Upstream to Tucannon Headwaters)	I.	Riparian: > 40 to 75% of maximum
	II.	Large Woody Debris: > 1 piece per channel width
	III.	Confinement: < 25 to 50% of streambank length
	IV.	Temperature: < 4 days > 72ºF
Asotin Creek MSA (mouth to headwaters including all tributaries except George Creek)	I.	Large Woody Debris: > 1 piece per channel width
	II.	Embeddedness: < 20%
	III.	Bed Scour: Reduce to < 10 cm
	IV.	Riparian: > 75% to 90% of maximum
George Creek Tributary of Asotin Creek)	I.	Embeddedness: < 10%
	II.	Large Woody Debris: > 1 piece per channel width
	III.	Riparian: >75% of maximum
	IV.	Temperature: < 4 days > 72ºC

EDT modeling indicates that achieving the targeted levels of habitat improvement will translate into increases in both juvenile production capacity and survival rates through the key summer and winter juvenile rearing periods (Chapter 7). Current and future increases in Chinook salmon production from tributary habitats will be further bolstered by actions aimed at reducing mortalities during juvenile and adult migrations to and from the ocean.

The Tucannon hatchery program has been using adaptive management processes since its inception and continues to evolve based on information obtained through monitoring and evaluation and other regional mediated processes. The use of hatchery fish to reintroduce fish in Asotin Creek is currently being discussed with the regions co-managers and NMFS.

The recovery strategy for the Tucannon River population involves reducing straying of fish over Lower Granite Dam. Current information documents this phenomenon (see Appendices on hatchery management and current status), but the causal mechanisms are not clear, so management actions cannot be taken until these mechanisms are understood. Further research is needed to understand the causal mechanisms of this phenomenon.

An important element across all of the SEWMU populations is to continue to manage harvest in a manner that supports recovery efforts. SEWMU populations are subject to harvest in mainstem Columbia River fisheries (at 5 to 17 percent total harvest rate, depending on abundance) (NMFS Harvest Module, indevelopment) and in tributary fisheries directed at hatchery-origin fish. Fisheries in each geographic area are currently managed under impact limits for natural-origin fish and all recreational fisheries prohibit retention of natural-origin fish.

Key actions proposed (see Tables 6-2 and 6-10 for additional information):

- Protect, improve, and increase freshwater habitat for Chinook salmon production. Improvements to freshwater habitat should be targeted to address specific limiting factors in specific areas as described in Chapter 5 of this plan.
- Conduct research to determine the cause of straying of Tucannon natural- and hatchery-origin fish that continue upstream of Lower Granite Dam instead of into the Tucannon River.
- Reduce straying of Tucannon natural- and hatchery origin fish upstream of Lower Granite Dam.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008c).
- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.
- Coordinate between scientists, planners, and implementers for sequencing of recovery actions and monitoring for adaptive management.

6.10.4.2 Grande Ronde/Imnaha (Wenaha) MPG

The overall goal set by the SRSRB for recovery and restoration of the Grande Ronde/Imnaha spring/summer Chinook MPG is to have the Wenaha population at viable status, with representation of all the major life history strategies present historically. The remaining populations in this MPG are in Oregon.

Population	ICTRT Risk Level	Desired Status
Wenaha River	High Risk	Low Risk
Lostine/Wallowa Rivers	High Risk	See NE OR Recovery Plan
Minam River	High Risk	See NE OR Recovery Plan
Upper Grande Ronde River	High Risk	See NE OR Recovery Plan
Catherine Creek	High Risk	See NE OR Recovery Plan
Imnaha River	High Risk	See NE OR Recovery Plan

Recovery Scenario:

The Wenaha spring/summer Chinook salmon population is one of three intermediate sized populations within the MPG. The ICTRT (2007b) recommends that within the Grande Ronde basin, the Wenaha or the Minam population (the other intermediate populations) needs to meet viability status, while the Imnaha population (intermediate) is "required" for viability of the MPG.

Restoration Scenario:

For restoration, as defined in Chapter 4, all populations within each MPG need to meet restoration criteria.

Gap:

For the Wenaha population, the ICTRT estimated that a gap of 1.38 (138%) improvement in survival would be needed.

Threats and Limiting Factors:

- Mainstem passage and the survival concerns described in Chapter 4 that apply to all species
- Harvest, depending on abundance

Summary of MPG Recovery Strategy:

Because the Wenaha River population is part of the larger Grande Ronde MPG (that is mostly in Oregon), the Wenaha could be one of the two populations, besides the Imnaha population that needs to meet viability criteria.

Key actions proposed (see Tables 6-2 and 6-10 for additional information):

The vast majority of the Wenaha River lies entirely within a wilderness area administered by the USFS. The proposed action for this river is to continue protective status.

6.10.4.3 Lower Snake River Steelhead MPG

The overall goal set by the SRSRB for recovery and restoration of the Lower Snake steelhead MPG is to have the Tucannon population at viable status and Asotin Creek population at very low risk, with representation of all the major life history strategies present historically.

Population	ICTRT Risk Level	Desired Status
Tucannon River	High Risk (??)	Low Risk
Asotin Creek	Maintained (?) (High Risk??)	Very Low Risk

Recovery Scenario:

For the Lower Snake River MPG, the ICTRT suggests that one of the two populations should be highly viable.

Restoration Scenario:

For restoration, as defined in Chapter 4, all populations within each MPG need to meet restoration criteria.

Gap:

The ICTRT did not have enough information to determine a gap for either population.

Threats and Limiting Factors:

- Mainstem passage and the survival concerns described in Chapter 4 that apply to all species
- Habitat degradation in tributaries
- Possible effects of hatchery production/straying
- Harvest, depending on abundance

Key actions proposed (see Tables 6-2 and 6-10 for additional information):

- Protect, improve, and increase freshwater habitat for steelhead production. Improvements to freshwater habitat should be targeted to address specific limiting factors in specific areas as described in Chapter 5.
- Conduct research to determine the cause of straying of Tucannon natural- and hatchery-origin fish that continue upstream of Lower Granite Dam instead of into the Tucannon River.
- Reduce straying of Tucannon natural- and hatchery origin fish upstream of Lower Granite Dam.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008c).
- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.
- Continue to manage the Asotin Creek population for natural production only.
- Coordinate between scientists, planners, and implementers for sequencing of recovery actions and monitoring for adaptive management.

Summary of Recovery Strategies for steelhead:

The proposed actions for the steelhead populations in the Lower Snake River MPG are based on restoring important tributary habitat functions in areas that likely supported historical production. The particular actions proposed for each population are predicated upon restoring natural conditions, to the extent possible, supporting summer rearing and overwintering in high potential reaches. For the Lower Snake River MPG, reducing embeddedness, increasing recruitment of large woody debris, reducing temperature, and restoring riparian habitats are common elements. Restoring sufficient flow, addressing high summer water temperatures and other water quality issues are also key components (Table 6-7).

Table 6-7. Summary of habitat factors, and associated objectives for the Lower Snake River steelhead MPG.

MaSA	Priority	Habitat Factor and Objective
Upper Tucannon River (from Pataha Creek Upstream to Tucannon	I.	Riparian: > 40 to 75% of maximum
	II.	Large Woody Debris: > 1 piece per channel width

MaSA	Priority	Habitat Factor and Objective
Headwaters)	III.	Confinement: < 25 to 50% of streambank length
	IV.	Temperature: < 4 days > 72ºF
Asotin Creek MSA (mouth to headwaters including all tributaries except George Creek)	I.	Large Woody Debris: > 1 piece per channel width
	II.	Embeddedness: < 20%
	III.	Bed Scour: Reduce to < 10 cm
	IV.	Riparian: > 75% to 90% of maximum
Alpowa Creek	I.	Riparian: > 80% of maximum
	II.	Embeddedness: < 10%
	III.	Temperature: < 4 day > 72ºF
	IV.	Large Woody Debris: > 1 piece per channel width

EDT modeling indicates that achieving the targeted levels of habitat improvement will translate into increases in both juvenile production capacity and survival rates through the key summer and winter juvenile rearing periods (Chapter 7). Current and future increases in steelhead production from tributary habitats will be further bolstered by actions aimed at reducing mortalities during juvenile and adult migrations to and from the ocean.

The recovery strategy for the Tucannon River population involves reducing straying of fish over Lower Granite Dam. Current information documents this phenomenon, but the causal mechanisms are not clear, so management actions cannot be taken until these mechanisms are understood.

Hatchery reform strategies have been, or are being planned within the Lower Snake River MPG. For example, the use of Lyons Ferry steelhead stock is not used in the Tucannon as of 2011, with the hatchery program relying on Tucannon basin fish only. Other proposed changes can be seen in Appendix D.

An important element across all of the Lower Snake River MPG populations is to continue to manage harvest in a manner that supports recovery efforts. Lower Snake River MPG populations are subject to harvest in mainstem Columbia River fisheries and in tributary fisheries directed at hatchery-origin fish. Fisheries in each geographic area are currently managed under impact limits for natural-origin fish and all recreational fisheries prohibit retention of natural-origin fish.

6.10.4.4 Grand Ronde Steelhead MPG

The overall goal set by the SRSRB for recovery and restoration of the Grande Ronde steelhead MPG is to have the Lower Grande Ronde population at viable status and Joseph Creek maintained at very low risk, with representation of all the major life history strategies present historically.

Population	ICTRT Risk Level	Desired Status

Lower Grande Ronde	Maintained (?)	Low Risk
Joseph Creek	Very Low	Very Low Risk
Upper Grande Ronde	Maintained	See NE OR Recovery Plan
Wallowa	High Risk (??)	See NE OR Recovery Plan

Recovery Scenario:

For the Grande Ronde MPG, one large and one intermediate population must meet or exceed population-level viability criteria, and one population in the MPG must meet highly viable criteria.

Restoration Scenario:

For restoration, as defined in Chapter 4, all populations within each MPG (in Washington State) need to meet restoration criteria.

Gap:

The ICTRT did not have enough information to determine a gap for the Lower Grande Ronde or Wallowa populations. In addition, there is obviously no gap for Joseph Creek, since that population is considered highly viable.

Threats and Limiting Factors (from the NE OR Recovery Plan)

Aside from the limiting factors and threats that affect all populations (hydro, hatcheries, and harvest related), the following habitat limiting factors and threats are identified in the NE OR Recovery Draft Plan.

Table 6-8 Summary of habitat limiting factors and threats from the NE Oregon Draft Recovery Plan

Population	Primary Limiting Factor	Threats
Joseph Creek (RM 0-49)	Water quality (high summer temperatures); Excess fine sediment	Livestock grazing; Roads; Agricultural practices
Lower Grande Ronde River Mainstem—Mouth to Wenaha River (RM 0-46)	Limited habitat quantity/diversity (primary pools, glides, and spawning gravels); Excess fine sediment; and to a lesser extent, Predation; Water quality (high summer temperatures); Water quantity (low summer flows)	Agricultural practices, Livestock grazing, Roads, Recreation, and Residential development
Lower Tributaries to the Lower Grande Ronde River: These streams are the smaller Lower Grande Ronde River tributaries below the Wenaha River confluence and include: Shumaker, Deer, Rattlesnake, Buford, Cougar, Bear (1st), Menatchee, Grouse, Squaw Canyon, and Bear (2nd) creeks. Menatchee, Bear (1st), Buford creeks provide MiSA habitat. Bear Creek (2nd) lies within the Wenaha MaSA.	Excess fine sediment; Water quality (high summer temperatures); Degraded riparian condition; Limited habitat quantity/diversity (large wood); Fish passage; Water quantity (low summer flows due to upstream withdrawals)	Agricultural activities, Livestock grazing, Timber harvest, and Roads
Courtney, Mud, Grossman, and Wildcat Creeks: Courtney, Mud, Grossman, and Wildcat creeks are the larger tributaries to the Lower Grande Ronde (excluding Wenaha River and Joseph Creek)	Limited habitat quantity/diversity (large wood); Water quality (high summer temperatures); Excess fine sediment; Degraded riparian condition; Water quantity (high flows)	Livestock grazing, Roads, Agricultural activities, Timber harvest, Recreation (ATV use)
Wenaha River Mainstem: The mainstem of the Wenaha River extends from the river's mouth at the town of Troy to the forks of the Wenaha (RM 22.1)	Limited habitat quantity/diversity (large wood and pools)	Recreation, Natural causes
Wenaha River Forks and Tributaries: These Wenaha River tributaries include the North and South Forks, and the tributaries that contain summer steelhead habitat, including Crooked Creek and tributaries (Cross Canyon, Weller, Butte, Rock, Slick Ear, Beaver and Milk), and the North and South Forks of the Wenaha River and their tributaries.	Little data available. Legacy effects from past land uses	Historic livestock grazing and timber harvest; Dispersed recreation (minor effect)

Summary of MPG Recovery Strategy:

The proposed actions for the steelhead populations in the Grande Ronde River MPG are based on restoring important tributary habitat functions in areas that likely supported historical production, and will primarily be implemented through the NE OR Recovery Plan. The particular actions proposed for each population are predicated upon restoring natural conditions, to the extent possible, supporting summer rearing and overwintering in high potential reaches. Since Joseph Creek lies primarily in Oregon, priority actions for the portion of Joseph Creek within Washington are to address imminent threats. Objectives for the Lower Grande Ronde can be found in the Northeast Oregon Snake River Recovery Plan.

EDT modeling indicates that achieving the targeted levels of habitat improvement will translate into increases in both juvenile production capacity and survival rates through the key summer and winter juvenile rearing periods (Chapter 7). Current and future increases in steelhead production from tributary habitats will be further bolstered by actions aimed at reducing mortalities during juvenile and adult migrations to and from the ocean.

Key actions proposed (see Tables 6-2 and 6-8 for additional information):

- Protect, improve, and increase freshwater habitat for steelhead production. Improvements to freshwater habitat should be targeted to address specific limiting factors in specific areas as described in Chapter 5 of this plan.

- Maintain protection for the Wenaha Basin.

- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008c).

- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.

- Coordinate between scientists, planners, and implementers for sequencing of recovery actions and monitoring for adaptive management.

6.10.4.5 Umatilla/Walla Walla Steelhead MPG

The overall goal set by the SRSRB for recovery and restoration of the Umatilla/Walla Walla steelhead MPG is to have the Touchet and Walla Walla river populations at viable status, with representation of all the major life history strategies present historically.

Population	ICTRT Risk Level	Desired Status
Umatilla River	Maintained	See mid-Columbia Recovery Plan
Touchet River	High Risk	Low Risk
Walla Walla River	Maintained	Low Risk

Recovery Scenario:

For the Umatilla/Walla Walla MPG to be viable, two populations should meet viability criteria, and one should be highly viable.

Restoration Scenario:

For restoration, as defined in Chapter 4, all populations within each MPG need to meet restoration criteria.

Gap:

The median survival gap (assuming recent ocean and base hydrosystem conditions and 5 percent risk) for the Walla Walla mainstem population is 0.34 (meaning that a 34 percent increase in average life-cycle survival is required to achieve 5 percent risk in a 100-year time period). The ICTRT did not have enough information for the Touchet population to determine a gap.

Threats and Limiting Factors

- Mainstem passage and the survival concerns described in Chapter 4 that apply to all species
- Habitat degradation in tributaries
- Possible effects of hatchery production/straying
- Harvest, depending on abundance

Summary of MPG Recovery Strategy:

The proposed actions for the steelhead populations in the Umatilla/Walla Walla steelhead MPG are based on restoring important tributary habitat functions in areas that likely supported historical production. The particular actions proposed for each population are predicated upon restoring natural conditions, to the extent possible, supporting summer rearing and overwintering in high potential reaches. For the Umatilla/Walla Walla MPG, reducing embeddedness, increasing recruitment of large woody debris, reducing temperature and the restoring riparian habitats are common elements. For several populations, restoring sufficient flow, addressing high summer water temperatures, and other water quality issues are also key components (Table 6-9).

Table 6-9. Summary of habitat factors, and associated objectives for the Umatilla/Walla Walla steelhead MPG.

MaSA	Priority	Habitat Factor and Objective
	I.	Increase Stream Flow
Mainstem Walla Walla River	II.	Temperature: not more than 4 days above 72ºF
	III.	Large Woody Debris: 0.5 to 1 pieces per channel width
	IV.	Embeddedness: less than 10% embeddedness
	V.	Riparian Function: 40 to 90% of maximum
	VI.	Channel Confinement: reduce to 40% to 60% of stream length

MaSA	Priority	Habitat Factor and Objective
Mill Creek	I.	• Embeddedness: < 10%
	II.	• Temperature < 4 day > 72ºF
	III.	• Large Woody Debris: > 1 piece per channel width
	IV.	• Riparian: > 40 to 90% of maximum
Middle Touchet River (mainstem from Coppei Creek to Patit Creek)	I.	Embeddedness: < 10%
	II.	Temperature: < 4 days > 72ºF
	III.	Large Woody Debris: > 1 piece per channel width
	IV.	Confinement: <15 to 40% of stream bank length
Upper Touchet River (Patit Creek Upstream to Touchet Headwaters)	I.	Temperature: < 4 days > 72ºF
	II.	Riparian: >62 to 82% of maximum
	III.	Large Woody Debris: > 1 piece per channel width
		Confinement: <10 to 40% of stream bank length

Key actions proposed (see Tables 6-2 and 6-10 for additional information):

- Protect, improve, and increase freshwater habitat for steelhead production. Improvements to freshwater habitat should be targeted to address specific limiting factors in specific areas as described in Chapter 5 of this plan.

- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008c).

- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.

- Coordinate between scientists, planners, and implementers for sequencing of recovery actions and monitoring for adaptive management.

6.10.5 Summary of General Actions and Strategies for SEWMU Populations

In the following table (6-10), all of the general actions and strategies are summarized for SEWMU populations. Some of the descriptions of the strategies and actions are not exactly stated as above, but all of the components are illustrated.

Table 6-10. Recovery Strategies and Actions for the SEWMU Spring/summer Chinook Salmon and steelhead populations. Detailed, site-specific actions are shown in Appendix A.

Strategies (Not necessarily in order)	Populations Affected and Addressed	Key Actions	VSP Parameters Addressed	Limiting Factors Addressed
Tributary Habitat				
Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	All populations, especially protection for Wenaha basin.	• Protect highest quality habitats through acquisition and conservation. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.	All Parameters	Degradation of tributary habitat-forming processes and functions (loss of channel structure, floodplain connectivity, riparian vegetation and LWD recruitment)
Restore passage and connectivity to habitats blocked or impaired by artificial barriers.	Tucannon basin	• Reduce straying of Tucannon River spring/summer Chinook salmon and steelhead upstream of Lower Granite Dam	Abundance, Productivity, Spatial Structure	Tucannon River spring/summer Chinook and steelhead have been observed in recent years to be migrating past the Tucannon River, upstream of Lower Granite Dam. Local managers are concerned that this could be caused by the hydrosystem, where fish are potentially unable to locate the Tucannon River, or return back to the Tucannon once they migrate past Lower Granite Dam.
Restore floodplain connectivity and function.	All populations	• Reconnect side channels and off-channel habitats to stream channels. • Restore wet meadows. • Reconnect floodplain to channel. • Relocate or improve floodplain infrastructure and roads.	Abundance, Productivity, Spatial Structure	Degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone)
Restore channel structure and complexity.	All populations	• Place stable wood and other large organic debris in streambeds. • Stabilize stream banks.	Abundance, Productivity	Degraded channel structure and complexity (loss of spawning and rearing habitat, LWD, pools)

Strategies (Not necessarily in order)	Populations Affected and Addressed	Key Actions	VSP Parameters Addressed	Limiting Factors Addressed
		• Restore natural channel form.		
Restore riparian condition and LWD recruitment .	All populations	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery.	Abundance, Productivity	Degraded riparian condition (native riparian vegetative communities, LWD recruitment)
Restore altered hydrograph to provide appropriate flows during critical periods.	All populations	• Implement agricultural water conservation measures. • Improve irrigation conveyance and efficiency. • Lease or acquire water rights and convert to instream. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs for forest, agriculture and grazing practices and road management. • Protect and/or rehabilitate springs.	Abundance, Productivity	Altered hydrology (low summer flow, scouring peak flows due to degraded watershed conditions and/or streamflow alterations and withdrawals for irrigation and other uses)
Improve degraded water quality.	All populations	• Reduce chemical pollution inputs. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs for forest, agriculture and grazing practices and road management. • Upgrade or remove problem forest roads. • Conduct pathogen sampling and monitoring. • Construct water and sediment	Abundance, Productivity	Degraded water quality (abnormal temperatures or fine sediment, nutrients from runoff, pesticides and other chemicals, and/or degraded because of water withdrawals that reduce natural stream flows)

Strategies (Not necessarily in order)	Populations Affected and Addressed	Key Actions	VSP Parameters Addressed	Limiting Factors Addressed
		control basins.		
Harvest				
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	All populations	• Maintain current management regulations for low impact fisheries and adjust tributary harvest regulations in areas where harvest significantly impacts steelhead viability. • Monitor and evaluate effects of tributary harvest.	Abundance, Productivity	Not a primary limiting factor.
Use harvest to reduce abundance and proportion of stray hatchery spawners.	Currently for steelhead populations only.	• Develop educational outreach program to promote retention of hatchery fish in selective recreational fisheries to reduce the number of out-of-basin hatchery strays.	Abundance, Productivity, Diversity	Straying of Out-of-DPS hatchery fish into natural spawning areas.
Reduce illegal harvest on ESA- listed species.	All populations	• Eliminate illegal harvest by enforcing sport and Tribal regulations.	Abundance, Productivity	Not a primary limiting factor.
Hatchery				
Determine origin of hatchery strays and increase ability to recognize hatchery-origin fish.	Potential risk for all populations.	• Implement representative coded-wire-tagging (CWT) program so that all hatchery stocks have adequate CWT groups released annually. • Mark all hatchery fish released in Columbia River Basin to enable non-tribal fisheries and determine hatchery-origin fish on the spawning grounds (not all co-managers agree with this recommendation). • Recommend development of alternative broodstocks to reduce	Diversity, Productivity	Straying of Out-of-DPS hatchery fish into natural spawning areas.

Strategies (Not necessarily in order)	Populations Affected and Addressed	Key Actions	VSP Parameters Addressed	Limiting Factors Addressed
		stray rates for programs that contribute significantly to stray problem.		
Reduce uncertainty in abundance and proportion of hatchery strays spawning naturally.	Primarily concerns steelhead	• Increase efforts to monitor incidence of hatchery fish on spawning grounds through additional stream surveys and other methods.	Diversity, productivity	Out-of-DPS and Inside-DPS hatchery strays in tributary natural spawning grounds
Reduce abundance and proportion of stray hatchery fish that spawn naturally.	All populations	• Construct, improve trapping facilities and expand operations.	Abundance, Productivity, Diversity	Out-of-DPS and Inside-DPS hatchery strays in tributaries
Review effect of current hatchery practices and releases.	All populations	• Continue or increase current monitoring.	Abundance, productivity, diversity	Not a primary limiting factor

7 POTENTIAL EFFECTS OF PROPOSED RECOVERY ACTIONS

This chapter presents an analysis of the potential effects of actions on the performance of SEWMU salmonid populations.[20] Projected levels of effectiveness are analyzed using the ecosystem diagnosis and treatment (EDT) model.[21] Results are expressed as changes to population abundance and productivity parameters, as they were defined by the ICTRT for baseline conditions for each population (Chapter 4).

[20] It is important to note that this analysis was performed in 2004, and has not been updated. One major factor for consideration is that the ICTRT had not developed their de-listing criteria when this analysis was performed.

[21] For information pertaining to EDT, please see Appendix F.

7.1 METHODS

Based on EDT analysis that was performed in 2004, the actions proposed in this recovery plan are expected to substantially increase the abundance, productivity and diversity of listed species in the recovery area. Until the actions are implemented and their effectiveness are determined empirically, actual benefits to fish must be considered a working hypothesis to be tested and monitored over time (See Adaptive Management and RM&E appendix).

Because salmonid recovery is dependent on meeting the VSP criteria presented in Chapter 4, it was necessary to convert EDT estimates of adult abundance and productivity to points that could be placed on the viability curves developed by the ICTRT. The method used to make this conversion is presented in Appendix F and the actual EDT results are presented in Appendix F. The results are presented by subbasin and species below. Empirical data[22] available on the number of adults returning to the basin were included on the viability curves to provide comparisons with EDT adult estimates. The empirical data are presented as averages for the period of record. Due to changing ocean and freshwater environmental conditions, the number of adults returning each year might vary by an order of magnitude. For example, natural adult spring/summer Chinook adult returns to the Tucannon River have ranged from 11 to 611 fish from 1985 to 1999. The origin of the restoration goals presented for each population can be found in Chapter 4.

An EDT analysis was conducted for each MaSA identified by the ICTRT in the SEWMU by species in order to demonstrate how the spatial structure and diversity of the populations would change with the implementation of the recovery plan. This analysis was designed to demonstrate that proposed recovery plan actions are designed to improve fish performance in all major fish-producing areas in an effort to meet the spatial structure and diversity criteria established by the ICTRT. The numbers presented for each MaSA should be considered indicators of the expected change in fish performance. The actual change in VSP parameters will be determined empirically through the monitoring program (See Adaptive Management and RM&E appendix).

It should also be noted that the EDT analysis and results use the following assumptions:

- Results reflect the number of adults that would return to the basin if ocean and freshwater fisheries were eliminated. In general, harvest rates on the listed spring/summer Chinook and steelhead species are less than 10 percent. If harvest were to continue at this rate, then the EDT run size to the basin would be reduced by 10 percent.
- The model does not account for any competition that may occur due to the presence of hatchery fish, or hatchery fish spawning with wild fish as these impacts have not been quantified. If hatchery/wild fish interactions reduce the fitness of the wild population, then adult returns to the basin would be lower than the EDT estimate.
- When comparing EDT model estimates of adult abundance in a stream to empirical data, it must be remembered that the EDT estimate does not account for hatchery fish. Empirical estimates may include both wild and hatchery production as it is not always possible to distinguish between the two (although this has been improving in recent years).

[22] It is not always clear where the empirical data used in the 2004 analysis came from. As such, it is important to consider the information in light of the current assessment of SEWMU salmonids that appears in the Current Status Assessment of SEWMU Populations, Appendix B of this Plan.

- No improvements are expected in estuarine survival of juvenile fish. If estuary conditions improve from actions taken by entities in the lower Columbia River, then juvenile and possibly adult survival would also improve. Improved survival would result in an increase in the number of adults returning to the recovery region.
- Hydrosystem survival is assumed to remain unchanged for the 10-year planning period. A change in hydrosystem survival would result in more or fewer adults returning to the spawning grounds, dependent on the direction (higher or lower) of the change.
- Habitat improvements occur in Oregon portions of the basin, where applicable. The EDT analysis relies on the subbasin plans which assumed that stream habitat conditions improve in Oregon controlled portions of the basins. If Oregon stream habitat does not improve over time, then EDT estimated benefits from the recovery plan would be optimistic.
- The effects of low flow (and thus the need for remediation) may not have been adequately described in the habitat inputs used in modeling. Flow issues will be addressed through the watershed planning processes. Because of this, new flow related actions will likely be proposed which should increase the effectiveness of the SRSRP.
- All migration barriers have been removed in the recovery plan.
- The expected level of improvement as estimated by EDT assumes that the habitat objectives in Chapter 6 have been fully achieved. Although biologists know what type of actions would best meet the objectives, they do not know what level of improvement will actually be achieved. Therefore, the numbers presented for the recovery plan assume that all habitat objectives are achieved within 10-years.

7.2 QUALIFICATIONS OF ANALYSES BELOW

Abundance and productivity

A number of additional points must be made about figures and analyses that follow below. First, the figures below include both empirical and EDT-based estimates of current abundance and productivity. However, because data were not available in all basins to develop empirical estimates of intrinsic productivity, the EDT model result intrinsic productivity value was used. The assumptions behind the EDT results were described above. For comparison purposes with EDT generated estimates, only the average number of adults returning to the basin is shown in the figures for the empirical data. In reality, adult returns to each of the basins has varied by an order of magnitude. In addition, the empirical data were generated using various methodologies each of which has different levels of error associated with it. Finally, because not all hatchery fish are marked, the number of adult fish returning to some basins consists of a mixture of wild and hatchery fish. Thus, wild production may be overestimated in some years.

The figures below also include EDT-generated abundance and productivity estimates under Properly Functioning Conditions (PFC) and historical conditions (with the FCRPS in place), as well as a range of rebuilding goals expressed solely in terms of abundance. The latter is displayed as a grayed band labeled “Restoration”. The point labeled “PFC” denotes “Properly Functioning Conditions” for all habitat variables and represents for each habitat variable a condition that maintains the long-term viability of the population.

PFC represents an environmental scenario under which, for each habitat variable, conditions are of sufficient quality to maintain the long-term viability of the population (this is strictly habitat based). The PFC analysis does not consider improved habitat conditions to exceed those which existed historically. For example, if stream maximum temperatures were high historically in August, PFC does not assume that these conditions have been eliminated. The PFC values for each subbasin and population are presented because they represent likely WDFW and tribal long term (more than 30 years) habitat goals. PFCs are discussed further in Appendix F.

The intrinsic productivity values associated with EDT simulations were not produced by the EDT model directly; rather, they represent a mathematical transformation of the Beverton-Holt productivity parameter produced by the EDT model. Details of the mathematical transformation can be found in Appendix F.

Also, because of the uncertainty associated with model inputs and assumptions, predictions of future fish performance should not be taken as an absolute.

Diversity and spatial structure

Rather than defining diversity, the ICTRT describes the mechanisms that determine it.

Specifically, the ICTRT describes diversity as the result of the interaction of four basic mechanisms:

- **preservation of endemic genotypes and phenotypes** (preservation of distinctive life histories, age distributions, heterozygosity indices, and allele frequencies, etc.)
- **preservation of natural patterns of gene flow** (proportion of non-local spawners and the frequency of interbreeding among spawning aggregates)
- **preservation of local adaptations** (indexed to the diversity of habitat conditions occupied), and
- **preservation of the integrity of natural systems** (indexed by a lack of selection for a subset of genotypes or phenotypes because of anthropogenic habitat modifications).

The net result of these four aspects of diversity is a self-sustaining population with multiple spawning locations, ages of spawners, juvenile migration patterns, local adaptations, times of river entry and spawning, and so on. To the degree that the determinants of diversity under current conditions match the determinants under historical conditions, the population is considered capable of adapting to environmental fluctuations and local catastrophes and is, therefore, at lower risk of extinction.

In the EDT model, diversity is also indexed in terms of the number of self-sustaining life history patterns. Fish habitat is conceived of as a space/time matrix in which rows represent successive portions of habitat in subbasin, the mainstem Snake/Columbia, the estuary, and the ocean while the columns represent time and successive life stages. A unique life history pattern consists of the trajectory through this matrix that starts and ends at the same spawning reach and time: with parents spawning in reach X at time Y and progeny moving through all subsequent places and times of freshwater rearing, outmigration, marine rearing, adult migration, and holding and finally spawning in reach X at time Y. Every distinct trajectory represents a unique life history pattern and the proportion of self-sustaining trajectories is a reasonable measure of the functional life history diversity of the population.

Thus, the proportion of EDT life history patterns that are viable, i.e., that produce at least one returning adult per spawner, can be seen as the net result of the operation of four mechanisms that promote or diminish life history diversity. In other words, the ICTRT assesses diversity in terms of the robustness of the underlying mechanisms, while EDT assesses diversity directly, in terms of self-sustaining unique life history patterns. To the degree that input data for EDT simulations are accurate, it can be expected that diversity as conceived by EDT and by the ICTRT will vary in parallel. That is, both EDT and the

ICTRT's approach will predict improvement in diversity at the same time even though their underlying approaches are different.

It should be noted that in order to produce the data for figures below that pertain to diversity, the EDT Model had to be run multiple times under varying assumptions about spawning distribution. Therefore, the abundance values presented for the viability analysis may be different than the sum of the spawning areas. This is just one of the reasons that the numbers presented should be considered index values.

An additional caveat concerning quantitative EDT results should be noted. Some of the values reported differ to some degree from the values reported in the subbasin plans and annual reports. These differences reflect slightly different assumptions made in the two planning efforts. One of the major differences concerns the "fitness" of the populations modeled. In subbasin planning, many of the populations were not assumed to be as fit as wild fish. Fitness was assumed to be 100 percent only for Asotin Creek steelhead and spring/summer Chinook, Wenaha spring/summer Chinook, Lower Grande Ronde steelhead, and Joseph Creek steelhead. All other populations were assumed to have a fitness of 90 percent, meaning that 10 percent fewer offspring are produced per spawner because of assumed hybridization with hatchery fish. Fitness in the recovery plan was assumed to be 100 percent in all cases.

Conditions in the mainstem Snake and Columbia were also modeled differently in subbasin planning and the recovery plan. In subbasin planning, estimated historical conditions were assumed for the mainstem Snake and Columbia for "historical" simulations for most subbasins (Asotin, Tucannon, and Walla Walla). In the recovery plan, current mainstem conditions were assumed even for historical simulations in order to emphasize the role of the subbasin. There are other minor differences between the simulations performed during subbasin plan and the recovery plan including the changes in spawning distributions mentioned in the previous paragraph.

7.3 RESULTS

7.3.1 Bull Trout

Determining the effect recovery plan implementation will have on bull trout populations is not possible because there are currently no models available to forecast the change in bull trout abundance, productivity, or diversity resulting from habitat actions in any of the subbasins. Therefore, the recovery plan focuses on implementing actions that reduce known threats to bull trout. This approach is consistent with the bull trout biological opinion developed by the USFWS for recovery area populations (USFWS 2002a). USFWS (2002a) states that:

"…recovery for bull trout will entail reducing threats to the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life-history forms."

USFWS hypothesizes that bull trout will recover to healthy sustainable levels if all known threats to the population are reduced or eliminated. To address the threats, USFWS identified actions that need to be taken in each subbasin of the recovery area that currently support (or historically supported) bull trout. Those actions proposed by the USFWS for Washington waters have been incorporated into this recovery plan. The effect the actions have on bull trout abundance will be determined as part of the monitoring program discussed in Appendix C.

7.3.2 Asotin Creek

The expected benefits of the recovery plan to listed fish species in Asotin Creek are discussed below. The discussion focuses on the change in VSP parameters as they affect population viability, abundance, intrinsic productivity, and life history diversity.

7.3.2.1 Summer Steelhead

Population Viability

Figure 7-1 shows the viability analysis for steelhead in the Asotin Creek subbasin. EDT simulations indicate that the abundance of the Asotin steelhead metapopulation under the recovery plan will increase from 577 to 947, while intrinsic productivity increases from 1.28 to 1.38. With the information used for this exercise, the current abundance and productivity is meeting the ICTRT minimum threshold levels (Figure 7-1). Increases of abundance productivity based on EDT output will ensure that the population remains viable (at the 5% risk level), but potential additional actions may need to occur for the population to become highly viable, or to meet restoration goals (Figure 7-1).

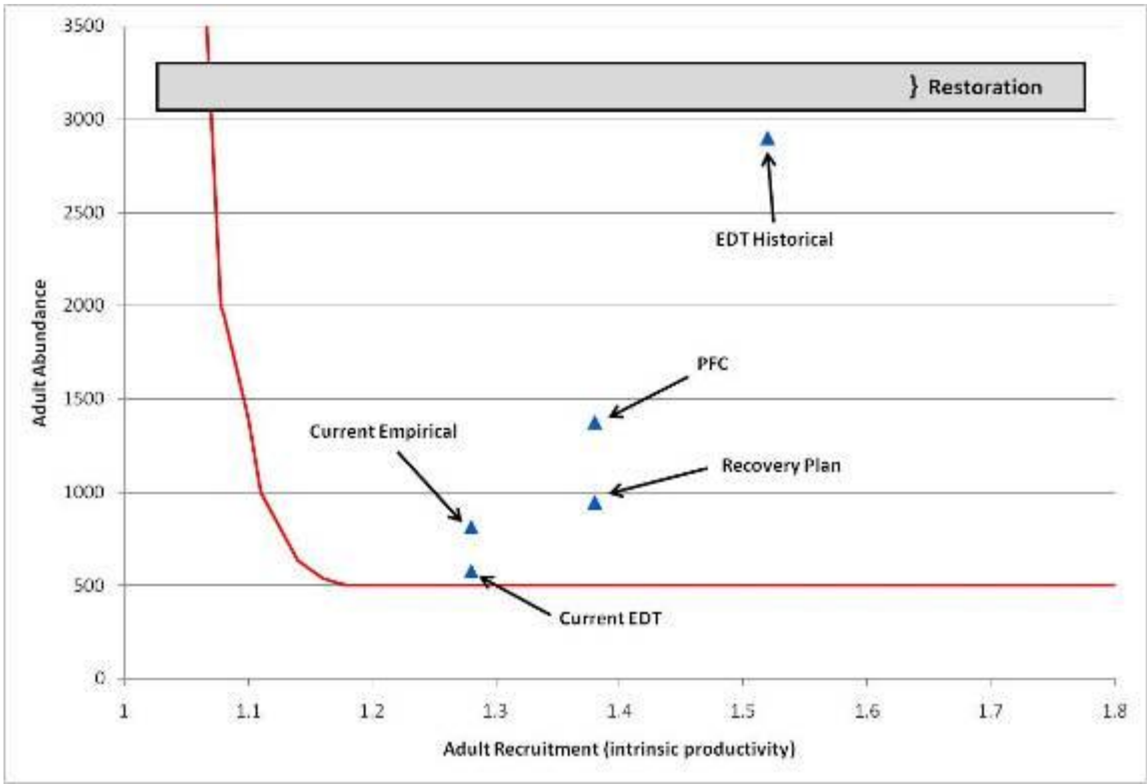


Figure 7-1. Revised (to compensate for revised minimum abundance threshold) EDT Viability Analysis (2004) for Asotin Summer Steelhead.

VSP Parameters for Major and Minor Spawning Aggregations

VSP index values for Asotin summer steelhead major and minor spawning aggregations are presented in Figure 7-2, which shows that the recovery plan improves all VSP parameters in all spawning areas. Therefore, to the degree that the viability of all major and minor spawning aggregations is improved, the habitat restoration actions proposed by the recovery plan increase the viability of the metapopulation as a whole in terms of its spatial structure.

Figure 7-2 shows that the majority of the summer steelhead production both currently and in the recovery plan is being produced in Asotin Creek (mainstem and forks) and Tenmile Creek. George Creek, Alpowa, Almota, and Couse creeks are able to support a limited run of summer steelhead, albeit at relatively high productivity with plan implementation. Thus, during periods of poor ocean or freshwater survival, or low stream flows that block passage, there may still be years when no adults return to some of these streams. In addition, there currently appears to be a high number of hatchery-origin fish that stray into these tributaries. That high stray rate may make it more difficult for the Asotin Population to reach the diversity criteria of the ICTRT.

Asotin Steelhead Equilibrium Abundance

	Asotin Cr	George Cr	Almota Cr	Alpowa Cr	Couse Cr	Tenmile Cr
Current	196	30	33			176
Recovery Plan	307	72	64			269

Asotin Steelhead Adult Intrinsic Productivity

	Asotin Cr	George Cr	Almota Cr	Alpowa Cr	Couse Cr	Tenmile Cr
Current	1.20	1.05	1.18			1.29
Recovery Plan	1.30	1.18	1.36			1.41

Asotin Steelhead Life History Diversity

	Asotin Cr	George Cr	Almota Cr	Alpowa Cr	Couse Cr	Tenmile Cr
Current	30%	1%	21%			60%
Recovery Plan	55%	15%	42%			74%

Figure 7-2. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Asotin Summer Steelhead Under Current and SRSRP Conditions (2004).

Summary of Conclusions

The data presented in Figure 7-1 show that, currently, Asotin Creek steelhead abundance and productivity values are likely meeting the viability curve defined by the ICTRT. The actions proposed in the SRSRP (*recovery plan* on graph) are forecast by EDT to increase overall Asotin Creek adult steelhead abundance by 64 percent. The resulting adult production is above the current minimum viability criteria, but below restoration goals, although the proportion of hatchery fish on the spawning grounds is higher than desired. However, as pointed out repeatedly in this document, the conclusion is based on modeling results that have a high degree of uncertainty associated with them.

7.3.2.2 Spring/Summer Chinook

Population Viability

EDT simulations indicate that the recovery plan will improve spring/summer Chinook salmon performance in Asotin Creek substantially. Relative to the EDT estimate of current production potential, improved habitat conditions are predicted to increase adult abundance and intrinsic productivity by 124 percent and 8 percent, respectively (Figure 7-3). Improvement of this magnitude would move the population just above the viability curve into the region of low extinction risk.

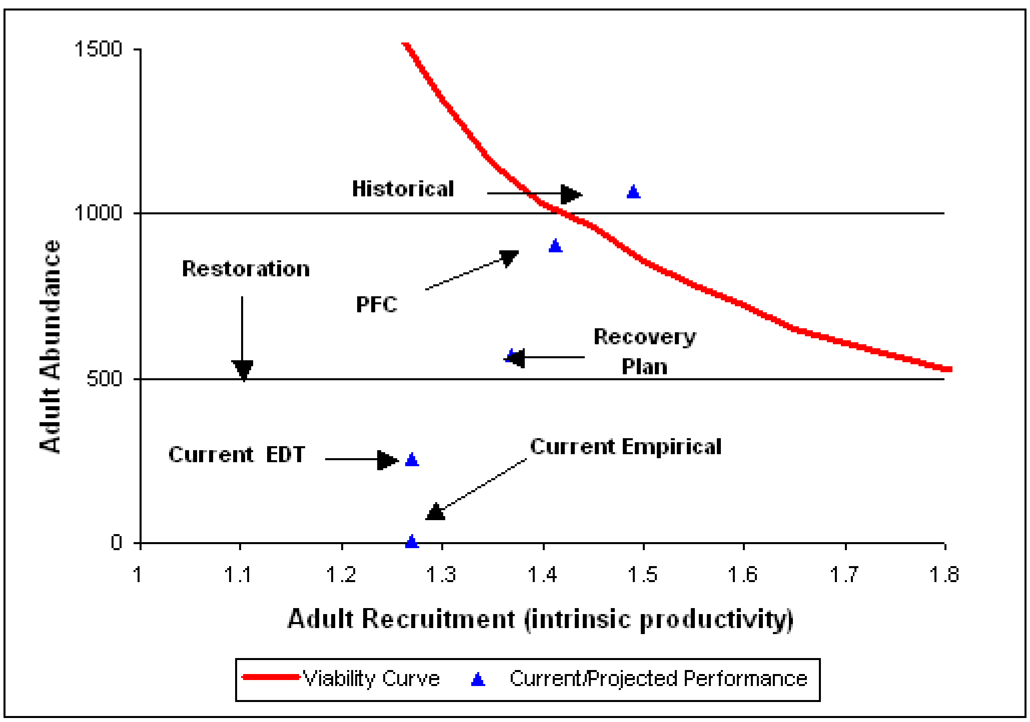


Figure 7-3. EDT Viability Analysis for Asotin Spring/Summer Chinook (2004).

The figure shows a large discrepancy between observed spring/summer Chinook salmon production and production potential as estimated by EDT is in order. EDT reaches may be biased to the high side by including spawning in several streams (South Fork Asotin, Charley Creek, and portions of George Creek) which may be too small to support salmon spawning or rearing. However, both of the values displayed in the figure can be “correct.” There is little doubt that the number of spring/summer Chinook salmon spawning in Asotin Creek in recent years is very low, but this fact does not mean that the subbasin does not possess the potential to support a considerably larger number of spawners. The native run of spring/summer Chinook salmon may have been extirpated years ago, so that the subbasin now receives only strays from other basins and perhaps from hatchery programs. If this is the case, the recolonization of Asotin Creek by spring/summer Chinook salmon would be a very slow process, especially given the low productivity expected under current degraded habitat conditions. ICTRT believes that populations with less than 500 adults are at high risk of extinction. The Asotin Creek EDT analysis is consistent with this assumption.

It appears that, because of the uncertainty of many EDT performance estimate determinants, as well as the marginal viability estimate itself, achieving viability may require additional improvements to habitat conditions inside and outside the subbasin. Moreover, because of the virtual absence of spawning adults in recent years, it is appropriate to consider implementing an integrated hatchery re-introduction/supplementation program, perhaps utilizing Tucannon River donor stock. Combining additional habitat improvements with supplementation by hatchery fish could allow spring/summer Chinook salmon to become self-sustaining in Asotin Creek, if out of basin limiting factors are not overly suppressing the population, and production in Asotin could contribute to the health of the Snake River spring/summer Chinook salmon ESU.

It should be noted however that the data presented in Chapter 5 indicate that 72 percent of the loss in Asotin Creek spring/summer Chinook salmon production was due to factors outside of the recovery area. This points out the need for fisheries managers to implement actions that increase fish survival through the hydrosystem and the estuary.

Figure 7-3 also includes EDT-generated abundance and productivity estimates under Properly Functioning Conditions (PFC) and historical habitat conditions (with FCRPS in place), as well as a range of restoration goals expressed solely in terms of abundance. The latter is displayed as a single line in the figure.

VSP Parameters for Major and Minor Spawning Aggregations

The recovery plan shows that the abundance index increases from 254 to 569 (a 124 percent increase), while intrinsic productivity increases from 1.27 to 1.37 (8 percent increase). The life history diversity value more than doubles, as it moves from 32 percent to 79 percent (Figure 7-4).

Summary of Conclusions

Both EDT generated results and empirical data collected in Asotin Creek show low abundance of spring/summer Chinook salmon. EDT estimates that habitat conditions are of sufficient quality to support ~250 adults, but as noted by the ICTRT and confirmed by empirical data, the population is at serious risk of extinction. In fact, the empirical data already indicate that the population is likely functionally extinct, consistent with the ICTRT.

With the implementation of the recovery plan, EDT forecasts that habitat conditions could be improved to support 500 adults. However, to recover this population would require that any remaining spawners be supplemented with hatchery fish. Because the success of such a supplementation program is not known, there is considerable uncertainty as to whether or not the population could ever achieve self-sustaining levels. Thus, the analysis concludes that the population may be recovered so long as the proposed hatchery supplementation program can be successful. Tucannon spring Chinook salmon may be transferred into Asotin Creek as a means of reintroduction into Asotin Creek while expanding the distribution and increasing adult abundance to help the Tucannon population meet highly viable status.

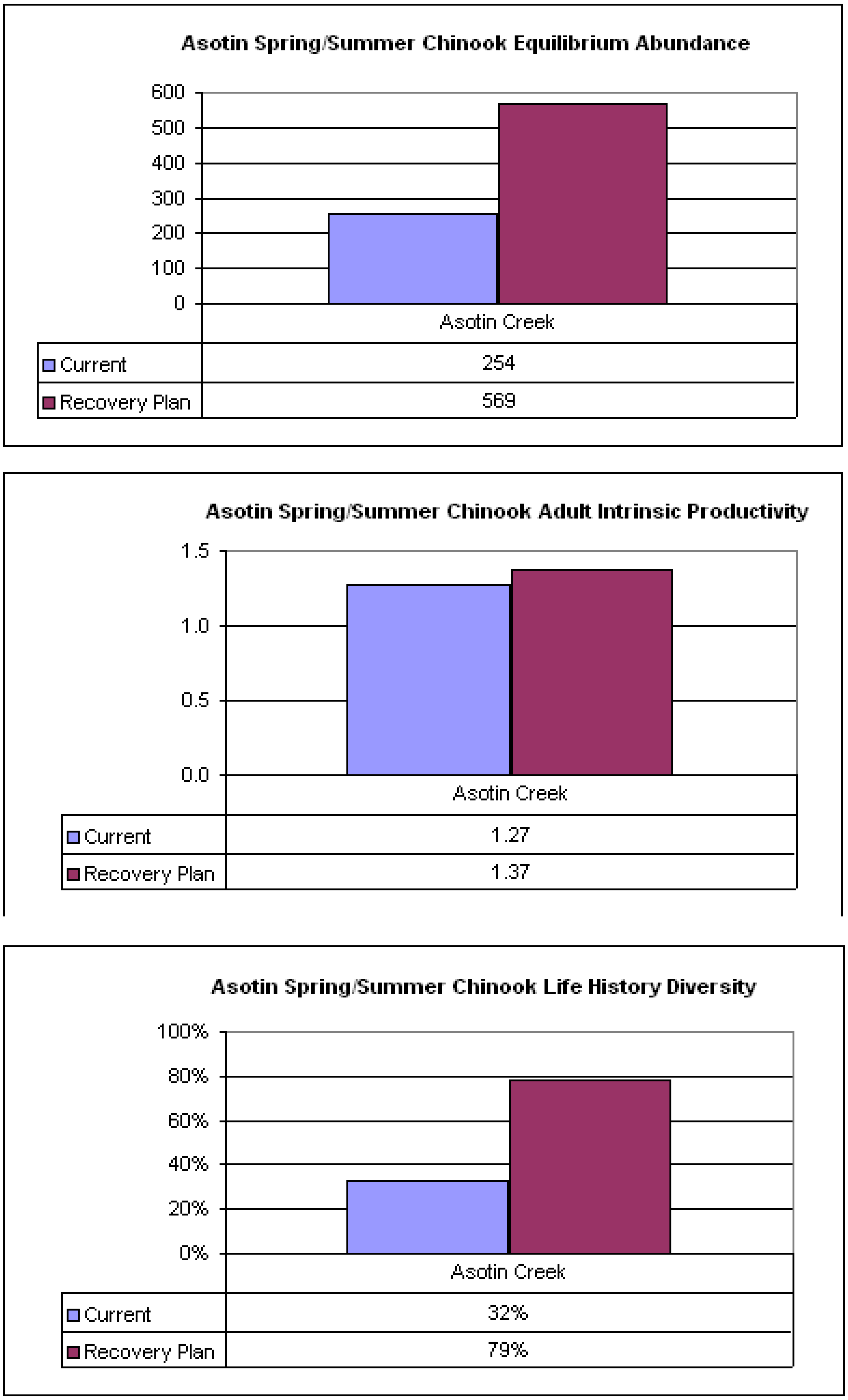


Figure 7-4. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Asotin Spring/Summer Chinook salmon Under Current and Recovery Plan Conditions (2004).

7.3.3 Tucannon River

7.3.3.1 Summer Steelhead

Population Viability

The ICTRT classified the Tucannon River as an intermediate-sized basin for summer steelhead production. Therefore, the basin must support a minimum of 1,000 adults at an intrinsic productivity of 1.25 to achieve the recovery objective for the basin. According to modeling forecasts, the recovery plan is expected to improve adult abundance and productivity by 43 percent and 4 percent, respectively. As shown in Figure 7-5, such changes (labeled “Recovery Plan” in the figure) would likely move the population above the viability curve into a region of relatively low risk.

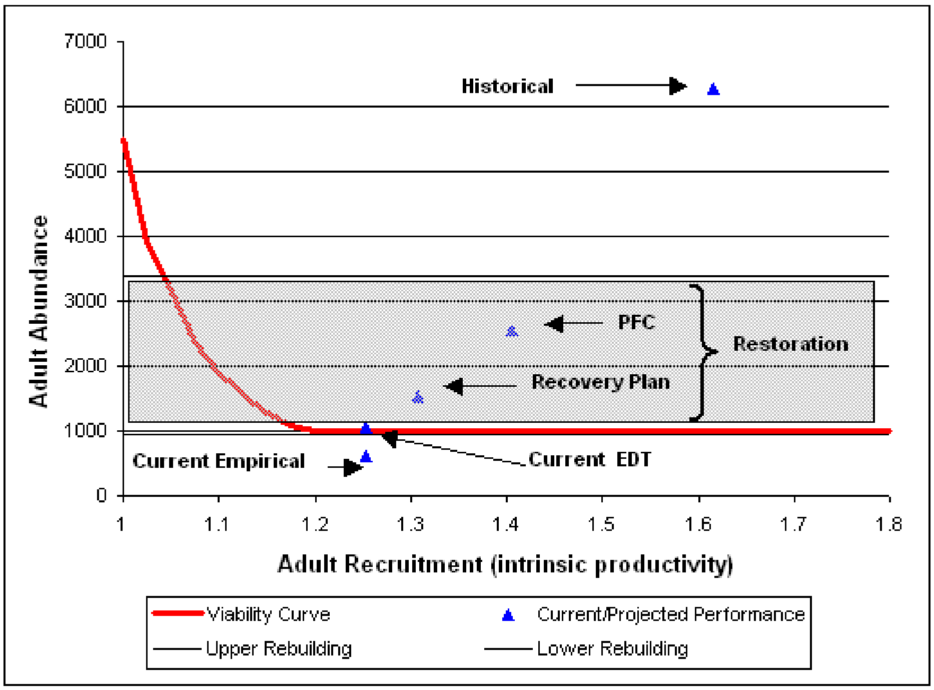
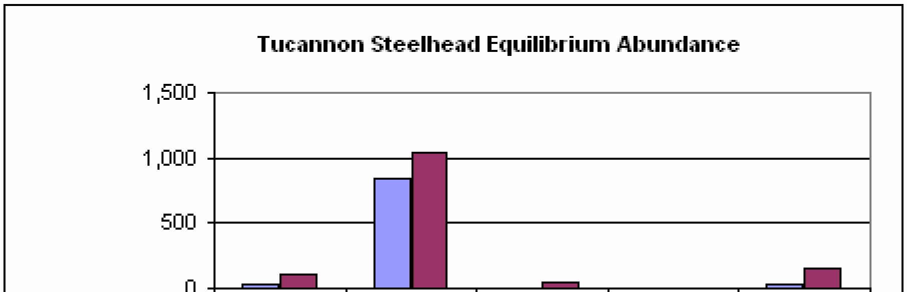


Figure 7-5. EDT Viability Analysis for Tucannon Summer Steelhead Metapopulation (2004).

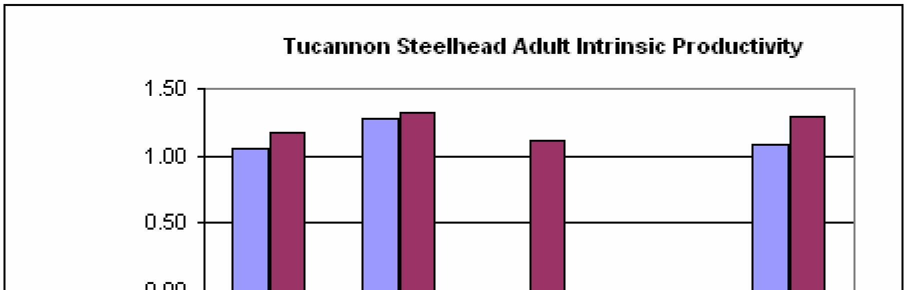
The analysis contained in Hyun and Talbot (2004), however, tempers this positive result. Their population viability analysis indicates that Tucannon steelhead are rapidly declining and at high risk of extinction. While the recent five-year status update from NMFS (Ford et al. 2010) lists Tucannon River steelhead as at high risk for extinction, NMFS does not have the detailed data needed to fully understand exactly where the population is in regards to the risk levels shown in the graph above (for further information on current status, see Appendix B).

VSP Parameters for Major and Minor Spawning Aggregations

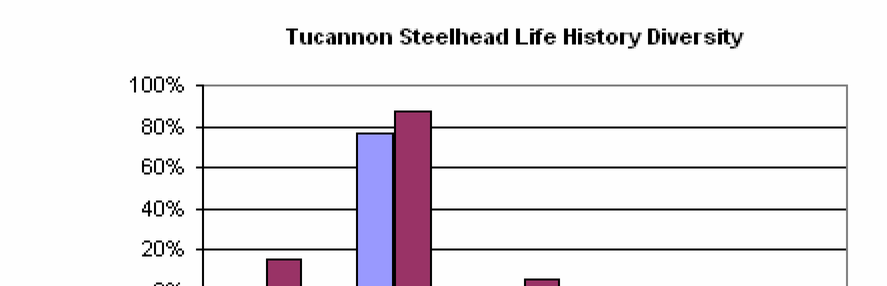
The resulting change in abundance, productivity, and life history diversity for major and minor spawning aggregations is shown in Figure 7-6. The recovery plan increases adult equilibrium or average abundance, intrinsic productivity, and life history diversity in each spawning area. These results show that recovery plan actions are not focused on a single area of the subbasin, but are widely spread. The improvement expected in each VSP parameter should result in increased population viability and a reduction in extinction risk.



	Deadman (Meadow)	Upper Tucannon	Lower Tucannon	Penawawa and Alkali	Pataha Cr
Current	29	836	0		35
Recovery Plan	104	1,047	44		153



	Deadman (Meadow)	Upper Tucannon	Lower Tucannon	Penawawa and Alkali	Pataha Cr
Current	1.05	1.27	0.00		1.09
Recovery Plan	1.17	1.32	1.11		1.29



	Deadman (Meadow)	Upper Tucannon	Lower Tucannon	Penawawa and Alkali	Pataha Cr
Current	1%	76%	0%		1%
Recovery Plan	16%	87%	6%		2%

Figure 7-6. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Tucannon Summer Steelhead Under Current and Recovery Plan Conditions (2004).

The majority of the production is centered on the Upper Tucannon River mainstem, with secondary production from Pataha, Penawawa, and Deadman creeks. This same trend holds true for the intrinsic productivity parameter, and to a lesser extent, life history diversity.

Summary of Conclusions

EDT forecasts that the actions proposed in the SRSRP should be sufficient to recover this population. However, based on empirical estimates of current adult abundance, the opposite conclusion is reached. Thus, it will be important to monitor this population closely over the next 15 years to track not only the effectiveness of implemented actions, but also to estimate resulting adult abundance and productivity.

Regardless if the recovery goal is achieved, the habitat actions proposed are expected to increase steelhead abundance and productivity by 43 percent and 4 percent respectively. This level of improvement would reduce extinction risk significantly.

7.3.3.2 Spring/Summer Chinook

Population Viability

Spring/summer Chinook salmon production in the Tucannon River is not forecast to achieve the viability criteria with the implementation of the recovery plan (Figure 7-7). Although the abundance criterion is achieved, intrinsic productivity falls just below the curve.

Modeling indicates that adult abundance is likely to double if implemented actions achieve full effectiveness. The intrinsic productivity of the population is also expected to increase by 11 percent.

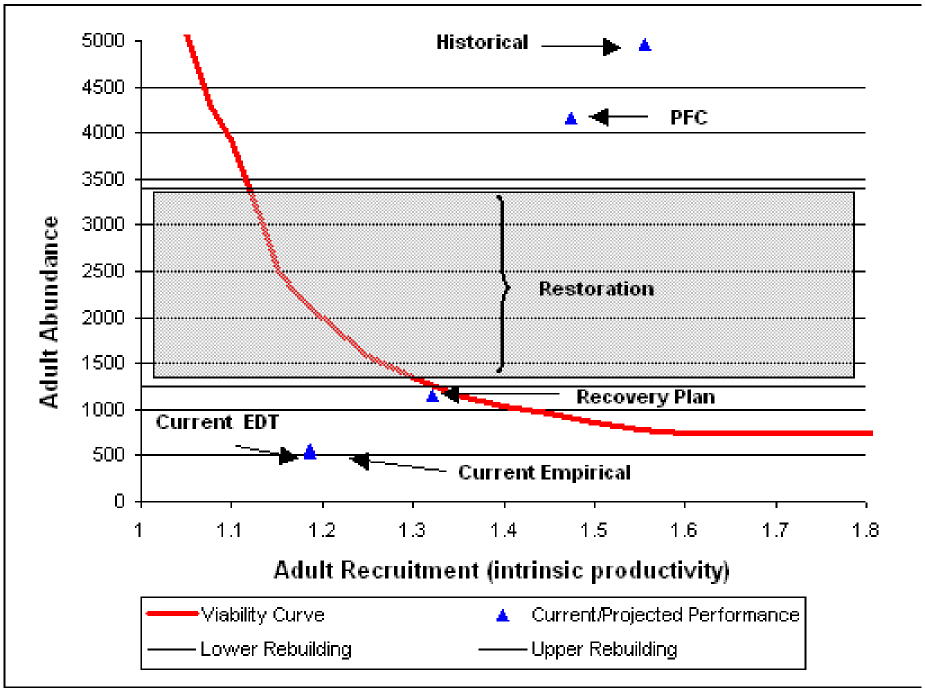


Figure 7-7. EDT Viability Analysis for Tucannon Spring/Summer Chinook salmon (2004).

This result must also be tempered by the Hyun and Talbot (2004) findings. The marginal "success" of the habitat restoration scenario should be weighed against their conclusion that Tucannon spring/summer Chinook salmon are in rapid decline and at serious risk of extinction. Since the late 1990s, the population has increased, ranging between three fish (1999) to 1,443 (2010). The 10-year geomean of abundance is currently 404 (Appendix B). The current 20-year return per spawner (R/S; a measure of productivity) for the Tucannon River spring Chinook salmon is 0.71 (Ford et al. 2010).

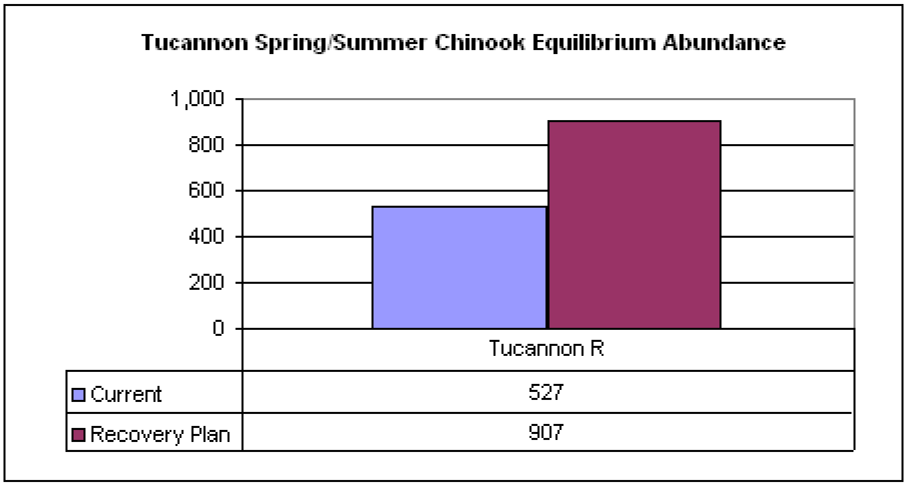
This population was listed at high risk of extinction in the most current status update by NMFS (Ford et al. 2010).

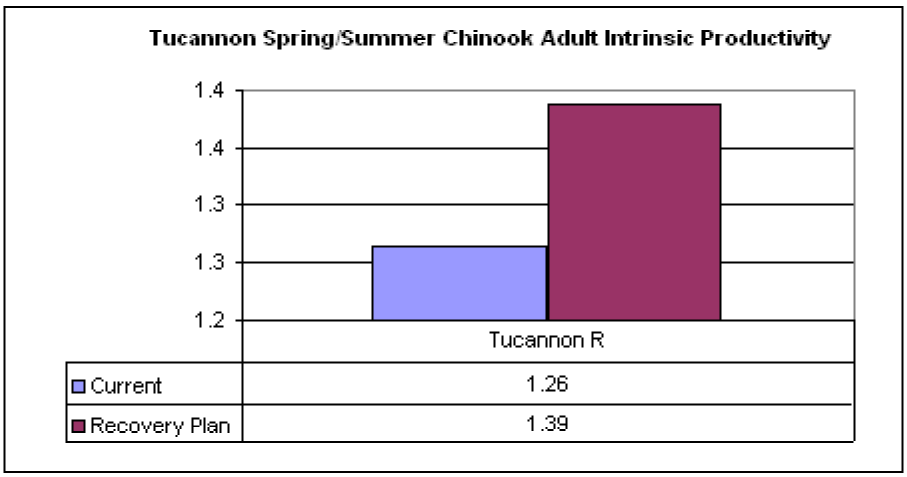
It is important to note, as has been done throughout this Plan, that approximately 25% of the returning Tucannon River adults (hatchery and natural-origin) bypass the Tucannon River and migrate past Lower Granite Dam.

VSP Parameters for Major and Minor Spawning Aggregations

All of the significant improvement in the VSP parameters occurs in the Upper Tucannon MaSA. Habitat changes from the implementation of the recovery plan would have little effect on the Lower Tucannon River or Pataha Creek spawning areas (Figure 7-8), although significant improvements have already occurred to water temperatures and river channel width in the lower Tucannon in the past 10-15 years (Glen Mendel, WDFW, personal communication).

The intrinsic productivity portion of the figure shows that productivity does increase, but values are slightly less than 1.0. Intrinsic productivity values below 1.0 mean that the population cannot be sustained over time. The result is that, in some years of high survival, fish production may occur in these areas; but in average or low survival years, adult production will likely be low to non-existent. Thus, even after full implementation of the recovery plan, Tucannon spring/summer Chinook salmon production will be highly dependent on a single MaSA, leaving the population more vulnerable to catastrophic events that could decimate production, unless the Asotin Creek reintroduction program is successful and they are considered part of the Tucannon population.





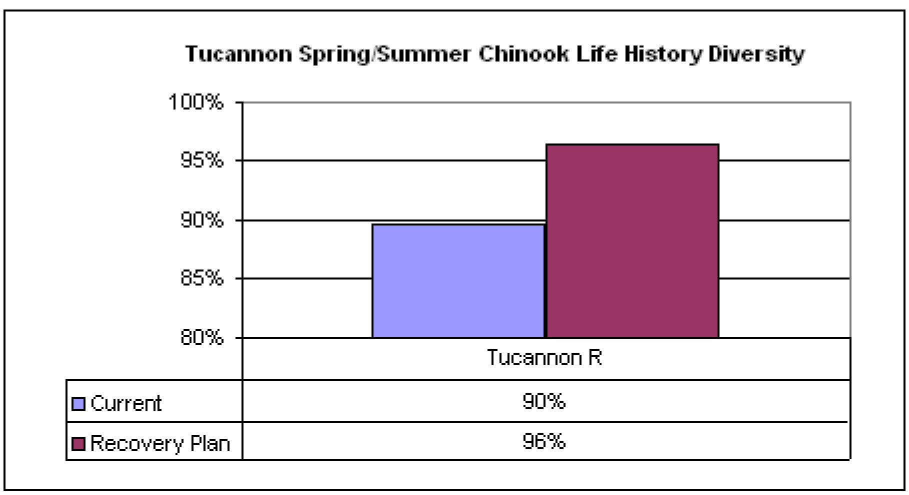


Figure 7-8. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Tucannon River Spring/Summer Chinook Salmon Under Current and Recovery Plan Conditions (2004).

Summary of Conclusions

The 2004 EDT analysis indicates that the recovery plan, although making significant improvements to adult abundance and productivity, would still fall short of achieving recovery the intrinsic productivity objective for this population. It does not account for ~ 24% of adult spring Chinook salmon bypassing the Tucannon River and migrating upstream of Lower Granite Dam. Also, given the uncertain effect hatchery fish are having on fish production in this stream, this conclusion should be considered speculative at this point.

7.3.4 Walla Walla River

The change in the VSP parameters expected for Walla Walla summer steelhead is discussed in this section of the report. Because Walla Walla spring/summer Chinook salmon are not listed under ESA, no VSP analysis is presented for this species.

7.3.4.1 Summer Steelhead

Population Viability

Based on 2004 modeling results, the recovery plan appears likely to achieve the viability criteria identified by the ICTRT for Walla Walla summer steelhead (Figure 7-9). Adult abundance and intrinsic productivity is forecast to increase by 59 percent and 1 percent, respectively. This level of performance improvement is likely to move the population into the Low Risk area of the curve.

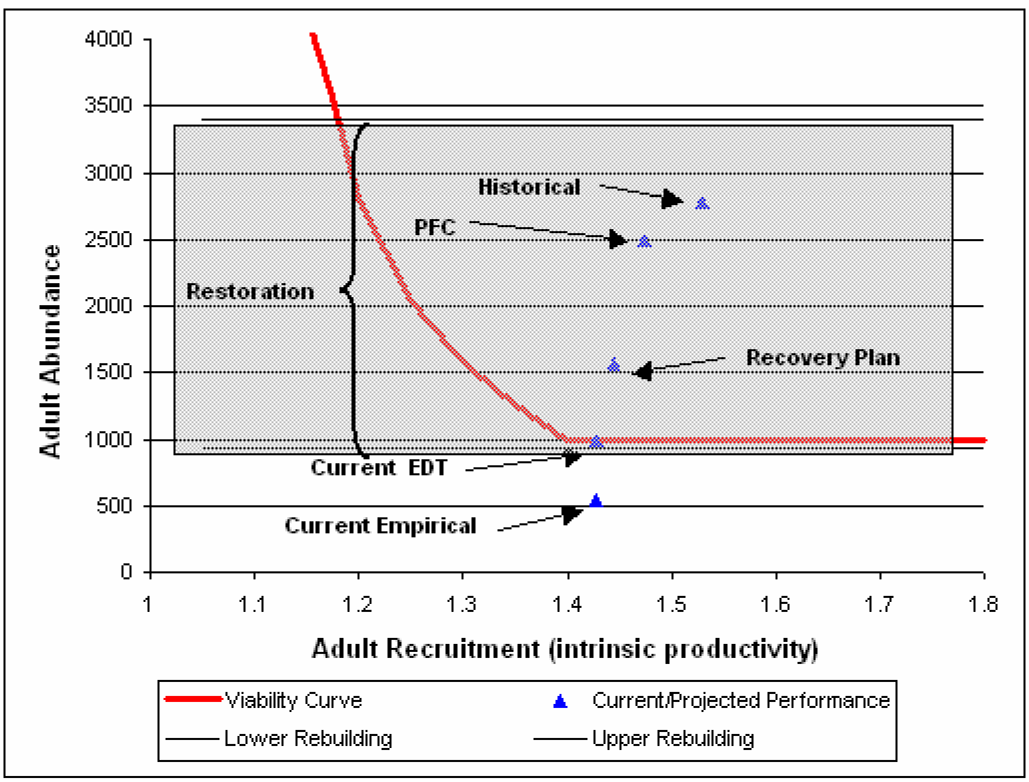
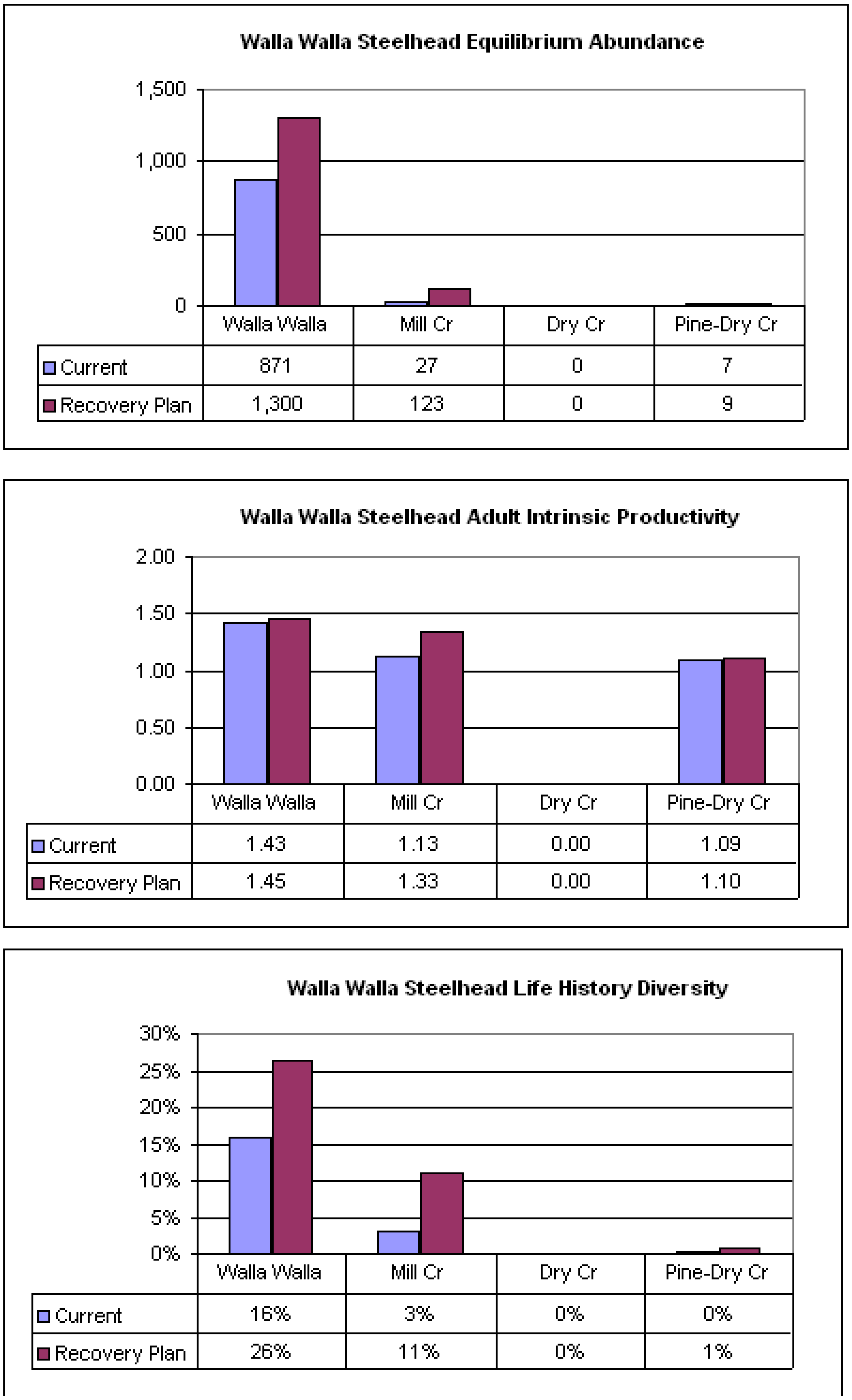


Figure 7-9. EDT Viability Analysis for Walla Walla Summer Steelhead (2004).

These results must be interpreted cautiously. For an updated status of the Walla Walla population, please see Appendix B and NMFS (2009).

VSP Parameters for Major and Minor Spawning Aggregations

With the exception of Dry Creek, the recovery plan increases index values for all VSP parameters in all spawning areas (Figure 7-10).



Walla Walla Steelhead Equilibrium Abundance

	Walla Walla	Mill Cr	Dry Cr	Pine-Dry Cr
Current	871	27	0	7
Recovery Plan	1,300	123	0	9

Walla Walla Steelhead Adult Intrinsic Productivity

	Walla Walla	Mill Cr	Dry Cr	Pine-Dry Cr
Current	1.43	1.13	0.00	1.09
Recovery Plan	1.45	1.33	0.00	1.10

Walla Walla Steelhead Life History Diversity

	Walla Walla	Mill Cr	Dry Cr	Pine-Dry Cr
Current	16%	3%	0%	0%
Recovery Plan	26%	11%	0%	1%

Figure 7-10. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Walla Walla Summer Steelhead Under Current and Recovery Plan Conditions (2004).

The majority of the production is expected to occur in the mainstem and forks of the Walla Walla River. The removal of obstruction problems in Mill Creek would result in increased production in this spawning aggregation. Intrinsic productivity would increase the most in Mill Creek and the Walla Walla mainstem. This same trend is evident between areas for life history diversity.

Summary of Conclusions

The 2004 EDT modeling forecasts that the recovery plan would likely meet recovery objectives defined by the ICTRT for this population. Although empirical data suggest that current steelhead abundance levels are lower than what EDT estimates for this population, the 59 percent improvement in abundance forecast by EDT, when added to the empirical estimate, would still move the population very close to the low risk portion of the viability curve.

7.3.4.2 Touchet River

The ICTRT defined the Touchet River as an intermediate-sized basin with a target goal of 1,000 summer steelhead.

Population Viability

The recovery plan improves summer steelhead population abundance and intrinsic productivity by 97 percent and 6 percent, respectively. However, even with this level of improvement, resulting fish production falls short of meeting the ICTRT defined viability criteria (Figure 7-11). At this level, the ICTRT would still consider the population to have a high risk of extinction, although the risk is substantially less than before plan implementation (note that the empirical estimate below does not adequately account for the areas downstream of Dayton and several tributaries).

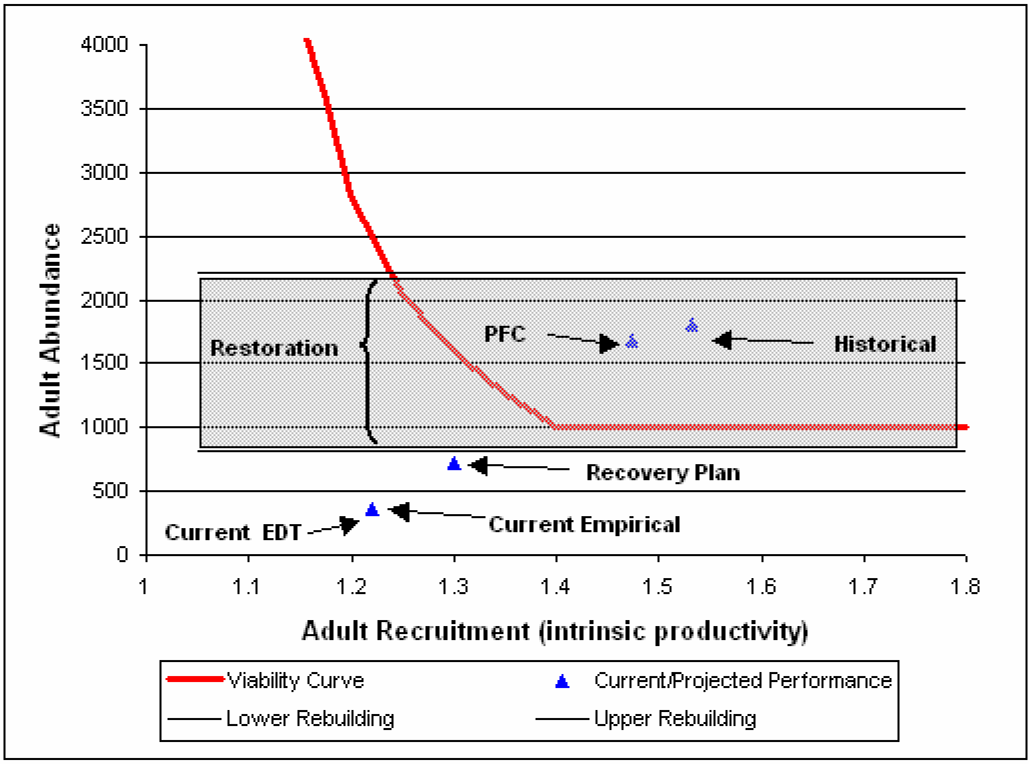


Figure 7-11. EDT Viability Analysis for Touchet Summer Steelhead.

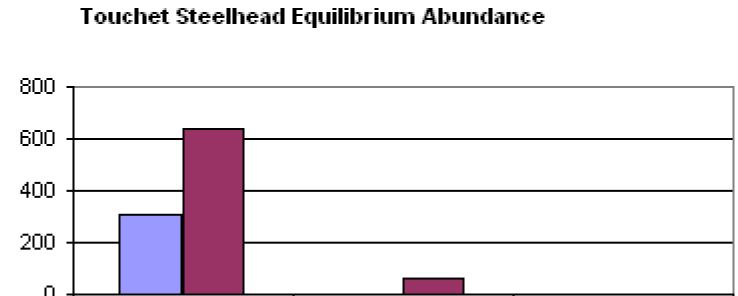
To achieve the viability criteria, adult summer steelhead abundance would need to be increased by an additional 40 percent. This increase in fish abundance could be achieved with more habitat actions, improvements in one of the other "Hs" (harvest, hydro, or hatcheries), or a combination of such actions.

The 2004 EDT results indicate that the viability benefits of habitat restoration in the Touchet drainage would be much lower than those in the Walla Walla. This would likely be due to the fact that the restoration agenda for the Walla Walla is more ambitious than that for the Touchet, and the lower Touchet River below Waitsburg would generally not contribute to production. The relative difference in restoration effort plus the assumed future full use of the large production potential of the North and South forks of the Walla Walla are the most reasonable explanations for the discrepancy. For an up to date analysis, please see NMFS (2009)

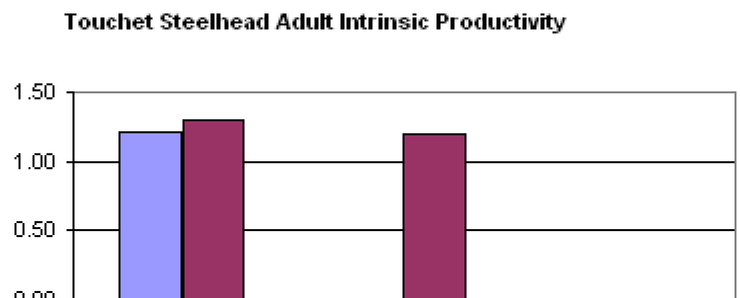
As is the case with most populations in the recovery area, there is considerable uncertainty regarding current population levels and their intrinsic productivity. As more data are collected as part of the monitoring plan described in Appendix C, the conclusions reached in this report would be updated and refined.

VSP Parameters for Major and Minor Spawning Aggregations

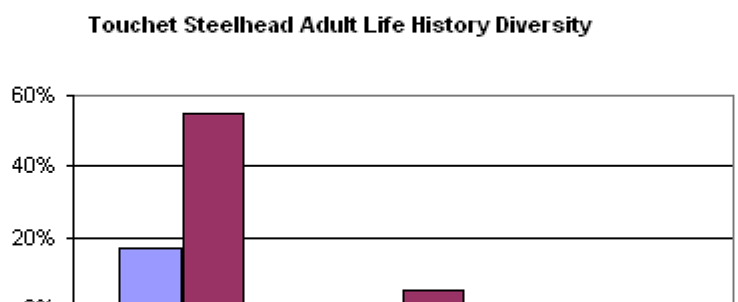
Resulting VSP index values for Touchet River summer steelhead major and minor spawning aggregations are presented in Figure 7-12. Most of the improvement in summer steelhead performance occurs in the Upper Touchet MSA. Under the recovery plan, Upper Touchet summer steelhead abundance, intrinsic productivity, and life history diversity increases by 106 percent, 7 percent, and 224 percent, respectively.



	Upper Touchet R	Middle Touchet R	Patit
Current	310	0	0
Recovery Plan	638	63	0



	Upper Touchet R	Middle Touchet R	Patit
Current	1.21	0.00	0.00
Recovery Plan	1.30	1.19	0.00



	Upper Touchet R	Middle Touchet R	Patit
Current	17%	0%	0%
Recovery Plan	55%	5%	0%

Figure 7-12. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Touchet Summer Steelhead Under Current and Recovery Plan Conditions (2004).

The recovery plan also increases productivity in the Lower Touchet River to a level that can sustain limited summer steelhead production (63 adults). The recovery plan thereby increases the spatial structure (distribution) of the population, which should reduce extinction risk.

No improvement is seen in the Patit Creek portion of the population because actions were not targeted to this area. Patit Creek will, however, be protected from further degradation through the enforcement of existing laws and regulations.

It is important to note that the 2004 analysis did not consider Coppei Creek, which is being currently used by the Touchet River steelhead population.

Summary of Conclusions

Based on the 2004 EDT forecasts, the actions proposed in the recovery plan do not appear sufficient to achieve the recovery objectives developed by the ICRT. However, a more up to date analysis is presented in NMFS (2009).

7.3.5 Joseph Creek (Grande Ronde)

7.3.5.1 Summer Steelhead

Population Viability

The majority of Joseph Creek is located in Oregon. Improvement in summer steelhead production in this stream will require habitat actions in both Washington and Oregon. Based on current stock status and actions proposed for both states, summer steelhead production is expected to meet ICTRT viability criteria. Summer steelhead adult abundance and intrinsic productivity is forecasted to increase by 197 percent and 19 percent, respectively (Figure 7-13).

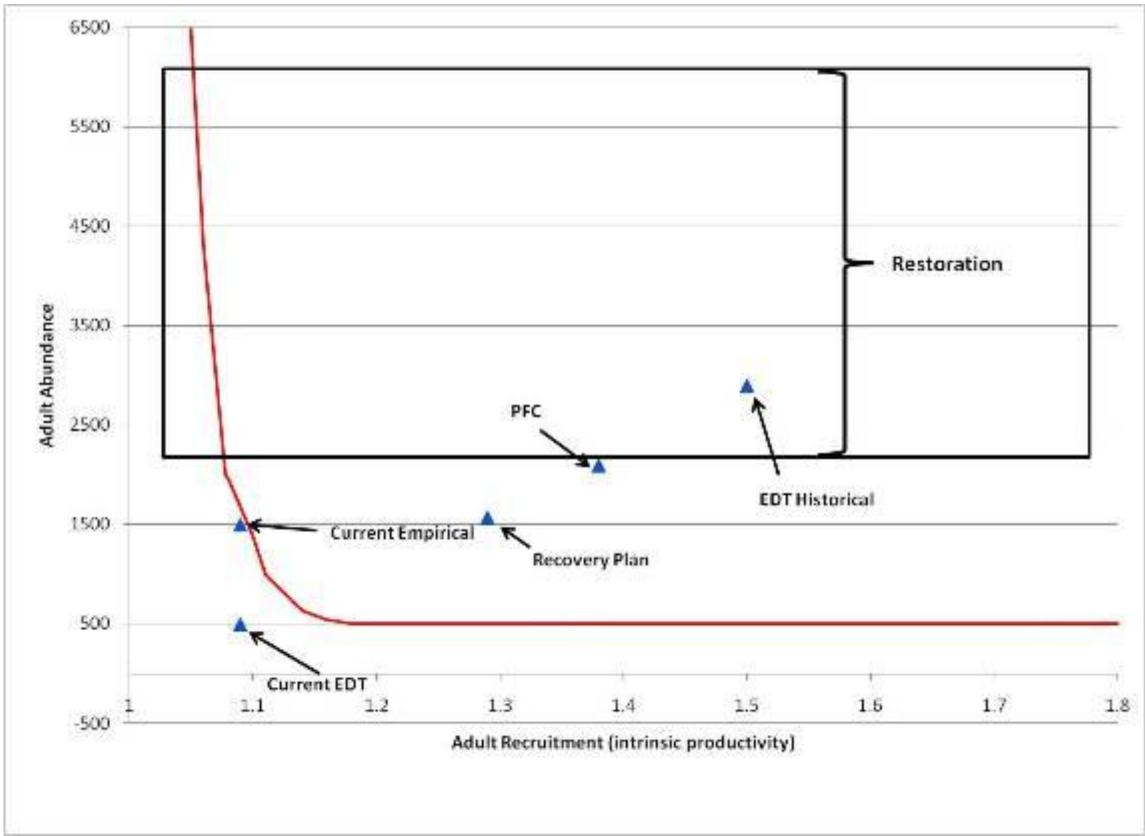
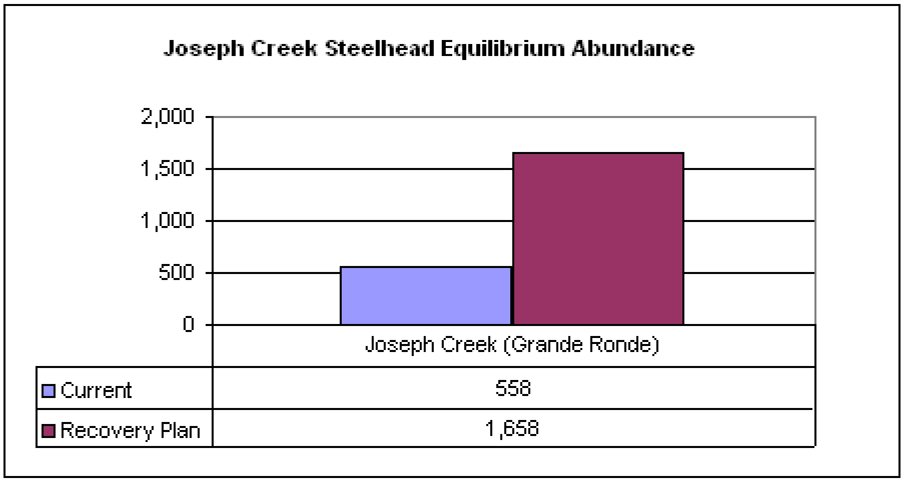


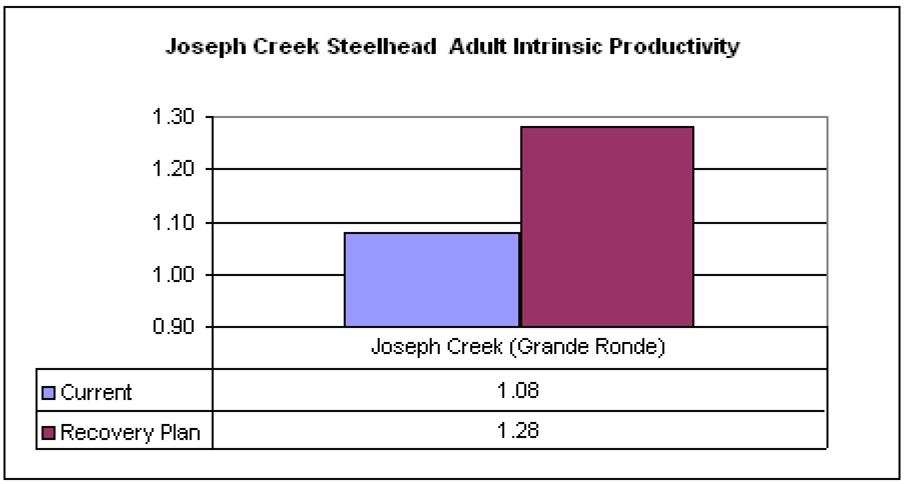
Figure 7-13. EDT Viability Analysis for Joseph Creek (Grande Ronde) Summer Steelhead (2004).

NFMS recent status update (Ford et al. 2010) suggests that the Joseph Creek population is highly viable. The EDT results shown in Figure 7-13 could be considered conservative.

VSP Parameters for Major and Minor Spawning Aggregations

Joseph Creek contains a single MaSA. EDT forecasted change in abundance, intrinsic productivity, and life history diversity is shown in Figure 7-14. The plan results in an increase in abundance, intrinsic productivity and life history diversity of 197 percent, 19 percent, and 69 percent (or 35 percentage points), respectively. If achieved, improvement in the VSP parameters will significantly reduce extinction risk for this population.





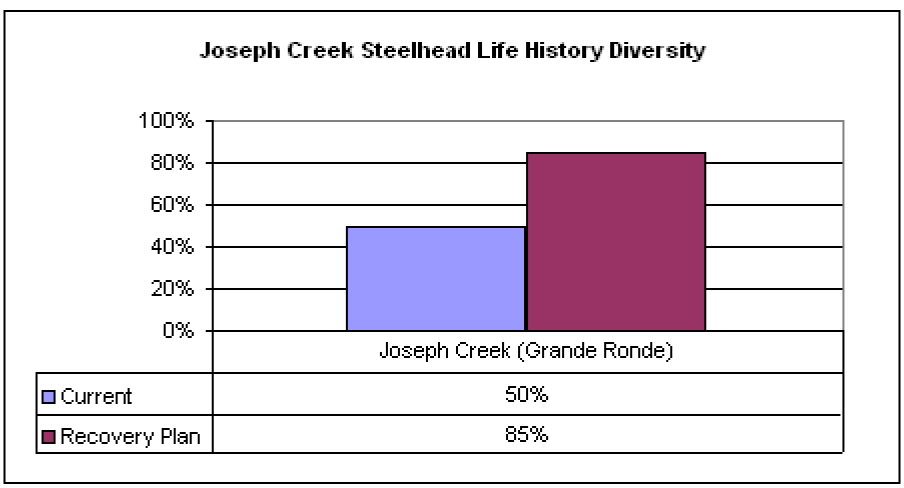


Figure 7-14.   Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity and Life History Diversity for Joseph Creek Summer Steelhead Under Current and Recovery Plan Conditions (2004).

Summary of Conclusions

Existing empirical data suggests that this population is already at recovery objectives; therefore, it is expected that the actions in this plan would further ensure that this status is maintained.

7.3.6 Lower Grande Ronde River

The Lower Grande Ronde River population includes the Wenaha River and several small tributaries in the lower portion of the subbasin. This grouping of streams applies only to the summer steelhead population. The Wenaha River was designated as a separate population for spring/summer Chinook under the assumption that few, if any, spring/summer Chinook salmon use the smaller tributaries.

7.3.6.1 Summer Steelhead

Population Viability

The Lower Grande Ronde summer steelhead population may be meeting the population viability criteria in terms of 2004 EDT projections (Figure 7-15), with or without recovery plan actions. Chilcote (2001) concluded that Lower Grande Ronde steelhead abundance not only surpasses viability criteria, but equals maximum sustained yield (MSY) seeding. However, NMFS (Ford et al. 2010) was unable to confirm the population's status because of lack of empirical information. For additional more up to date information see the draft recovery plan for Oregon spring/summer Chinook salmon and steelhead populations in the Snake River ESU and DPS (NMFS, in prep.).

The results of the viability analysis are not surprising given that the Wenaha River Basin is in relatively pristine condition. Because it is undisturbed, the recovery plan has targeted this stream for protection rather than restoration.

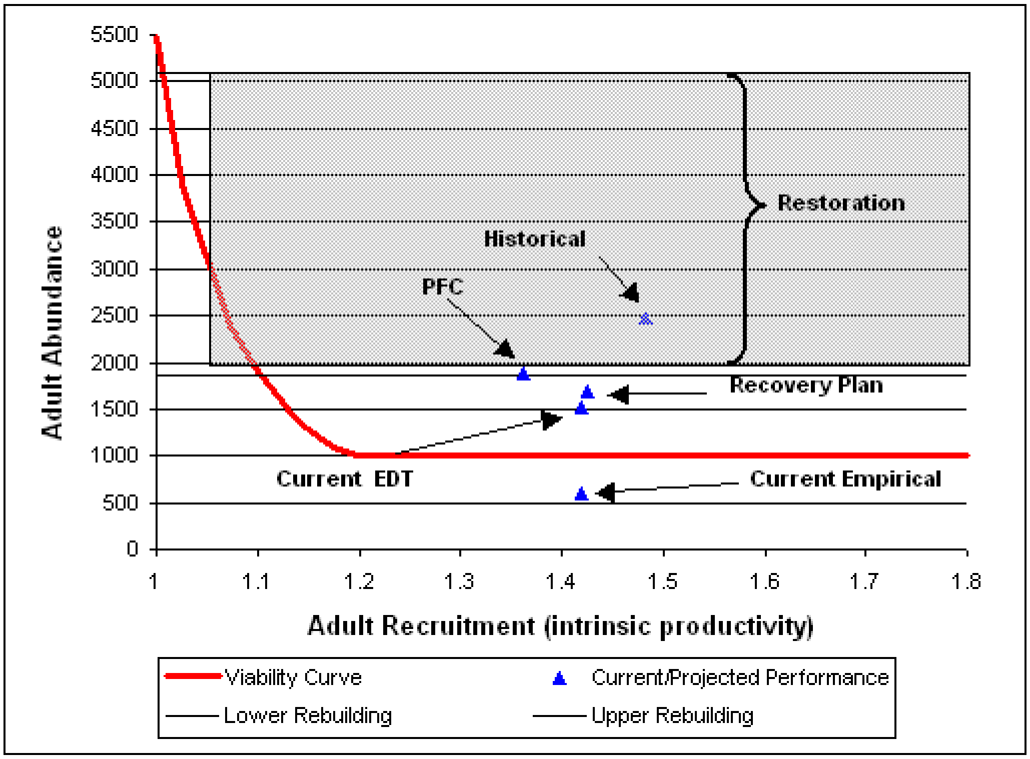
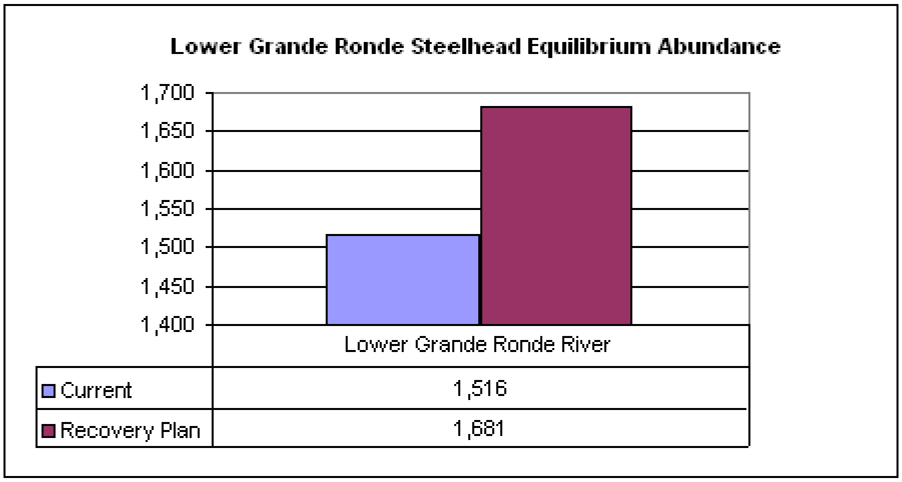
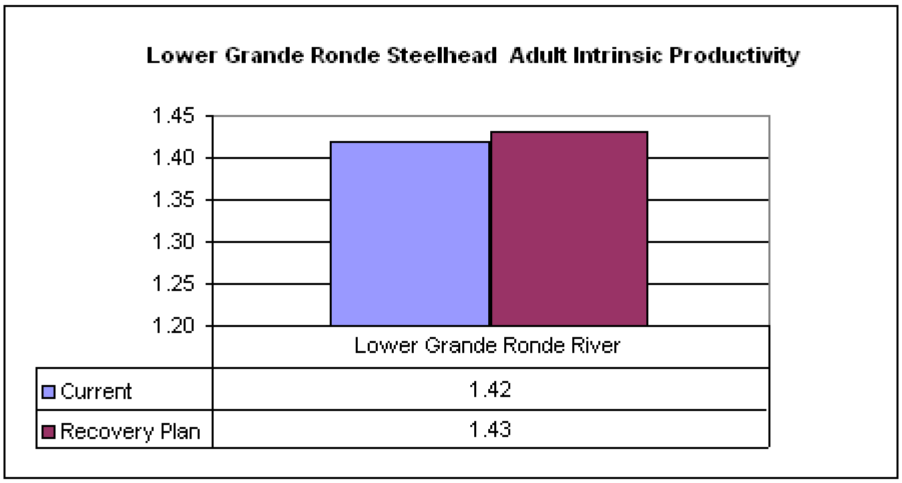


Figure 7-15. EDT Viability Analysis for Lower Grande Ronde Summer Steelhead (2004).

VSP Parameters for Major and Minor Spawning Aggregations

If recovery actions are as effective as the model indicates, adult abundance, intrinsic productivity, and life history diversity in the Lower Grande Ronde should increase by 11 percent, 1 percent and 40 percent (or 18 percentage points), respectively (Figure 7-16). Increases in all three VSP parameters should reduce extinction risk, while at the same time increasing the ability of the population to recover more quickly from periods of poor ocean or freshwater survival.


Lower Grande Ronde Steelhead Equilibrium Abundance
1,700
1,650
1,600
1,550
1,500
1,450
1,400
Lower Grande Ronde River
Current
1,516
Recovery Plan
1,681


Lower Grande Ronde Steelhead Adult Intrinsic Productivity
1.45
1.40
1.35
1.30
1.25
1.20
Lower Grande Ronde River
Current
1.42
Recovery Plan
1.43

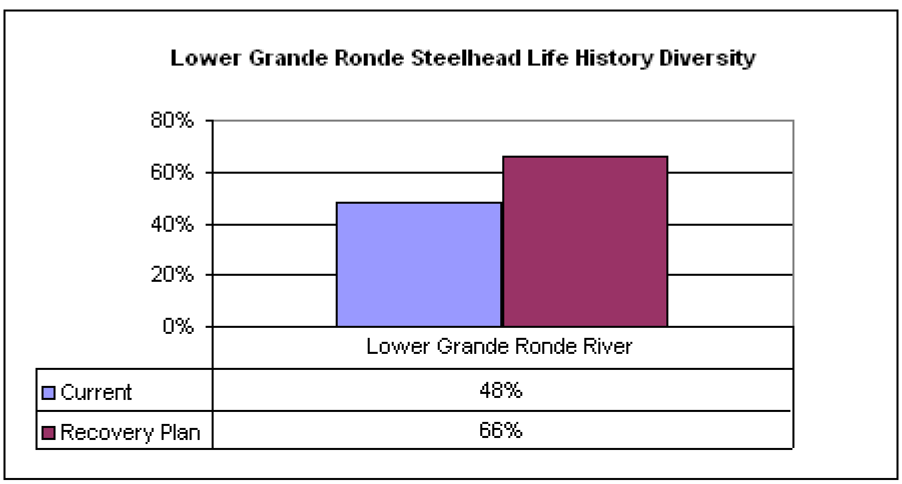

Lower Grande Ronde Steelhead Life History Diversity
80%
60%
40%
20%
0%
Lower Grande Ronde River
Current
48%
Recovery Plan
66%

Figure 7-16. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity, and Life History Diversity for Lower Grande Ronde Summer Steelhead Under Current and Recovery Plan Conditions (2004).

Summary of Conclusions

The EDT analysis concluded that current population abundance and productivity achieves the recovery criteria set forth by the ICTRT. NMFS (in prep.) assumed that productivity was similar for this population compared to other Grande Ronde populations, but did not speculate on abundance levels.

7.3.6.2 Spring/Summer Chinook

No recovery actions are proposed for the Wenaha River Basin because most of it is within designated wilderness. Therefore, population viability is expected to be the same for current conditions and for the Recovery Plan (Figure 7-17)[23]. Neither abundance nor productivity will achieve the viability criteria identified by the ICTRT. If modeling results are accurate, given the relatively pristine condition of the Wenaha River, only actions outside of the subbasin could increase survival sufficiently to achieve the viability criteria.

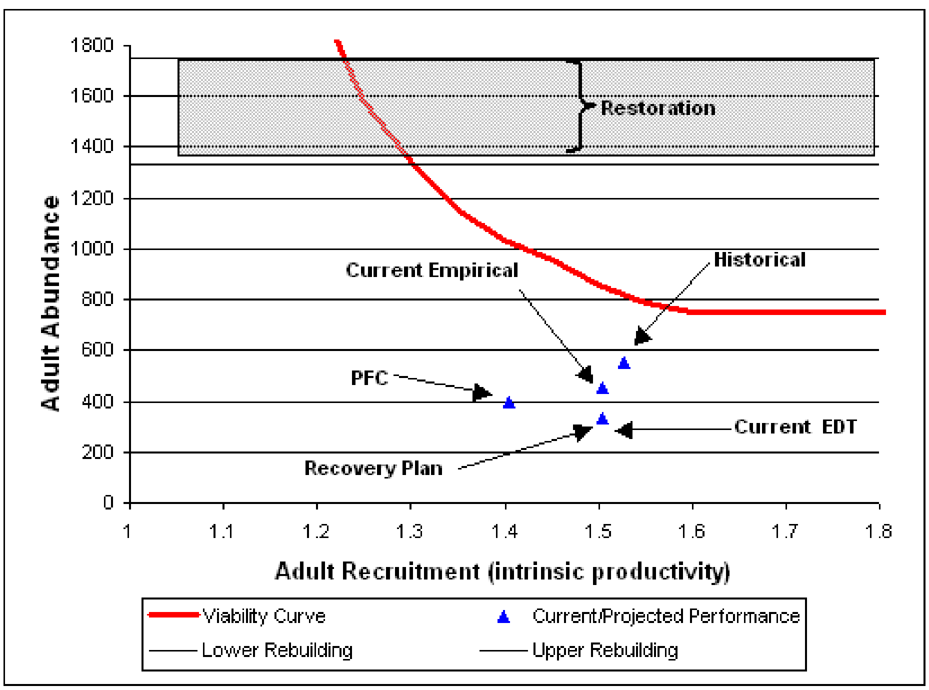


Figure 7-17. EDT Viability Analysis for Wenaha River Spring/Summer Chinook (2004).

The most current status of this population can be found in Appendix B and Ford et al. (2010). This population is still considered by NMFS to be at high risk.

[23] It should be noted, that while the primary strategy for this population is preservation of current good habitat within the Wenaha Basin, out-of-basin improvements should increase viability of this population.

VSP Parameters for Major and Minor Spawning Aggregations

The Wenaha River was defined as a single MSA by the ICTRT. As can be seen in Figure 7-18, the change in the VSP parameters is expected to be quite low.

Summary of Conclusions

Because no actions are proposed to improve habitat in the Wenaha River basin as part of this plan, no improvement in fish performance is expected with plan implementation, but improvement may occur because of migration corridor improvements. The existing empirical, as well as analyses completed by others, show that current spring/summer abundance in the Wenaha River is less than the abundance level established by the ICTRT. Because of this, it is assumed that the recovery plan would not achieve the recovery objectives. However, because there is missing data on Wenaha River spring/summer Chinook salmon distribution and abundance, results of stream surveys conducted as part of the monitoring program (Appendix C) would be used to update this conclusion as they become available.

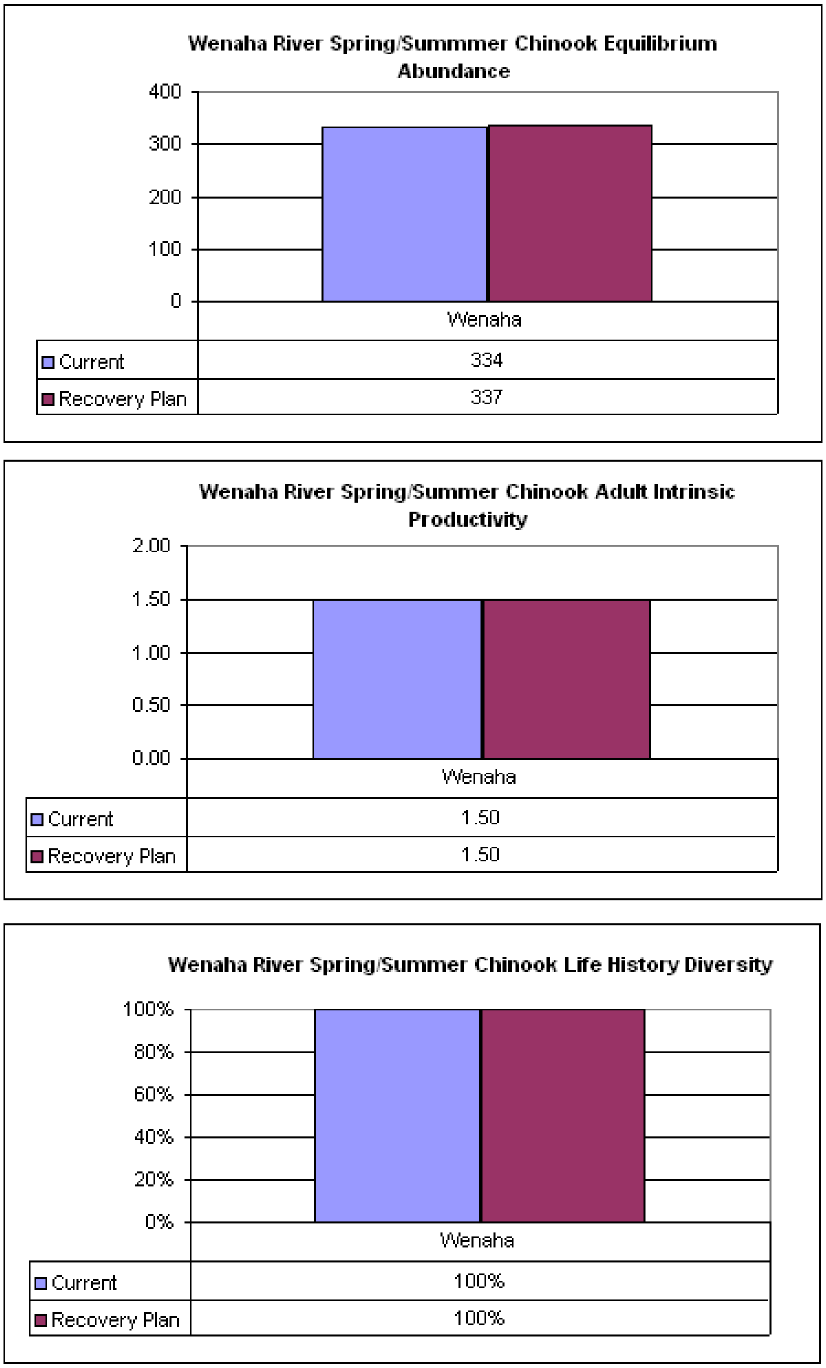


Figure 7-18. Viability Curve Modified EDT Index Values of Abundance, Intrinsic Productivity, and Life History Diversity for Wenaha River Spring/Summer Under Current and Recovery Plan Conditions (2004).

8 REFERENCES

Araki, H., Berejikian, B.A., Ford, M.J., and Blouin, M.S. 2008. Fitness of hatchery-reared salmonids fish in the wild. Evol. Appl., **1**(2): 342–355. doi:10.1111/j.1752-4571.2008.00026.x.

Asotin County Conservation District (ACCD). 2001. Draft: Asotin Creek Subbasin Summary. Prepared for Northwest Power Planning Council, Portland, Oregon.

Asotin County Conservation District (ACCD). 2004. Asotin Subbasin Plan. Prepared for the Northwest Power and Conservation Council. 205 pages

Asotin County. 1997. Asotin County geography and brief history of Asotin County. Retrieved March 11, 2004, from http://www.co.asotin.wa.us.

Asotin Creek Model Watershed Plan (ACMWP). 1995. Prepared by the Asotin Creek Landowner Steering Committee with assistance from the Technical Advisory Committee of the Asotin Creek Model Watershed. Prepared for the Asotin County Conservation District.

Bauer, H.H. and J.J. Vaccaro. 1990. Estimates of ground-water recharge to the Columbia Plateau regional aquifer system, Washington, Oregon, and Idaho, for predevelopment and current land-use conditions. U.S. Geological Survey Water-Resources Investigations Report 88-4108.

Baxter, C.V. 2002. Fish movements and assemblage dynamics in a Pacific Northwest Riverscape. Doctoral dissertation, Oregon State University, Corvallis, Oregon.

Beamish, R.J. [ed.] 1995. Climate change and northern fish populations. Can. Spec. Publ. Fish. Aquat. Sci. 127. 739 pages.

Behnke, R.J. 2002. Trout and Salmon of North America. The Free Press, New York, New York.

Bishop, E.M. 2003. In Search of Ancient Oregon: A Geological and Natural History. Timber Press, Portland, OR, and Cambridge, England, UK.

Blankenship, and G. Mendel. 2010. Genetic Characterization of Adult Chinook Trapped in lower Asotin Creek. WDFW, http://wdfw.wa.gov/publications/01137/wdfw01137.pdf 12 pages.

Bodeutsch, G. 1999. State of Washington County Profiles. Retrieved March 11, 2004, from http://www.wa.gov/esd/lmea/pubs/profiles/profiles.htm.

Bryant F. G. and Z. E. Parkhurst. 1950. "Survey of the Columbia River and its Tributaries; Part 4: Area III Washington Streams from the Klickitat and Snake Rivers to Grand Coulee Dam, with Notes on the Columbia and its Tributaries Above Grand Coulee Dam." U.S. Fish and Wildlife Service Special Scientific Report: Fisheries No. 37, 108 pp.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife.

Bumgarner, J., and J. Dedloff 2009. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead Annual Report 2006 and 2007 Run Year to USFWS Lower Snake River Compensation Plan Office.

California Department of Fish and Game (CDFG). 2002. July 2002 Review Draft Russian River Basin – fisheries restoration plan. Retrieved April 26, 2004, from http://hopland.uchrec.org/ihrmp/publications/draftbp/BASINP.0702.07.FishHab.pdf.

Chapman, D. W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transactions of the American Fisheries Society 115:662-670.

Cheng, Y.W. and M. P. Gallinat. 2004. Statistically analysis of the relationship among environmental variables, inter-annual variability and smolt trap efficiency of salmonids in the Tucannon River. Fisheries Research 70: 229-238.

Chilcote, M.W. 2001. Conservation assessment of steelhead populations in Oregon (unpublished). Natural Production Section, ODFW, Portland, Oregon.

Chilcote, Mark M.W., K.W. Goodson, and M.R. Falcy. 2011. Reduced recruitment performance in natural populations of anadromous salmonids associated with hatchery-reared fish. Can. J. Fish. Aquat. Sci. **68**:511-522.

Christie, M. R., M. L. Marine, and M. S. Blouin 2011. Who are the missing parents? Grandparentage analysis identifies multiple sources of gene flow into a wild population. Molecular Biolog 14 pages.

Columbia Conservation District (CCD). 2004. Tucannon Subbasin Summary. Prepared for Northwest Power Planning Council, Portland, Oregon. 209 pages.

Confederated Tribes of the Umatilla Indian Reservation. 2004. Our History & Culture, Part 1. Retrieved March 13, 2004, from http://www.umatilla.nsn.us.

Connell, J.H. 1978. Diversity in tropical rain forests and coral reefs. Science 99:1302–1310.

Connor, W. P., J. G. Sneva, K.F. Tiffan, R. K. Steinhorst, and D. Ross. 2005. Two alternative juvenile life history types for fall Chinook salmon in the Snake River basin. Transactions of the American Fisheries Society 134:291-304.

Coronado, C. and R. Hilborn, (1998) Spatial and temporal factors affecting survival in coho and fall chinook salmon in the Pacific Northwest. Bulletin of Marine Science 62(2):409-425.

Covert, J., J. Lyerla, and M. Ader. 1995. Initial watershed assessment: Tucannon River watershed, part of water resources inventory area 35. Open file report 95-04. Washington State Department of Ecology, Seattle, Washington.

Dayton, Washington. 2004. A Brief History of Dayton, Washington & Columbia County; area profile. Retrieved March 13, 2004, from http://www.historicdayton.com.

Drost, B.W., and Whiteman, K.J. 1990. The Geologic Framework of the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho: U.S. Geological Survey Water-Resources Investigations Report 87-4238.

Economic & Engineering Services (EES). 1994. Walla Walla/College Place Coordinated Water System Plan. Prepared for the Cities of Walla Walla and College Place, Washington.

Economic & Engineering Services (EES). 2002. WRIA 32, Walla Walla Watershed Level 1 Assessment. Prepared for Walla Walla County, Washington.

Economic & Engineering Services (EES). 2004. WRIA 35-Middle Snake River Watershed Level I Assessment. Prepared for Asotin County, Washington.

Ehrenreich, J. H. and J.M. Aikman. 1963. An ecological study of the effect of certain management practices on native prairie in Iowa. Ecological Monographs. 33(2): 113-130.

Faler, M. P., G. Mendel, and C. Fulton. 2008. Evaluation of Bull Trout Movements in the Tucannon and Lower Snake Rivers Project Completion Summary (2002 through 2006). Prepared for U.S. Department of Energy, Bonneville Power Administration (BPA), Project number 2002-006-00.

Faler, M., G. Mendel, C. Fulton. 2004. Evaluate Bull Trout Movements in the Tucannon and Lower Snake Rivers. Project 2002-00600. BPA Report DOE/BP-00009774-1.

Fish Passage Center (FPC). 1986. Compilation of salmon and steelhead losses in the Columbia Basin. Northwest Power Planning Council, Portland, Oregon.

Ford M.J. (ed.), Cooney T, McElhany P, Sands N, Weitkamp L, Hard J, McClure M, Kope R, Myers J, Albaugh A, Barnas K, Teel D, Moran P, Cowen J. 2010. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Northwest. Draft U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NWFSC-XXX.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology, and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Northwest Science 63: 133-143.

Franklin, J.F and C.T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Gallinat, M. P, and L. A. Ross. 2009. Tucannon River spring Chinook hatchery evaluation program. 2008 Annual Report. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID

Goetz, F.A. 1989. Biology of bull trout, Salvelinus confluentus, a literature review. U.S. Department of Agriculture, Forest Service, Willamette Nat. Forest, Eugene, Oregon.

Good, T. P., R.S. Waples, and P. Adams (editors). 2005. Updated status of Federally listed ESUs of West Coast salmon and steelhead. U.S. Commerce. NOAA Technical Memo. NMFS-NWFSC-66, 598p. Available at http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-allspecies.pdf

Governor's Salmon Recovery Office. 1999. Statewide strategy to recover salmon – summary. Retrieved April 21, 2004, from http://www.governor.wa.gov/gsro/strategy/summary.htm.

Haas, G. 2001. The mediated associations and preferences of native bull trout and rainbow trout with respect to maximum water temperature, its measurement standards, and habitat. In: M.K. Brewin, A.J. Paul, and M. Monita (Ed), Friends of the Bull Trout II Conference Proceedings. Bull Trout Task Force (Alberta), Calgary, AB, Canada.

Hatchery Scientific Review Group (HSRG). 2009. System-Wide Report on Columbia River Basin Hatchery Reform. Available at http://www.hatcheryreform.us/hrp/welcome_show.action

Hayes, G. E., and J. B. Buchanan. 2002. Washington State status report for the peregrine falcon. Washington Department of Fish and Wildlife-Wildlife Program.

Healey, M. C. 1991. Life history of Chinook salmon (Oncorhynchus tshawytscha). In: C. Groot and L. Margolis, ed. Life histories of Pacific salmon. University of British Columbia, Vancouver, B.C.

Hecht, B., R. Enkeboll, C. Ivor, and P. Baldwin. 1982. Sediment transport, water quality, and changing bed conditions, Tucannon River, Southeastern Washington. USDA, Soil Conservation Service, Spokane, Washington.

Hemmingsen, A.R., S.L. Gunckel, P.M. Sankovich, and P.J. Howell. 2002. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon. U.S. Department of Energy, Bonneville Power Administration Environment, Fish and Wildlife, Portland, Oregon.

Hruby, T., S. Stanley, T. Granger, T. Duebendorfer, R. Friesz, B. Lang, B. Leonard, K. March, and A. Wald. 2000. Methods for assessing wetland functions, Volume II: Depressional wetlands in the Columbia Basin of eastern Washington. WA State Department of Ecology Publication #00-06-47.

Hyun, S-Y. and A. Talbot. 2004. Prioritization of naturally produced Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O.mykiss*) populations based on population trends. Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

Independent Scientific Advisory Board (ISAB). 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. ISAB Climate Change Report, ISAB 2007-2. May 11, 2007.

Independent Scientific Group. 2000. Return to the River 2000: restoration of salmonid fishes in the Columbia River Ecosystem. NPPC 2000-12, Northwest Power Planning Council, Portland, Oregon.

Interactive Biodiversity Information System (IBIS). March 2004. Wildlife--habitat relationships and regional habitat classifications. Retrieved March 2004 from http://www.nwhi.org/ibis/home/ibis.asp.

Interior Columbia Basin Technical Recovery Team. 2003. Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units Within the Interior Columbia River Domain. Working Draft, July 2003. Northwest Fisheries Science Center, NMFS Northwest Region.

Interior Columbia Basin Technical Recovery Team. 2004. Preliminary guidelines for population-level abundance, productivity, spatial structure, and diversity supported viable salmonid populations, an update. ICTRT, 12/13/04.

Interior Columbia Technical Recovery Team (ICTRT). 2005. Interior Columbia Basin TRT: Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. ICTRT Internal Review Draft. July 18, 2005.

Interior Columbia Technical Recovery Team (ICTRT). 2007a. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review draft March 2007. Available at: http://www.nwfsc.noaa.gov/trt/trt_viability.cfm.

Interior Columbia Technical Recovery Team (ICTRT). 2007b. Required Survival Rate Changes to Meet Technical Recovery Team Abundance and Productivity Viability Criteria for Interior Columbia River Basin Salmon and Steelhead Populations. ICTRT Review Draft. Nov. 30, 2007.

Kuttel, M. Jr. 2000. Draft salmonid habitat limiting factors, WRIA 32, Walla Walla Watershed. Washington Conservation Commission.

Kuttel, M. Jr. 2001. Salmonid habitat limiting factors, Water Resource Inventory Areas 32 Walla Walla Watershed. Washington State Conservation Commission.

Kuttel, M. Jr. 2002. Salmonid habitat limiting factors, Water Resource Inventory Areas 33 (Lower) and 35 (Middle) Snake Watersheds and Lower Six Miles of the Palouse River. Washington State Conservation Commission, Olympia, Washington.

Lestelle, L.C., L.E. Mobrand, J.A., Lichatowich, and T.S. Vogel. 1996. Applied Ecosystem Analysis – A Primer. Prepared for Bonneville Power Administration Environmental Fish and Wildlife Division. Project Number 9404600, Contract #94 AM 33243. Portland, Oregon.

Mahoney B. D., G. Mendel, M. Lambert, J. Trump, P. Bronson, M. Gembala and M. Gallinat. 2009. The Walla Walla Subbasin Collaborative Salmonid Monitoring and Evaluation Project: 2007 and 2008 Annual Report. Confederated Tribes of the Umatilla Indian Reservation and Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2000-039-00. 138 pages.

Mahoney B. D., Glen Mendel, Rey Weldert, Jeremy Trump, Joelle Pomraning, Michael Gembala and Michael Gallinat. 2011. Walla Walla Subbasin Collaborative Salmonid Monitoring and Evaluation Project: 2009 and 2010 Annual Report. Confederated Tribes of the Umatilla Indian Reservation and Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2000-039-00.

Matthews, G.M. and R.S. Waples. 1991. Status Review for Snake River spring and summer Chinook salmon. U.S. Department of Commerce, NOAA Tech. Memo. NMFS NMFS-F/NWC 200.

Mayer, K. and M. Schuck. 2009. Assess Salmonids in the Asotin Creek Watershed, 2008 Annual Report, BPA Project No. 200205300, 17 pages.

Mayer, K., M. Schuck, and P. Iversen. 2010. Assess Salmonids in the Asotin Creek Watershed, 2009 Annual Report, BPA Project No. 200205300, 29 pages.

Mayer, K., Schuck, M., and D. Hathaway. 2006. Assess Salmonids in the Asotin Creek Watershed, 2005 Annual Report, BPA Project No. 200205300, 37 pages.

Mayer, K., Schuck, M., Wilson, S., and B. Johnson. 2005. Assess Salmonids in the Asotin Creek Watershed, 2004-2005 Annual Report, Project No. 200205300, 40 pages, BPA Report No. DOE/BP-00018229 and No. DOE/BP-00022720.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2003. A large-scale, multi-species status assessment: Anadromous salmonids in the Columbia River basin. Ecol. Appl. 13(4):964–989.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and recovery of Evolutionarily Significant Units. U.S. Department Commerce., NOAA Tech. Memo. NMFS-NWFSC-42, Seattle, Washington.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel, C. Willis. 2006. Revised Viability Criteria for Salmon and Steelhead in the Willamette and Lower Columbia Basins. Willamette/Lower Columbia Technical Recovery Team and Oregon Department of Fish and Wildlife. Review Draft, April 1, 2006.

Meinig, D.W. 1968. The Great Columbia Plain: A Historical Geography, 1805-1910. University of Washington Press, Seattle, Washington.

Mendel, G., V. Naef, and D. Karl 1999. Assessment of salmonid fishes and their habitat conditions in the Walla Walla River Basin-1998 Annual Report. U.S. Department of Energy, Bonneville Power Administration No. FPA 99-01.

Molenaar, D. 1968. A Geohydrologic Reconnaissance of Northwestern Walla Walla County, Washington. Washington Department of Water Resources, Monograph No. 1.

Mudd, D. R. 1975. Touchet River Study, Part I, Wildlife. Washington Department of Game.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo., NMFS-NWFSC-35. Seattle, Washington.

National Marine Fisheries Service (NMFS). 1991. Factors for Decline: A Supplement to the Notice of Determination for Snake River Spring/summer Chinook Salmon Under the Endangered Species Act. Environmental and Technical Services Division, Portland, Oregon.

National Marine Fisheries Service (NMFS). 2007. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. November 5, 2007. available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Estuary-Module.cfm

National Marine Fisheries Service (NMFS). 2008a. Biological Opinion: Impacts of US v OR Fisheries in the Columbia River in years 2008-2017 on ESA-listed Species and Magnuson-Stevens Act Essential Fish Habitat. May 5, 2008. Available at https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=107547

National Marine Fisheries Service (NMFS). 2008b. Recovery Plan Module for Mainstem Columbia River Hydropower Projects ("Hydro Module"). NMFS Northwest Region. Portland, Oregon.

National Marine Fisheries Service (NMFS). 2008c. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. ("FCRPS BiOp") NMFS, Portland, Oregon. Available at http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm

National Marine Fisheries Service (NMFS). 2008d. Recovery Plan Module for Mainstem Columbia River Hydropower Projects ("Hydro Module"). NMFS Northwest Region. Portland, Oregon.

National Marine Fisheries Service (NMFS) 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. 260 pages.

National Marine Fisheries Service (NMFS). 2004a. Endangered Species Act 2004/2004-2008, Implementation Plan for the Federal Columbia River Power System.

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2000. Passage of juvenile and adult salmonids past Columbia and Snake River dams. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, Washington.

National Resources Conservation Service (NRCS). 2001. Asotin Creek inventory and assessment report.

Newcomb, R. C. 1965. Geology and ground-water resources of the Walla Walla River Basin, Washington and Oregon. Washington Division of Water Resources, Water Supply Bulletin No. 21.

Nez Perce Tribe. 2002. The Nez Perce Reservation and its Location. Retrieved March 13, 2004, from http://www.nezperce.org.

Nowak, M.C. 2004. Grande Ronde Subbasin Plan. Prepared for the Northwest Power and Conservation Council. 491 pages.

Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW). 1998. Status Report, Columbia River Fish Runs and Fisheries, 1938-1997.

Pacific Fisheries Management Council (PFMC). 1979. Freshwater habitat, salmon produced, and escapements for natural spawning along the Pacific Coast of the United States. Report of the Anadromous Salmonid Environmental Task Force. Pacific Fishery Management Council, Portland, Oregon.

Palouse–Rock Lake Conservation District. 2001. Draft: Palouse Subbasin Summary. Prepared for Northwest Power Planning Council, Portland, Oregon.

Parametrix. 2003. Snake River Salmon Recovery Planning – Biological/Technical Conditions Report. Prepared for Snake River Salmon Recovery Board.

Pasco, Washington. 2003. Pasco's Colorful history, general information. Retrieved March 13, 2004, from http://www.ci.pasco.wa.us.

Peven, C. M., R. R. Whitney, K. R. Williams. 1994. Age and length of steelhead smolts from the mid-Columbia River basin, Washington. North American Journal Fisheries Management 14: 77-86.

Pomeroy Conservation District (PCD). 2004. Lower Snake River Subbasin Summary. Prepared for the Northwest Power and Planning Council, Portland, Oregon. 195 pages.

Port of Whitman County (PWC) 2000. Comprehensive plan. Retrieved March 15, 2004, from http://www.portwhitman.com/CompPlan.pdf.

Pullman, Washington. 2003. Pullman, Washington information. Retrieved March 13, 2004, from http://www.pullman-wa.gov.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Department of Agriculture, Forest Serv., Intermountain Research Station, Gen. Tech. Rept. INT_302, Ogden, Utah.

Robbins, W.G. 1997. Landscapes of Promise: The Oregon Story 1800-1940. Univ. of Washington Press, Seattle, WA and London, England.

Ruckelshaus, M.H., K. Currens, R. Furstenberg, W. Graeber, K. Rawson, N.J. Sands, and K.J. Scott. 2002. Planning ranges and preliminary guideline for the delisting and recovery of the Puget Sound Chinook salmon Evolutionarily Significant Unit. Puget Sound Technical Recovery Team.

Saul, D., C. Rabe, A. Davidson, and D. Rollins. 2001. Draft Walla Walla Subbasin summary. Prepared for Northwest Power Planning Council, Portland, Oregon.

Saul, D., L. Gephart, M. Maudlin, A. Davidson, L. Audin, S. Todd, and C. Rabe. 2000. Draft Walla Walla River watershed assessment. Washington State University Center for Environmental Education. Pullman, Washington.

Scott, J.B. and Gill, W.T. 2006. Oncorhynchus mykiss: Assessment of Washington State's Anadromous Populations and Programs. Washington Department of Fish and Wildlife. Olympia, WA.

Snake River Salmon Recovery Board (SRSRB). 2006. Technical Document Snake River Salmon Recovery Plan for SE Washington. Prepared for the Washington Governor's Salmon Recovery Office. 408 pages, plus appendices.

Snake River Salmon Recovery Committee. 2004. 2004 Lead Entity Habitat Protection & Restoration Strategy: Snake River Region.

Soil Conservation Service (SCS) 1981. Southeast Washington Cooperative River Basin Study: Deadman Creek Watershed.

State of Washington. 2004. Office of Financial Management. April 1 Population of Cities, Towns and Counties. Retrieved September 12, 2004, from www.ofm.wa.gov/pop.

Stinson, D.W., J. W. Watson, and K. R. McAllister. 2001. Washington status report for the bald eagle. Washington Department of Fish and Wildlife-Wildlife Program.

Tucannon River Model Watershed Plan (TRMWP). 1997. Prepared by the Landowner Steering Committee in cooperation with the Technical Advisory Committee. Sponsored by the Columbia Conservation District and Bonneville Power Administration.

U.S. Army Corps of Engineers (USACE). 1997b. Walla Walla River Watershed, Oregon and Washington reconnaissance report. Walla Walla District.

U.S. Army Corps of Engineers (USACE). 2004a. Salmon River, Idaho, Aquatic Ecosystem Restoration Project. Retrieved April 25, 2004, from http://www.nww.usace.army.mil/salmonriver/chinook.htm.

U.S. Army Corps of Engineers (USACE). 2004b. Walla Walla District Recreation Area. Retrieved March 23, 2004, from http://www.nww.usace.army.mil/corpsoutdoors/.

U.S. Department of Agriculture. 1997. Census of agriculture: geographic Area Series, Vol. I, IA, IB, IC. National Statistics Service, Washington, D.C. retrieved from http://agcensus.mannlib.cornell.edu.

U.S. Fish and Wildlife Service (USFWS). 2001. Hudson Bay District Improvement Company, Walla Walla River Irrigation District and Gardenia Farms Irrigation District #13. FWS.PN.2731.

U.S. Fish and Wildlife Service (USFWS). 2002a. *Draft* Bull trout (Salvelinus confluentus) recovery plan. Retrieved April 27, 2004, from http://pacific.fws.gov/bulltrout/recovery.

U.S. Fish and Wildlife Service (USFWS). 2002b. Chapter 24, Snake River Washington Recovery Unit, Oregon. In: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentis*) Draft Recovery Plan. Portland, OR.

U.S. Fish and Wildlife Service (USFWS). 2004. Lower Snake River compensation plan/programs. Retrieved March 2004 from http://lsnakecomplan.fws.gov/Programs/LyonsFer.htm.

U.S. Fish and Wildlife Service (USFWS). No date a. Mid-Columbia River Refuges. Retrieved March 26, 2004, from http://midcolumbiariver.fws.gov/mcnarypage.htm.

U.S. Fish and Wildlife Service (USFWS). No date b. Umatilla National Forest: Wenaha-Tucannon Wilderness. Retrieved March 26, 2004, from http://www.fs.fed.us/r6/uma/wenaha.htm.

U.S. Forest Service (USFS). 1998b. Tucannon River biological assessment of ongoing activities for consultation on bull trout by the Umatilla National Forest with U.S. Fish and Wildlife Service.

U.S. Forest Service (USFS) and Bureau of Land Management. 2000. Interior Columbia Basin supplemental draft environment impact statement, Volume 1. Interior Columbia Basin Ecosystem Management Project, Walla Walla, WA and Boise, ID.

U.S. Geological Survey (USGS). No date. GIRAS: Land use/land cover for Washington State. GIS layer. Retrieved March 2, 2004 from http://wagda.lib.washington.edu/data/lulc250k/.

Walla Walla County. 2004. Walla Walla County History. Retrieved March 13, 2004, from http://www.co.walla-walla.wa.us.

Walla Walla Valley Chamber of Commerce. 2002. Walla Walla Valley Chamber of Commerce information. Retrieved March 12, 2004, from http://www.wwchamber.com.

Walla Walla Watershed Planning Unit (WWPU) and Walla Walla Basin Watershed Council (WWWC). 2004. Walla Walla Subbasin Plan. Prepared for Northwest Power and Conservation Council, Portland, Oregon. 252 pages.

Waples, R.S., O.W. Johnson, and R.P. Jones, Jr. 1991a. Status review for Snake River sockeye salmon. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-F/NWC 195.

Washington Department of Ecology (WDOE). 1999a. Introduction to Washington's Shoreline Management Act (RC 90.58). Retrieved March 17, 2004, from http://www.ecy.wa.gov/programs/sea/sma/smaintro.pdf.

Washington Department of Ecology (WDOE). 2002. Water quality program, 303(d)list. Retrieved March 15, 2004, from http://www.ecy.wa.gov/programs/wq/303d/2002/2002_list.html.

Washington Department of Ecology (WDOE). 2003. Total maximum daily load for lower Snake River total dissolved gas. Publication No. 03-03-020.

Washington Department of Ecology (WDOE). 2004. What are noxious freshwater weeds? Retrieved April 5, 2004, from http://www.ecy.wa.gov/programs/wq/plants/weeds/exotic.html.

Washington Department of Fish and Wildlife (WDFW). 1998. Washington State salmonid stock inventory: Bull T rout/Dolly Varden. WDFW, Fish Management.

Washington Department of Fish and Wildlife (WDFW). 2000a. Bull Trout and Dolly Varden Management Plan. September 2000.

Washington Department of Fish and Wildlife (WDFW). 2003. Fishing prospects. Retrieved April 5, 2004, from http://www.wdfw.wa.gov/fish/prospects/county_d_j.htm.

Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW). 2002. Status Report. Columbia River Fish Runs and Fisheries, 1938-2000.

Weeber, M. A., S. J. Starcevich, S. Jacobs, and P. J. Howell. 2007. Migratory Patterns, Structure, Abundance, and Status of Bull Trout Populations from Subbasins in the Columbia Plateau and Blue Mountain Provinces 2006 Annual Report. Prepared for: U.S. Department of Energy, Bonneville Power Administration, Environment, Fish and Wildlife, P.O. Box 3621, Portland, OR 97208-3621, Project Number 199405400 Contract Number 26681.

Weeks, G. 2000. State of Washington County Profiles. Retrieved March 11, 2004, from http://www.wa.gov/esd/lmea/pubs/profiles/profiles.htm.

Weeks, G. 2001. State of Washington County Profiles. Retrieved March 11, 2004, from http://www.wa.gov/esd/lmea/pubs/profiles/profiles.htm.

Weeks, G. 2002. State of Washington County Profiles. Retrieved March 11, 2004, from http://www.wa.gov/esd/lmea/pubs/profiles/profiles.htm.

Whiteman, K.J., J.J. Vaccaro, J.B. Gonthier, and H.H. Bauer. 1994. The hydrogeologic framework and geochemistry of the Columbia Plateau aquifer system, Washington, Oregon, and Idaho. U.S. Geological Survey Professional Paper 1413-B.

Whitman County. 2003. Whitman County information. Retrieved March 11, 2004, from http://www.whitmancounty.org.

Whitson, T.D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B.E. Nelson, R. D. Lee, and R. Parker. 2001. Weeds of the West. The Western Society of Weed Science. Jackson, Wyoming

APPENDIX A SITE SPECIFIC ACTIONS AND COST

List of Tables – Appendix A

APPENDIX A Site Specific Actions and Cost

The ESA requires site specific actions and costs to be identified in a recovery plan that will achieve the plan's goal and to achieve intermediate steps toward that goal. Specifically, section 4(f)(1)(B) directs that "The Secretary, in development and implementing recovery plans, shall, to the maximum extent practicable - incorporate in each plan - a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of this section, that the species be removed from the list and; estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal."

The recovery plan provides objective, measurable criteria that, when met, will result in a deterimantion that the species should be removed from the list. Implementation of the actions described in the plan are predicted to meet those criteria, i.e., required viability levels for 4 of the 8 extant populations in the southeast Washington Management Unit in the next 10 years. However, 4 of the extant populations are not predicted to meed the criteria within 10 years. The plan stops short of predicting the time and cost of meeting the criteria for those populations but provides the intermediate steps toward that goal as represented by the 10-year actions and costs. The actions specified in this plan were identified to make incremental improvements needed to move populations from their current status to healthy and harvestable levels. Adjustments in effort or direction will need to be made if actions do not achieve their desired goals, and to take advantage of new information, more specific objectives, and changing opportunities. The adaptive management plan will provide the mechanism to facilitate these adjustments and updated cost estimates based on new information/data, objectives and opportunities will be be made in 2016.

This recovery plan includes near-term site specific actions and costs as well as a 10-year list of actions and costs at a broader geographic scale (MaSA and MiSA). The near-term actions are understandably more precise than those on the 10-year list. The near-term list of actions and their costs are maintained in a 3-year work schedule. The list includes habitat protection and restoration projects (actions), monitoring/evaluation programs, assessments and studies, and outreach. To view the 3-year work schedule go to www.snakeriverboard.org. The 3-year work schedule is organized by MaSA/MiSA and then by project category. Each of the actions are groupd by category, i.e., habitat projects, monitoring, studies, and outreach. Each action has a prospective lead, estimated cost and implementation schedule.

The actions on the 3-year work schedule are identified by SRSRB staff, consultants, agencies, tribes, conservation districts, non-profit organizations, local governments and others. The 3-year work schedule is updated annually to reflect new information and is therefore not included as a table in this recovery plan because it is a dynamic table updated each year. Identified actions are reviewed by the regional technical team based on each action's benefit to salmon relative to the limiting factors and priority areas. Only those actions approved by the RTT appear on the 3-year work schedule. Actions on the 3-year work schedule are priority for funding.

In addition to the 3-year work schedule, a 10-year implementation cost estimate was developed specifically for habitat protection and restoration actions needed to achieve or make progress towards meeting the habitat objectives for each population (Table 6-2). The basis for the actions and associated cost was an evaluation of current habitat conditions relative to the objectives or targets for those conditions. For instance, if the objective for floodplain connectivity is 80% of a 20-mile long MaSA and the current condition is 40% connected then actions to improve 8 miles needs to occur. The cost of improving floodplain connectivity varies by site condition but is defined well enough for developing a 10-year cost estimate. A smiliar exercise was conducted for each of the key actions identified in table 6-10 for each population in southeast Washington and is summarized int eh following table then broken out for each population and strategy in the subsequent table.

As stated, the 10-year implementation cost estimate includes only costs associatd with habitat-related (capital) actions. An evaluation of the non-capital costs of recovery was prepared by Evergreen Funding Consultants for the Governor's Salmon Recovery Office and the Council of Regional Salmon Recovery Organizations in March 2011. The non-captial costs included program operations, monitoring and studies/asessments, education/outreach, and development of regulations. The costs of those non-capital items necessary to fulfill committtments in the regional salmon recovery plan are provided in Table A-1 for the Southeast Washington Salmon Recovery Plan and are then described for each ESU/DPS in the MU in Table A-2.

It is important to note that there are costs related to hatchery and harvest improvements that are not captured in these cost estimates that are nonetheless important to salmon recovery. These costs were not included because the details (costs) of hatchery programs and associated monitoring efforts or fishery evaluations relative to recovery are provided in specific hatachery genetic management plans and fishery management plans which are updated frequently. Table A-1 and A-2 do include estimated costs for monitoring and evaluation needed to determine the effectiveness of recommended actions, and whether they are leading to improvements in population viability which is described in detail in Appendix C.

Table A-1. 10-Year implementation cost estimate for southeast Washington MU.

Capital Projects	Million
Habitat Restoration	$68
Land and Easement Acquisition	$25
Passage Barrier Retrofits	$39
Instream Flow Enhancements	$50
Water Quality Improvements	$25
Sub-Total	$207
Non-Capital Expenes	
Program Operations	$8
Monitoring & Studies/Assessments	$28
Outreach and Education	$2
Development of Regulations	$2
Sub-Total	$41
TOTAL	$248

For the purpose of informing the Middle Columbia Steelhead DPS-wide recovery plan and the Snake River Steelhead and Spring/Summer Chinook ESU and DPS-wide recovery plan, the costs listed in the table above have been distributed among the Middle Columbia DPS and the Snake River ESU/DPS for each capital project category. For non-captial expenses, the table lists the costs for RME according to DPS/ESU but not for the other non-capital expenses that apply MU-wide (program operations, outreach/education and development of regulations). These specific non-capital expenses could theoretically be divided by 2 assuming that the expense and effort for operations, education/outreach and development of regulations are evenly split between the two geographic areas.

Table A-2. 10-year implementation cost estimate for each DPS/ESU in the southeast Washington MU

<table>
<tr><th>Capital Projects</th><th>Middle C DPS</th><th>Snake DPS/ESU</th></tr>
<tr><td>Habitat Restoration</td><td>$35</td><td>$24</td></tr>
<tr><td>Land and Easement Acquisition</td><td>$42</td><td>$19</td></tr>
<tr><td>Passage Barrier Retrofits</td><td>$21</td><td>$2</td></tr>
<tr><td>Instream Flow Enhancements*</td><td>$38</td><td>$3</td></tr>
<tr><td>Water Quality Improvements</td><td>$10</td><td>$10</td></tr>
<tr><td>Sub-Total</td><td>$147</td><td>$58</td></tr>
<tr><td>Non-Capital Expenes</td><td colspan="2"></td></tr>
<tr><td>Program Operations – MU wide</td><td colspan="2">$8</td></tr>
<tr><td>Monitoring & Studies/Assessments**</td><td>$13</td><td>$15</td></tr>
<tr><td>Outreach and Education – MU wide</td><td colspan="2">$2</td></tr>
<tr><td>Development of Regulations</td><td colspan="2">$2</td></tr>
<tr><td>Sub-Total for Non-Captial Expenses</td><td>$19</td><td>$21</td></tr>
<tr><td>TOTAL***</td><td>$166</td><td>$79</td></tr>
</table>

* The instream flow enhancement cost estimate for Mid C Steelhead DPS does not include costs of flow enhancement above the amount identified as necessary for steelhead and bull trout recovery, i.e., the cost of increasing flow to achieve the restoration goals identified in the plan.
**Many of the specific RME tasks have costs that are yet to be determined so the values in this table represent the minimum expense for the overall category at this time.
*** This figure reflect evenly splitting the costs associated with program operations, outreach/education and development of regulations and then adding to the itemized costs from the rows above.

Funding for capital activies is currently provided by a mix of sources including SRFB (pacific coastal salmon recovery and state funding), BPA, USDA, DOE, Land Trust, RFEG, NGO's, landowners, and other state and federal sources. Funding for non-capital activies is currently provided by SRFB, BPA, DOE, USFS, Conservation Commision, and RFEG. As of 2011, approximately $6 million in funding was provided for capital expenses while about $2 million for non capital expenses. At this rate of funding, funding levels are sufficient to support only about one-third of the costs proposed in the plan. The largest gap in funding for capital projects is habitat restoration followed by instream flow enhancement, passage barrier retrofit, land and easement acquisition and water quality improvements. The vast majorty of the gap in funding for non-captial activities is monitoring.

Table A-3 Walla Walla Summer Steelhead Population

Prioritized Strategies	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated 10-Year Cost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$2,000,000	WWCD
					Riparian Easements	MaSA and its tribs	$9,000,000	Land Trust
					Floodway Easements	MaSA/MiSA	$5,000,000	Land Trust
					Fencing and Planting	MaSA/MiSA	$4,300,000	WW Conserve Dist*
					Land acquisition/easements	MaSA/MiSA	$10,000,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback	MaSA reach	$25,000,000	Walla Walla County Conservation District*, WDFW, RFEG, CTUIR
					Floodplain reconnection	MaSA reach		
					Channel reconsruction	MaSA		
					Develop off-channel habitat	MaSA reach		
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enhance passage and habitat connectivity	Improve passage in Mill Creek	Mill Creek concrete chanel	$14,000,000	WDFW
					Improve passage in Yellowhawk	Yellowhawk	$850,000	Walla Walla CD*, WDFW, RFEG, CTUIR
					Improve passage in steelhead bearing streams	steelhead bearing streams	$1,000,000	Walla Walla CD*, WDFW, RFEG, CTUIR
					Screen irrigation diversions	steelhead bearing streams	$1,000,000	Walla Walla CD*, WDFW, RFEG, CTUIR
					Improve passage at Bennington Dam	Bennington Dam	$4,000,000	USACE
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity	Stream Flow, Water Temperature and habitat quantity and quality	Surface water conservation and/or acquisition	Improve irrigation efficiency	MaSA and MiSA	$10,200,000	WWCD
					Acquire water rights	MaSA and MiSA	$10,000,000	Water trust/WWB Partnership
					Construct water detention ponds/wetlands	MaSA and MiSA	$2,200,000	WWCD
					Flow enhancement	MaSA and MiSA	$10,000,000	WWCCD/CTUIR
					Shallow aquifer recharge	MaSA	$3,000,000	WWCD/WDFW
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	MaSA	$4,100,000	USFS*
					Conservation tillage practices	MaSA	$2,000,000	WWCD
					Grass waterways/ditches	MaSA	$500,000	WWCD
					Farm access road improvements	MaSA	$500,000	WWCD
						TOTAL	$118,650,000	

Table A-4. Touchet Summer Steelhead Population

Recovery Strategies as Prioritized in Recovery Plan	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated 10-yearCost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$2,000,000	WW & Col Co CD
					Riparian Easements	MaSA and its tribs	$4,000,000	Land Trust
					Floodway Easements	MaSA	$2,000,000	Land Trust
					Land Acquisition/Easements	MaSA	$4,000,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback	MaSA reach	$10,000,000	Columbia Conservation District*, WDFW, RFEG, CTUIR, County
					Floodplain reconnection	MaSA reach		
					Develop off-channel habitat	MaSA reach		
					Create floodplains	MaSA reach		
					Wolf Fork floodplain restoration	Green and Burnt Fks	$200,000	Col Co CD / CTUIR*
					Rainwater floodplain restoration	South Touchet	$200,000	CTUIR*
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enhance passage and habitat connectivity	Replace failing culvert	USFS Road 64	$300,000	USFS*
					Replace stream fords	Tamarack Trail	$100,000	USFS*
					Replace failing culvert	Corral creek	$100,000	RFEG
					Repair passage in Coats Crk.	Coates Creek	$50,000	RFEG
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity			Improve irrigation efficiency	MaSA and MiSA	$1,000,000	Col Co CD, WW CD, RFEG
					Pipe ditches	Hearn Ditch	$400,000	
					Construct water detention ponds/wetlands	Patit and Hogeye	$200,000	
					Improve hyporheic storage	Tribs to MaSA reach	$100,000	WDFW*
					Lease/purchase water	MaSA/MiSA	$1,000,000	Water Trust/WWB Partnership
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	USFS Road 600	$2,000,000	USFS*
					Conservation tillage practices	Londigan, Boles/Ford, Hogeye, Miller and Payne	$400,000	WW Conserve Dist*, Columbia Cons. Dist, RFEG
					Grass waterways/ditches		$300,000	
					Farm access road improvements		$300,000	
						TOTAL	$28,650,000	

Table A-5. Tucannon Spring Chinook and Summer Steelhead Populations

Recovery Strategies as Prioritized in Recovery Plan	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated 10-year Cost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$2,000,000	CCCD
					Riparian Easements	MaSA and its tribs	$2,000,000	Land Trust
					Floodway Easements	MaSA	$1,000,000	Land Trust
					Land Acquisition/Easements	MaSA	$2,000,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback/floodplain reconnect	MaSA reach	$10,000,000	Columbia Conservation District*, WDFW, RFEG, CTUIR, County
					Relocate overhead power lines		$1,200,000	
					Reconfigure fishing lakes	Beaver, Watson, Big 4,	$2,000,000	
					Relocate road to Camp Wooten	USFS Guard Station	$1,500,000	
					Install LWD	MaSA Reach	$3,000,000	
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enhance passage and habitat connectivity	Pataha Passage	pataha creek	$500,000	USFS*
					Hixon creek passage	hixon creek	$200,000	USFS*
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity			Improve irrigation efficiency		$400,000	Columbia Conservation District*, RFEG
					Pipe ditches		$200,000	
					Construct water detention ponds/wetlands		$200,000	
					Improve hyporheic storage		$300,000	WDFW*
					Purchase/lease water rights	MaSA / MiSA	$300,000	Water Trust/CCD
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	USFS Road 600	$2,000,000	USFS*
					Conservation tillage practices	Londigan, Boles/Ford, Hogeye, Miller and Payne	$400,000	WW Conserve Dist*, Columbia Cons. Dist, RFEG
					Grass waterways/ditches		$500,000	
					Farm access road improvements		$500,000	
						TOTAL:	$30,200,000	

Table A-6. Asotin Spring Chinook and Summer Steelhead Populations

Recovery Strategies as Prioritized in Recovery Plan	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated Cost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$2,000,000	ACCD
					Riparian Easements	MaSA and its tribs	$1,000,000	Land Trust
					Floodway Easements	MaSA/MiSA	$400,000	Land Trust
					Fencing and Planting	MaSA/MiSA	$1,000,000	ACCD
					Land acquisition/easements	MaSA/MiSA	$2,000,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback/floodplain reconnection	MaSA reach	$2,000,000	ACCD, WDFW, NPT
					Channel reconsruction	MaSA	$1,000,000	
					Develop off-channel habitat	MaSA reach	$1,000,000	
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA and MiSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enhance passage and habitat connectivity	Headgate Dam Passage	Asotin Creek	$200,000	ACCD
					Alkali Flat headcut	Alkali Creek	$50,000	WDFW
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity	Stream Flow, Water Temperature and habitat quantity and quality	Surface water conservation and/or acquisition	Improve irrigation efficiency	MaSA and MiSA	$300,000	ACCD
					Acquire water rights	MaSA and MiSA	$400,000	Water Trust
					Construct water detention ponds/wetlands	MaSA and MiSA	$400,000	WDFW
					Shallow aquifer recharge	MaSA	$300,000	WDFW
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	MaSA	$2,000,000	USFS/NPT
					Conservation tillage practices/CRP	MaSA	$400,000	ACCD
					Grass waterways/ditches	MaSA	$200,000	ACCD
					Farm access road improvements	MaSA	$500,000	ACCD
						TOTAL:	$15,150,000	

Table A-7. Lower Grande Ronde (within Washington)Summer Steelhead Population

Recovery Strategies as Prioritized in Recovery Plan	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated 10-Year Cost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$1,000,000	ACCD
					Riparian Easements	MaSA and its tribs	$400,000	Land Trust
					Floodway Easements	MaSA/MiSA	$400,000	Land Trust
					Fencing and Planting	MaSA/MiSA	$550,000	ACCD
					Land acquisition/easements	MaSA/MiSA	$2,200,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback/floodplain reconnection	Rattlesnake Creek et al	$1,000,000	ACCD, WDFW, NPT
					Channel reconsruction	MaSA	$400,000	
					Develop off-channel habitat	MaSA reach	$400,000	
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA and MiSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enhance passage and habitat connectivity	Bufford Creek passage	Bufford Creek	$400,000	WDFW/WADOT
					Rattlesnake Creek passage (2)	Rattlesnake Creek	$300,000	WDFW/WADOT
					Cottonwood Creek passage	Cottonwood Creek	$400,000	WDFW
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity	Stream Flow, Water Temperature and habitat quantity and quality	Surface water conservation and/or acquisition	Improve irrigation efficiency	MaSA and MiSA	$100,000	ACCD
					Acquire water rights	MaSA and MiSA	$100,000	Water Trust
					Construct water detention ponds/wetlands	MaSA and MiSA	$50,000	WDFW
					Shallow aquifer recharge	MaSA	$0	WDFW
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	MaSA	$2,000,000	USFS/NPT
					Conservation tillage practices/CRP	MaSA	$400,000	ACCD
					Grass waterways/ditches	MaSA	$200,000	ACCD
					Farm access road improvements	MaSA	$400,000	ACCD
						TOTAL:	$10,700,000	

Table A-8. Joseph Creek Summer Steelhead Population (within Wa

Recovery Strategies as Prioritized in Recovery Plan	Spawning Area (MaSA/MiSA)	VSP Parameter(s) Addressed	Limiting Factor(s) Addressed	Action Type	Specific Action(s)	Specific Geographical Location(s)	Total Estimated 10-year Cost ($)	Implementing Entity *Lead
6.1 Strategies to Restore and Protect Habitat								
1. Protect floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Protect existing habitat from future degredation	CREP	CREP-eligible reaches	$100,000	ACCD
					Riparian Easements	MaSA and its tribs	$200,000	Land Trust
					Floodway Easements	MaSA/MiSA	$100,000	Land Trust
					Fencing and Planting	MaSA/MiSA	$100,000	ACCD
					Land acquisition/ease ments	MaSA/MiSA	$200,000	Land Trust
2. Restore floodplain and riparian function as well as channel migration processes, structure and complexity								
	MaSA	Abundance, Productivity, and Life History Diversity	Sediment, Temperature, and channel complexity	Restore channel, floodplain and riparian condtion	Dike setback/floodplai n reconnection	Joseph Creek	$500,000	ACCD, WDFW, NPT
					Channel reconsruction	MaSA	$200,000	
					Develop off-channel habitat	MaSA reach	$100,000	
3. Improve passage and connectivity between habitat areas and screen irrigation diversions								
	MaSA and MiSA	Abundance, Productivity, and Life History Diversity	Passage	Restore/Enha nce passage and habitat connectivity			$0	WDFW/WADOT
							$0	WDFW/WADOT
							$0	WDFW
							$0	
4. Improve instream flow during critical periods								
	MaSA/MiSA	Abundance, Productivity, and Life History Diversity	Stream Flow, Water Temperature and habitat quantity and quality	Surface water conservation and/or acquisition	Improve irrigation efficiency	MaSA and MiSA	$100,000	ACCD
					Acquire water rights	MaSA and MiSA	$100,000	Water Trust
					Construct water detention ponds/wetlands	MaSA and MiSA	$0	WDFW
					Shallow aquifer recharge	MaSA	$0	WDFW
5. Maintain and/or reduce sediment delivery to streams								
			Sediment	Implement BMPs to reduce sediment origination and delivery to streams	Decommission roads	MaSA	$100,000	USFS/NPT
					Conservation tillage practices/CRP	MaSA	$80,000	ACCD
					Grass waterways/ditche s	MaSA	$40,000	ACCD
					Farm access road improvements	MaSA	$40,000	ACCD
						TOTAL:	$1,960,000	

APPENDIX B CURRENT STATUS ASSESSMENT OF SEWMU POPULATIONS

Table of Contents - Appendix B

Current Status Assessment of SEWMU Populations

Table of Figures – Appendix B

List of Tables – Appendix B

Appendix B – Current Status Assessment of SEWMU Populations

In the following appendix, the current status of the SEWMU populations is shown. Most of the information is based on reports from local agencies and Tribes that collect and report population metrics. NMFS is in the process of updating their status reviews (Ford et al. 2010), and it is important that consistent information is used throughout the Columbia Basin. Therefore, to be consistent, some of the information was downloaded from the Northwest Science Center, where the ICTRT data is being stored (NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0), or from the draft status review update (Ford et al. 2010). While most of the information on the website is based on local reports, some of it has been modified, or certain metrics (e.g., recruit per spawner) derived. This information was used when available and is clearly identified.

One of the principles the ICTRT used when determining abundance and productivity was that they delineated the data if it was, in their estimation, greater than 75% of the current carrying capacity of the population, i.e., data were not used if greater than 75% of carrying capacity. In other words, not all of the information was used by the ICTRT. However, for comparison sake, this Plan reports information using the full data set and then compares any metrics derived to those created by the ICTRT.

B.1 SPRING/SUMMER CHINOOK SALMON

For the entire ESU, Snake River spring/summer Chinook salmon abundance is monitored by a combination of spawning surveys (conducted by IDFG, WDFW, ODFW, USFWS, NPT, and the CTUIR) and counts at mainstem Snake River dams (NMFS also assists at Lower Granite Dam). In the SEWMU, WDFW (in WA State), ODFW (Or portion of Lower Grande Ronde River MPGs), and the CTUIR (Walla Walla River) perform redd surveys.

Currently, spring/summer Chinook salmon are counted at Lower Snake River dams (Table B-1; Figure B-1). Counts began in 1964 at Ice Harbor Dam, and began at the other dams as they were completed. The average number and range of the counts are depicted at the bottom of Table B-1. The number of spring/summer Chinook returning to the Snake River basin has increased in the last decade (Figure B-1). Dam counts are a good indicator of relative run strength and trends, but are not accurate to depict spawner abundance. Counts at dams also cannot be separated into hatchery and wild components reliably[24]; therefore, the percentage of wild fish cannot be determined using these counts (although external marks are recorded). Carcass surveys do, however, allow for differentiating wild and hatchery fish for spring/summer Chinook salmon.

Returns of spring/summer Chinook salmon have increased since 2001 for both hatchery- and natural-origin fish. These increases have been seen throughout the Columbia Basin for various species and runs, and therefore, probably reflect improving marine and mainstem Snake and Columbia river survival rates, in addition to on-going tributary habitat restoration.

---

[24] However, the 10-20% sample rate at the adult trap at the Lower Granite Dam can give good information on size, age and gender, with collection of scales for age and tissues for genetic analysis.

Table B-1. Spring/Summer (S/S) Chinook Salmon Passage in the Snake River, 1964-2010 (DART 2010).

Year	Ice Harbor Dam		Lower Monumental Dam		Little Goose Dam		Lower Granite Dam	
	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult
1964	1,358	18,895						
1965	1,098	11,076						
1966	2,153	41,728						
1967	2,851	32,742						
1968	5,040	39,723						
1969	3,533	48,362	6,659	41,977				
1970	3,075	44,906	4,238	41,373	5,598	38,474		
1971	3,738	28,900	6,091	24,796	6,669	21,763		
1972	3,128	47,222	3,034	41,288	2,869	38,531		
1973	2,252	58,387	2,610	60,107	2,662	52,767		
1974	1,343	18,018	1,731	16,711	1,742	15,501		
1975	1,242	20,159	1,547	19,851	1,094	17,332	1,556	16,083
1976	4,632	20,424	4,363	20,009	4,635	17,750	4,555	15,920
1977	2,860	51,898	2,364	44,990	2,167	37,388	3,286	43,913
1978	490	59,253	478	55,344	325	44,002	395	52,362
1979	1,596	10,259	1,179	8,825	731	7,149	1,644	9,467
1980	2,345	10,628	1,870	8,101	1,062	5,788	2,057	8,149
1981	1,073	18,908	1,072	17,295	554	13,114	1,006	16,441

Year	Ice Harbor Dam		Lower Monumental Dam		Little Goose Dam		Lower Granite Dam	
	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult
1982	621	18,506	498	19,089	unavailable	unavailable	697	16,577
1983	1,014	16,510	910	16,639	unavailable	unavailable	1,276	13,412
1984	1,899	13,624	2,416	14,393	unavailable	unavailable	3,225	11,940
1985	3,424	35,360	3,685	31,657	unavailable	unavailable	4,098	30,145
1986	1,776	45,021	2,055	43,570	unavailable	unavailable	2,562	37,730
1987	1,183	37,835	1,175	36,714	unavailable	unavailable	1,606	34,726
1988	1,474	40,778	1,368	39,716	unavailable	unavailable	1,286	35,640
1989	2,415	18,829	3,016	19,656	unavailable	unavailable	2,451	16,124
1990	382	26,142	501	25,342	unavailable	unavailable	372	22,408
1991	2,268	14,874	2,106	12,790	1,961	10,563	2,159	10,432
1992	1,038	29,453	859	26,793	945	24,372	831	24,405
1993	341	31,513	380	31,475	505	30,400	313	28,924
1994	137	4,338	152	4,513	195	4,006	116	3,915
1995	545	2,243	738	2,529	659	2,105	530	1,797
1996	2,507	9,250	2,733	9,107	2,821	8,379	2,583	6,814
1997	197	50,594	246	47,632	173	47,246	208	44,564
1998	434	17,907	432	14,888	452	14,810	437	14,209
1999	3,968	9,251	4,070	7,296	4,273	6,718	4,091	6,556
2000	12,668	43,048	13,613	40,200	13,928	38,628	14,074	37,761

Year	Ice Harbor Dam		Lower Monumental Dam		Little Goose Dam		Lower Granite Dam	
	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult
2001	5,423	186,443	3,396	200,074	5,793	190,752	6,939	185,693
2002	4,263	111,814	3,247	100,048	4,069	98,086	4,042	97,184
2003	12,621	98,912	10,933	89,321	10,616	83,357	12,432	87,031
2004	7,658	89,979	5,982	82,266	5,667	71,542	6,992	79,509
2005	2,257	36,876	1,806	34,287	1,897	30,979	2,336	32,764
2006	1,420	33,973	1,071	33,515	1,329	28,992	1,635	29,588
2007	9,892	36,062	8,460	38,799	10,088	31,848	12,364	30,184
2008	12,721	76,835	9,775	81,857	12,616	72,144	16,018	72,758
2009	37,623	79,291	31,742	90,284	35,538	72,964	47,431	64,149
2010	9,550	130,771	10,260	132,431	9,429	125,369	11,703	122,981

Overall Average	3,947	41,011	3,925	41,132	4,783	40,713	4,981	37,840
Overall Minimum	137	2,243	152	2,529	173	2,105	116	1,797
Overall Maximum	37,623	186,443	31,742	200,074	35,538	190,752	47,431	185,693
Pre 1990 avg.	2,216	31,075	2,493	29,624	2,509	25,797	2,113	23,909
1990-1999 avg.	1,182	19,557	1,222	18,237	1,332	16,511	1,164	16,402

Year	Ice Harbor Dam		Lower Monumental Dam		Little Goose Dam		Lower Granite Dam	
	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult	S/S Jack	S/S Adult
2000-2010 avg.	10,554	84,000	9,117	83,917	10,088	76,787	12,361	76,327

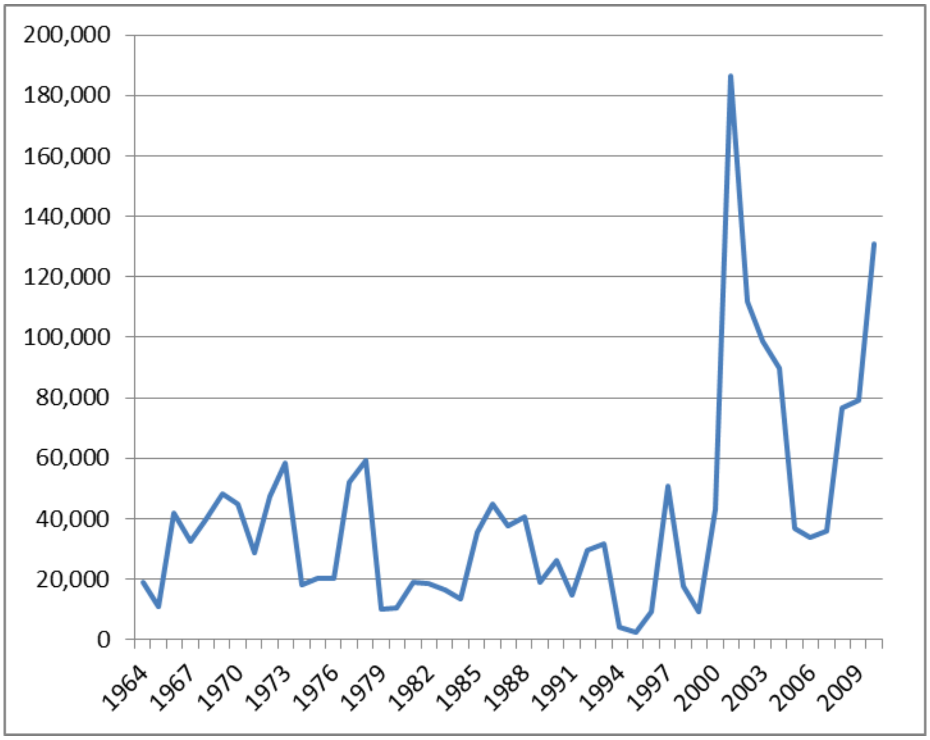


Figure B-1. Adult hatchery- and natural-origin Spring/Summer Chinook Salmon Counts at Ice Harbor Dam from 1964 to 2010 (DART 2010).

B.1.1 Abundance, distribution, and productivity of individual subbasins and populations

Tucannon River

Adult Abundance and Productivity

In the Tucannon subbasin, spring/summer Chinook salmon spawn almost exclusively in the mainstem Tucannon River (Gallinat and Ross 2010). Spawning occurs in the Tucannon River from just above the mouth of Sheep Creek (RM 52) downstream to King Grade (RM 21). Although a very limited amount of spawning has been documented in lower Panjab Creek, spawning is rarely observed in any other Tucannon River tributary (Glen Mendel, WDFW, personal communication).

The Tucannon River spring/summer Chinook salmon population declined substantially between the mid 1980s through the late 1990s (Table B-2; Figure B-2). Since the late 1990s, the population has increased, ranging between three fish (1999) to 1,443 (2010; Figure B-2). The 10-year geomean of abundance is currently 404 (Table B-2, Figure B-2).

The current 20-year return per spawner (R/S; a measure of productivity) for the Tucannon River spring Chinook salmon is 0.71 (Ford et al. (2010); Table B-2, Figure B-3). The 20-year geomean for R/S discussed here differs from the estimate by the ICTRT because they delimit their data when these metrics reach 75% of their estimated carrying capacity threshold.

Hatchery fraction

There has been a hatchery supplementation program in the Tucannon River since 1985. Fish used for broodstock have always been comprised of some proportion of natural-origin fish. Hatchery-origin fish have made up some percentage of the naturally spawning population since 1988. Since 2000, hatchery-origin fish have made up 48% of the total run (Table B-3).

In response to the severe decline of spawners, WDFW has on more than one occasion, collected nearly all the run for hatchery broodstock in an effort to maximize survival and maintain the population.

Table B-2. Estimated Spring/Summer Chinook Salmon abundance and productivity to the Tucannon River, 1985-2010 (Gallinat and Ross 2011, NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0, and Glen Mendel, WDFW, personal communication).

Brood Year	Total Redds	Percent natural-origin	Natural - origin adult run	10-year geomean natural-origin run	Adjusted return per spawner	20-year geomean of R/S
1986	200	100%	636		1.09	
1987	185	100%	582		1.14	
1988	117	96%	410		0.69	
1989	106	76%	336		2.26	
1990	180	66%	494		0.27	

1991	90	49%	260		0.84	
1992	200	56%	418		0.08	
1993	192	54%	317		0.45	
1994	44	70%	98	353	0.98	
1995	5	39%	21	266	0.31	
1996	68	66%	165	233	0.27	
1997	73	46%	160	204	1.55	
1998	26	59%	85	175	2.51	
1999	41	1%	3	109	1.05	
2000	92	24%	82	91	1.46	
2001	298	71%	718	101	0.63	
2002	299	35%	350	99	0.27	
2003	118	56%	248	97	0.47	
2004	160	70%	400	111	0.83	0.67
2005	102	69%	289	145	2.29	0.71
2006	101	55%	140	142		
2007	81	58%	198	145		
2008	199	45%	534	175		
2009	451	40%	750	303		

2010	481	57%	1,443	404		
Overall Average	156	0.58	365			
Overall Minimum	5	1%	3	91	0.08	0.67
Overall Maximum	481	1	1443	404	2.51	0.71
Pre 1990 avg.	152	0.93	491			
1990-1999 avg.	92	0.51	202			
2000-2010 avg.	217	0.53	468			

[a] The natural-origin adult run is reconstructed based on redd counts, adult per redd estimates from the trap and spawning upstream and expanding for the redds downstream of the weir.

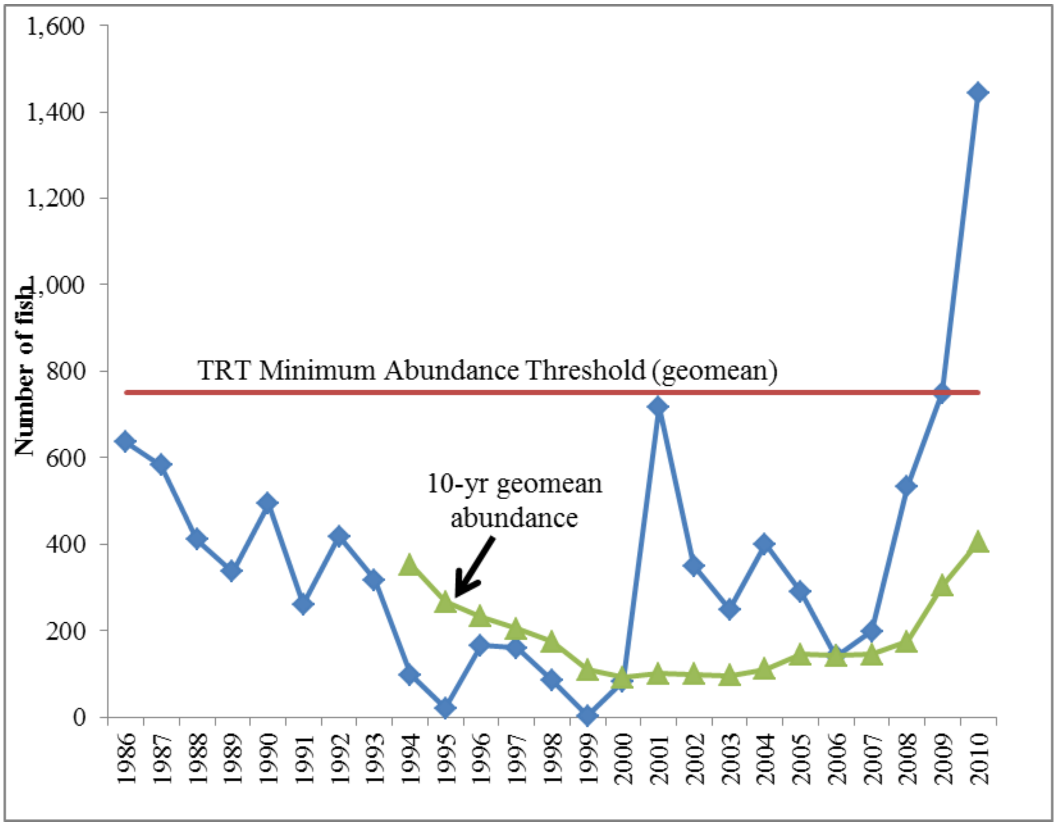


Figure B-2. Estimated abundance of Tucannon River natural-origin spring/summer Chinook salmon adults and 10-year geomean between 1986 and 2010 (Gallinat and Ross 2011).

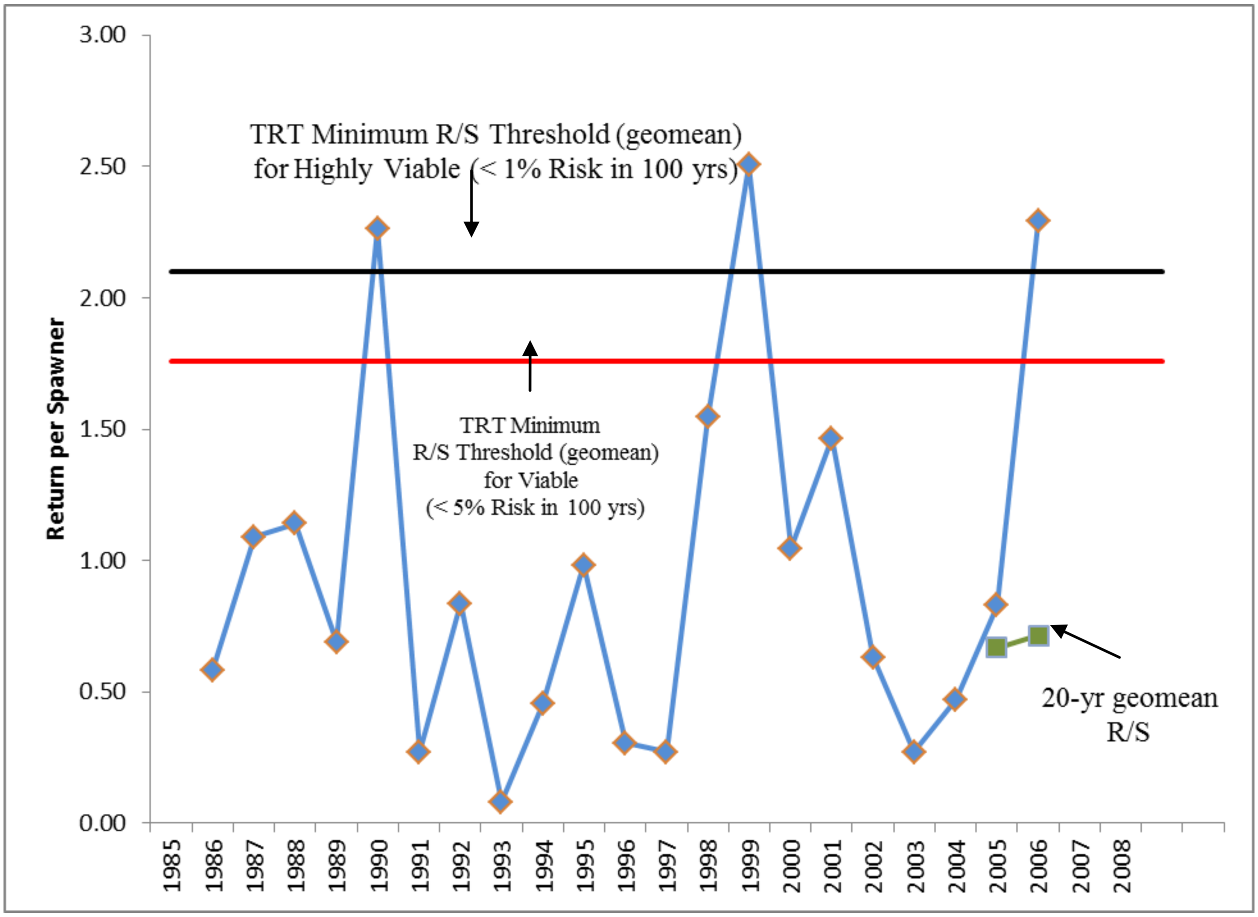


Figure B-3. Estimated productivity of natural-origin spring/summer Chinook salmon adults and 20-year geomean from the Tucannon River (NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0) for 1986-2003. For 2003-2005 from Gallinat and Ross (2010).

Note that the recruits per spawner is often less than one and Gallinat and Ross (2010) have documented that R/S is nearly always less than one for any spring Chinook salmon that spawn naturally in the Tucannon River. This is a critical issue for this population that must be clearly identified and addressed under RM&E to determine the cause and prompt actions that increase it.

Viability Curve

The ICTRT (2007) has developed a "viability curve" for the Tucannon River (Figure B-4). The point estimate for abundance and productivity is shown in relationship to various levels of risk of extinction within 100 years. As previously mentioned (Chapter 4), it will be necessary that the Tucannon River spring Chinook salmon population meet the 1% risk of extinction, denoted by the point of the arrow in Figure B-4 below, suggesting that the descending part of the curve should be moved to the right.

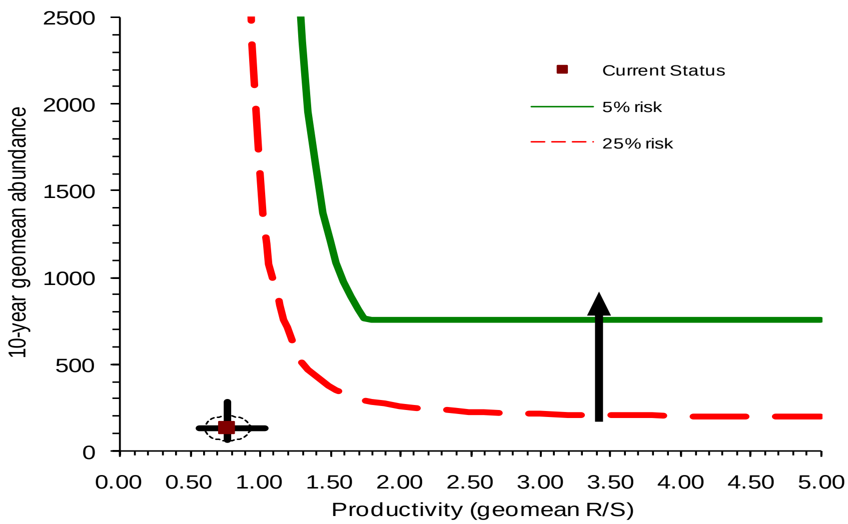


Figure B-4. Tucannon River spring Chinook salmon population abundance/productivity compared to the various risks of extinction within 100 years. Ellipse = 1 SE. Error bars = 90% CI (from Tom Cooney, NMFS, personal communication). The arrow denotes where the population productivity would need to be to meet "highly viable" criteria.

Adult Distribution

Most of the spring Chinook salmon in the Tucannon River spawn in the "HMA" section between river kilometers 39.9 to 55.5 (Table B-3). Gallinat and Ross (2010) note that spawning distribution has changed since 1985. Between 1985 and 1999, the proportion of redds upstream of the Tucannon Fish Hatchery weir decreased (Figure B-4). Changes in hatchery practices and increases in SAR reversed this trend, and now most of the fish spawn upstream of the weir, where there is better habitat (Figure B-5).

Table B-3 Spring/Summer Chinook Redd Distribution in the Tucannon River (1985-2009; Gallinat and Ross 2009).

Section	Rkm	Percent of Total Redds	Average Redds
Mouth to Marengo (Lower)	0-20.1	0	0
Marengo	20.1-39.9	1.1	2
Hartstock	39.9-55.5	19.3	29
HMA	55.5-74.5	67.4	98

Wilderness	74.5-86.3	12.2	18
Upstream of Trap	> 59	60.7	87
Downstream of trap	< 59	39.3	56

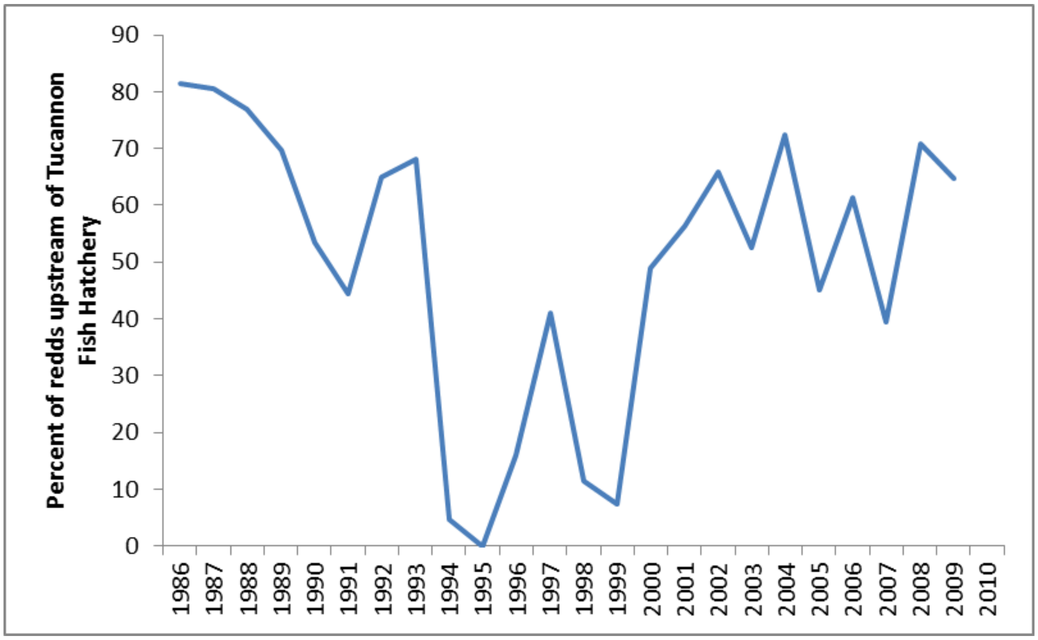


Figure B-5. Percentage of redds observed upstream from the Tucannon Fish Hatchery, 1986-2010 (from Gallinat and Ross 2010, and Glen Mendel, WDFW, personal communication).

Nearly one-quarter of the returning adults appear to bypass the Tucannon River upon return based on PIT tag detections at Lower Granite Dam (Gallinat and Ross 2010). This phenomenon does not appear to be based on origin, since both hatchery and natural-origin fish that were tagged as juveniles pass Lower Granite Dam in equal proportions; 23.5% and 23.8%, respectively. Only one fish has been detected entering the Tucannon River after being detected at Lower Granite Dam, but the recent addition of a remote PIT tag detector array near the mouth of the Tucannon should help evaluate fish returning to the Tucannon River (although additional work on the remote detector may need to be done to increase its reliability; Gallinat and Ross 2010).

Stray hatchery-origin fish

WDFW has estimated the number of stray hatchery-origin fish entering the Tucannon River since 1990 (Table B-4). In only four years was the ICTRT criteria of > 5% non-population and out of MPG origin fish in the subbasin exceeded.

Table B-4. Estimated number and percentage of run of stray (non Tucannon River) hatchery-origin fish into the Tucannon River from 1990-2009 (Gallinat and Ross 2009).

Year	Number of non-Tucannon Hatchery-origin fish (expanded)	Percentage of estimated Tucannon River run
1990	14	1.9
1991		
1992	10	1.3
1993	2	0.3
1994		
1995		
1996	3	1.3
1997	9	2.6
1998		
1999	20	8.2
2000	46	13.6
2001	13	1.3
2002	97	9.7
2003	1	0.2
2004	17	3.0
2005	6	1.4

Year	Number of non-Tucannon Hatchery-origin fish (expanded)	Percentage of estimated Tucannon River run
2006	8	3.2
2007	28	8.1
2008	24	2.0
2009	17	0.9

Juvenile Abundance and Production

WDFW has estimated the number of parr produced in the Tucannon River through various methods since 1985 (Table B-5). The average number of parr estimated between brood years 1985 and 2005 was 51,270, fluctuating between 0 (1995) and 103,292 (1992).

Table B-5. Estimated number of female spawners, parr and smolts produced from the Tucannon River (from Gallinat and Ross 2010).

	Female spawners				
Brood Year	Natural	Hatchery	Total	Parr[a]	Smolts
1985	219		219	90,200	42,000
1986	200		200	102,600	58,200
1987	185		185	79,100	44,000
1988	117		117	69,100	37,500
1989	103	3	106	58,600	30,000
1990	128	52	180	86,259	49,500
1991	51	39	90	54,800	30,000
1992	119	81	200	103,292	50,800
1993	112	80	192	86,755	49,560
1994	39	5	44	12,720	7,000
1995	5	0	5	0	75
1996	53	16	69	2,845	1,612
1997	39	33	72	32,913	21,057
1998	19	7	26	8,453	5,508
1999	1	40	41	15,944	8,157
2000	26	66	92	44,618	20,045

Brood Year	**Female spawners**			**Parr[a]**	**Smolts**
	Natural	**Hatchery**	**Total**		
2001	219	79	298	63,412	38,079
2002	104	195	299	72,197	60,530
2003	67	51	118	40,900	23,003
2004	117	43	160	30,809	21,057
2005	77	25	102	21,162	17,579
2006	65	36	101		30,228
2007	49	32	81		8,529
2008	95	104	199		
2009	179	272	451		
Average	96	60	146	51,270	28,436
Minimum	1	0	5	0	75
Maximum	219	272	451	103.292	60.530

[a] Number of parr estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-2005). After 2005, based on screw trapping information (Gallinat and Ross 2009).

Based on the estimated number of female spawners and juvenile data collected in the basin, WDFW was able to determine the number of parr and smolts produced per female spring/summer Chinook spawner (Figure B-6; Gallinat and Ross 2010). The data indicate that smolt production generally increases with an increase in adult returns to the basin, although a potential capacity is suggested within Figure B-6. It appears that production of parr and subsequent smolts may be reduced after about 200 female spawners. Standardized stock-recruitment type curves applied to these data for this plan, but WDFW has done this and the data clusters in the lower left of the curve because only recently have there been years of relatively large returns.

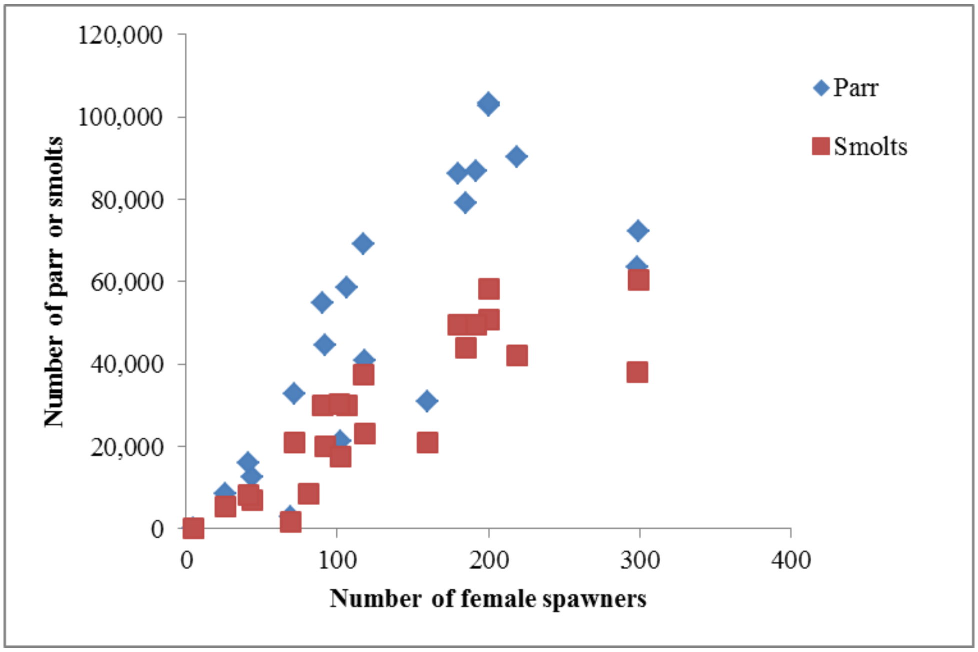


Figure B-6. The relationship between the number of female spawners (hatchery- and natural-origin) and parr and smolts produced (data from Table B-5).

Asotin Subbasin

Adult Abundance and Productivity

The WDFW and ICTRT classified Asotin Creek spring/summer Chinook salmon as functionally extinct because of extremely low redd counts and the origin of the small number of spawners was generally unknown (more recent information concerning origin of spawning Chinook salmon in Asotin Creek is discussed below). Annual redd abundance in Asotin Creek remains at extremely low levels (Table B-6).

Historically, spring runoff may have provided sufficient connectivity to allow some adults access to most reaches within the Asotin Creek system before a thermal barrier blocked the entrance; however, limited habitat availability and low summer flows and marginal temperatures probably limited pre-spawn holding to upper portions of the mainstem and North Fork. It is currently not known if this is still an issue.

Spawning has been documented in the upper mainstem of Asotin Creek (above Charley Creek) and in North Fork Asotin Creek from its confluence with Lick Creek to near the border of the Umatilla National Forest. Blankenship and Mendel (2010) evaluated 31 Chinook salmon sampled at a WDFW trap in lower Asotin Creek in 2005 and 2007. They concluded that the fish sampled in Asotin Creek apparently were mostly Snake River spring/summer Chinook salmon, with potentially a few Snake River fall Chinook salmon also. Their tests suggest that the fish sampled in Asotin Creek were most similar to, or likely to be from the Tucannon River spring/summer Chinook salmon, but not entirely. Some spring Chinook also appeared to be from the Imnaha River.

Table B-6 Redd and Spawner Counts in Asotin Creek, 1972-2010 (Glen Mendel, WDFW, personal communication).

Year	Total Redd Count	Live + Dead Fish
1972	12	76
1973	13	21
1984	8	17
1985	1	8
1986	1	3
1987	3	6
1988	1	0
1989	0	0
1990	2	0
1991	0	0
1992	0	0
1993	2	1
1994	0	0
1995	0	0
1996	0	0
1997	1	0
1998	0	0

Year	Total Redd Count	Live + Dead Fish
1999	0	0
2000	1	0
2001	4	4
2002	4	0
2003	1	0
2004	13	6
2005	2	1
2006	11	4
2007	3	3
2008	6	3
2009	6	3
2010	5	2

.

Juvenile Abundance and Production

Mayer et al. (2010) have enumerated juveniles captured at a rotary screw trap in lower Asotin Creek since 2004. They have counted between 219 and 1,884 juvenile Chinook salmon, and have expanded those counts to between 319 and 4,125 (Table B-7).

Table B-7. Number of juvenile Chinook salmon captured in spring and fall sampling at the Asotin Creek rotary screw trap and expanded population estimate (from Mayer et al. 2009).

Year	Number captured	Total fish emigrating
2004	1,884	4,145
2005	219	319
2006	1,035	2,358
2007	1,173	2,553
2008	1,127	2,265
2009	553	1,617

MPG Viability

Overall, Ford et al. (2010) rated the Tucannon and Asotin Creek populations at high risk of extinction (Figure B-7).

Spatial Structure/Diversity Risk

Abundance/Productivity Risk		Very Low	Low	Moderate	High
	Very Low (<1%)	**HV**	**HV**	**V**	**M**
	Low (1-5%)	**V**	**V**	**V**	**M**
	Moderate (6 – 25%)	**M**	**M**	**M**	**HR**
	High (>25%)	**HR**	**HR**	**HR** Tucannon River	**HR** Asotin Creek

Figure B-7. Lower Snake River spring Chinook salmon MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics (based on Ford et al. 2010). ***Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR –High Risk (does not meet viability criteria). Darker cells are at higher risk.***

Walla Walla Subbasin

Spring Chinook salmon were extirpated from the Walla Walla Subbasin more than 75 years ago due to over appropriated stream flow, loss of habitat and inadequate fish passage. Today, the CTUIR is working with the local community to restore the subsistence, economic, religious and cultural values of salmon (Mahoney et al. 2010).

The CTUIR's spring Chinook salmon re-introduction program is modeled after its successful Umatilla Fisheries Restoration Program and consists of: 1) habitat and flow restoration, 2) best practices hatchery reintroduction, 3) monitoring and evaluation, and 4) adaptive harvest management.

The CTUIR's management goal is to reintroduce natural spawning spring Chinook salmon populations to the Walla Walla Subbasin in order to provide sustainable returns for hatchery broodstock and natural spawning, plus tribal and sports tributary harvest. The Tribe's spring Chinook salmon reintroduction goal is to meet a return average of 5,500 adults back to the mouth of the Walla Walla River to produce 2,750 hatchery returns from smolt releases in the Walla Walla River. Another 1,100 naturally produced adults are expected to return to the Walla Walla River, plus returns from adult out-plants in Mill Creek and the Touchet River (in the future). Bench-mark criteria towards meeting this goal include: 1) a 10 year geometric mean of 1,100 natural origin spring Chinook salmon returning to the upper mainstem and

South Fork Walla Walla Rivers; 2) adult productivity (recruit per spawner) above replacement and 3) a smolt-to-adult return greater or equal to 0.55 percent (CTUIR 2009).

Spring Chinook salmon reintroduction began in 2000 with the CTUIR releasing surplus out-of-basin hatchery adults to spawn naturally in the South Fork Walla Walla River and upper Mill Creek.   The first four-year-old adults returned in 2004 as naturalized progeny. In 2005, the Tribe also began annual releases of roughly 250,000 out-of-basin spring Chinook salmon smolts to the South Fork Walla Walla River; and in 2007, the first 4-year-old fish returned in significant numbers as hatchery-origin progeny from these smolts. Returns of adult spring Chinook in 2010 exceeded 1,200 fish to the Walla Walla Basin.

Wenaha River (Grande Ronde Subbasin)

Currently, SEWMU spring/summer Chinook salmon are limited to migration in the mainstem Grande Ronde within the Washington portion of the subbasin and limited spawning in Wenaha tributaries within WA.. Spawning and rearing of spring/summer Chinook salmon occurs in the Wenaha River and its tributaries in the Oregon portion of the drainage and in Butte Creek (a Wenaha tributary of which all but about 1.5-2 miles is within Washington), and the lower half of the North Fork Wenaha (up to just upstream of the state line) in the Washington portion of the drainage.

Table B-8. Spring/summer Chinook salmon spawning ground surveys in tributaries of the Wenaha River (Glenn Mendel, WDFW, personal communication for the WA data, and Joe Feldhaus, ODFW, for the OR data).

	Butte Creek					
	OR, mouth to Stateline ~ 3.2 km	WA,West Butte (4.6 km)	WA, Forks down 6.4 km to near State line	North Fork Wenaha River	South Fork and Milk Creek[a]	Comments
1987			8			only 3.2 km surveyed below forks
1988		0	10			2 surveys 3 wks apart on 29 Aug and 19 Sep
1989		0	1			state line upstream 4 km
1990						
1991						
1992			14			2 live fish, and 1 carcass with Lookinglass CWT
1993			5			
1994						
1995						
1996						
1997	4					
1998	3					
1999	2					
2000	1					

	Butte Creek					
	OR, mouth to Stateline ~ 3.2 km	**WA,West Butte (4.6 km)**	**WA, Forks down 6.4 km to near State line**	**North Fork Wenaha River**	**South Fork and Milk Creek[a]**	**Comments**
2001	11					
2002	6			20	75	
2003	0				86	
2004	8				84	
2005	3		7	12	54	plus, 1 carcass, Butte Creek - forks down to 8.7 km to stateline
2006	5		3		52	Butte Creek - forks down to top of Box Canyon only ~1.3 km
2007	0				38	
2008	3				34	
2009	7			1	40	One redd in lower end of N. Fork
2010	10			19	84	

[a] the South Fork and Milk Creek, are all in Oregon.

Adult Abundance and Productivity

Prior to the mid 1970s, the population appears to have fluctuated between about 700-2,500 (Figure B-8[25]). Since that time, it declined through the mid- to late 1990s (as did most Columbia basin populations), and has increased since then. Currently, the population is still below the ICTRT minimum abundance threshold, but trending towards it. The abundance estimates in the graph below do not include the spawners in Butte Creek (WA) or in sampled OR tributaries (e.g. table above).

[25] The information provided in Figure 5-8 is from the mainstem Wenaha, in Oregon, and does not include tributaries.

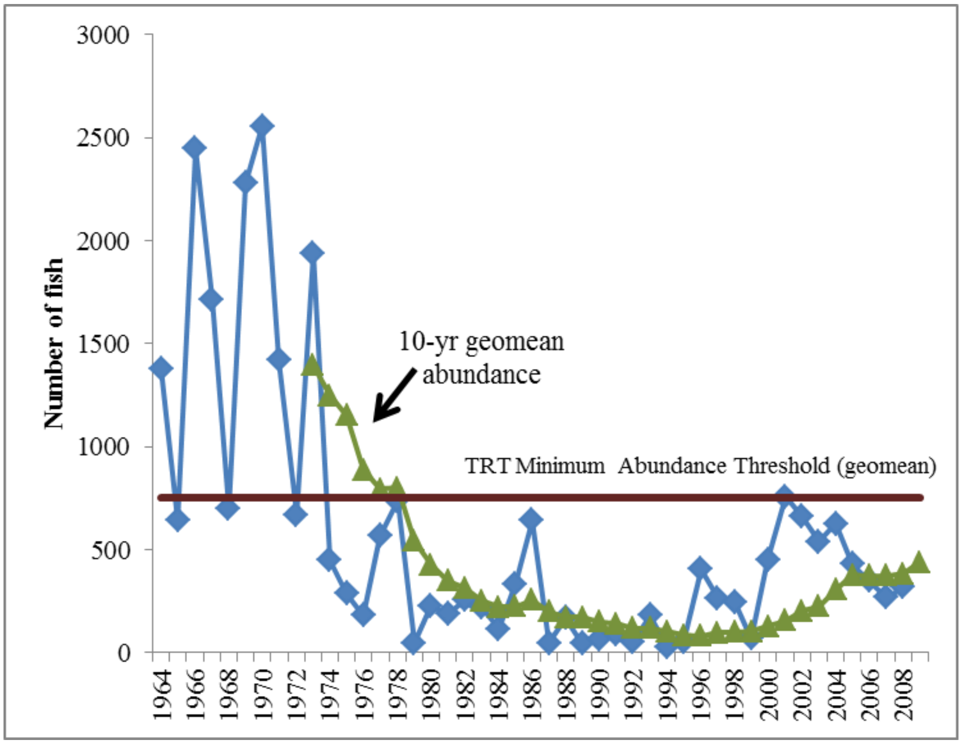


Figure B-8. Adult abundance, and 10-year geomean of abundance for Wenaha spring Chinook salmon (NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0).

Viability Curve

The ICTRT has developed a "viability curve" for the Wenaha River (Figure B-9). The point estimate for abundance and productivity is shown in relationship to various levels of risk of extinction within 100 years.

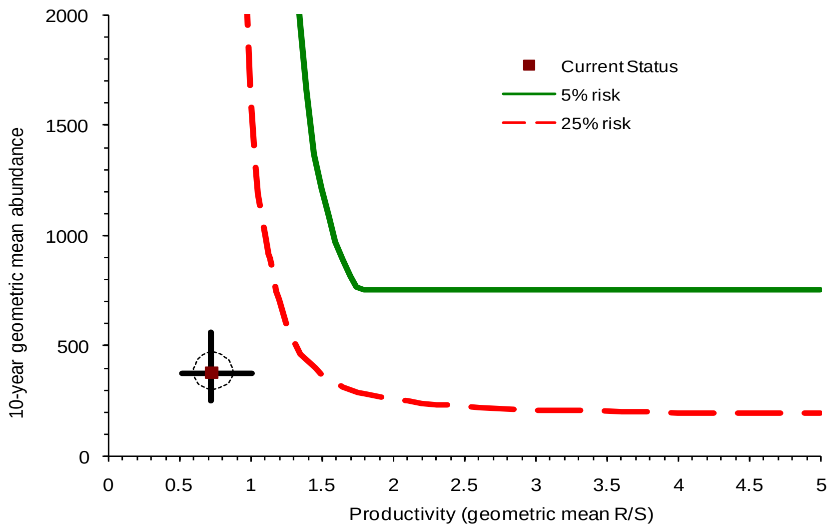


Figure B- 9. Wenaha River spring Chinook salmon current abundance and productivity compared various risks of extinction within 100 years. Ellipse = 1 SE. Error bars = 90% CI (from Ford et al. 2010). It should be noted that tributary spawning is not included in this assessment.

Hatchery fraction

There are no hatchery releases within the Wenaha Basin. Hatchery-origin spawners have comprised an average of 15% of total spawners in frequently sampled areas since 1964, and the recent 10-year average is 5%, although the hatchery fraction reached nearly 90% in the late 1980s and 1990s (Figure B-10).

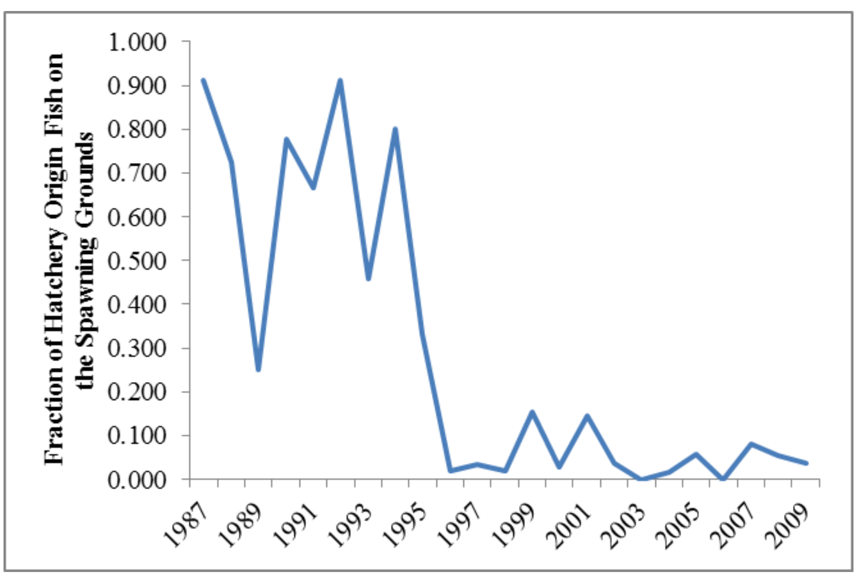


Figure B-10. Fraction of hatchery-origin fish determined from carcass sampling in the Wenaha River Basin (Rich Carmichael and Joseph Feldhaus, ODFW, personal communication).

Adult Distribution

Current spawning distribution is similar to historic with major production areas in the South Fork and mainstem Wenaha River from the confluence of the North and South forks downstream to Crooked Creek. Additional spawning occurs in the North Fork Wenaha River and in Butte Creek (Table B-8).

Stray hatchery-origin fish

Prior to 1995, strays were of Carson and Rapid River hatchery stock origin. In recent years, strays originated from local broodstock sources from other Grande Ronde River basin populations (Ford et al. 2010).

MPG Viability

Overall, the Ford et al. (2010) rated the Wenaha population at high risk of extinction (Figure B-11).

	Spatial Structure/Diversity Risk			
Abundance/ Productivity Risk	**Very Low**	**Low**	**Moderate**	**High**
Very Low (<1%)	**HV**	**HV**	**V**	**M**
Low (1-5%)	**V**	**V**	**V**	**M**
Moderate (6 – 25%)	**M**	**M**	**M**	**HR**
High (>25%)	**HR**	**HR**	**HR** **Wenaha** **Lostine/Wallowa** **Minam** **Catherine** **Imnaha**	**HR** **Upper Grande Ronde**

Figure B-11. Grande Ronde/Imnaha MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics (based on Ford et al. 2010). ***Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR –High Risk (does not meet viability criteria). Darker cells are at higher risk.***

B.2 SUMMER STEELHEAD

Currently, information on abundance and productivity for individual populations of mid-Columbia and Snake River steelhead is lacking to a great extent. For long-term trend analysis, detailed population level information within the SEWMU is available for only Joseph Creek. However, in recent years, more detailed information has been collected and what is available is reported below.

As previously discussed, dam counts offer an index of total run size returning to the Snake River basin. Based on dam counts, abundance of the total run ascending the Snake River and the percentage of natural-origin steelhead has risen substantially since the mid-1990s (Table B-9; Figure B-12).

Table B-9 Adult Steelhead Passage at Ice Harbor and Lower Granite Dams, 1993-2010 (DART, 2010).

Year	Ice Harbor			Lower Granite		
	Total	Natural-origin	Percent natural-origin	Total	Natural-origin	Percent natural-origin
1993	73,107	12,354	16.9	66,699	11,965	17.9
1994	51,704	6,525	12.6	47,550	8,089	17.0
1995	92,026	7,989	8.7	80,925	7,630	9.4
1996	97,272	10,047	10.3	86,131	9,589	11.1
1997	94,796	9,375	9.9	85,880	8,943	10.4
1998	77,656	11,045	14.2	71,778	9,644	13.4
1999	81,236	13,211	16.3	73,189	11,585	15.8
2000	120,254	22,996	19.1	113,049	20,587	18.2
2001	255,720	46,257	18.1	262,558	47,716	18.2
2002	202,173	51,308	25.4	218,718	57,291	26.2
2003	191,675	47,329	24.7	180,672	45,391	25.1
2004	171,380	40,575	23.7	154,587	36,255	23.5
2005	156,801	35,571	22.7	152,802	35,240	23.1
2006	124,813	27,697	22.2	145,991	29,836	20.4
2007	154,739	31,675	20.5	157,083	32,969	21.0
2008	172,410	42,003	24.4	175,475	43,676	24.9

2009	328,105	76,434	23.3	323,697	76,203	23.5
2010	206,971	58,743	28.4	200,530	59,341	29.6
Average	147,380	30,619	19.0	144,295	30,664	19.4
Minimum	51,704	6,525	8.7	47,550	7,630	9.4
Maximum	328,105	76,434	28.4	323,697	76,203	29.6

[a] The *Total* column includes both hatchery and natural-origin counts. Prior to 1995, natural-origin steelhead data was not published on a daily basis. The *Natural-origi*n column is a subset of the total column and may include unmarked hatchery-origin fish.

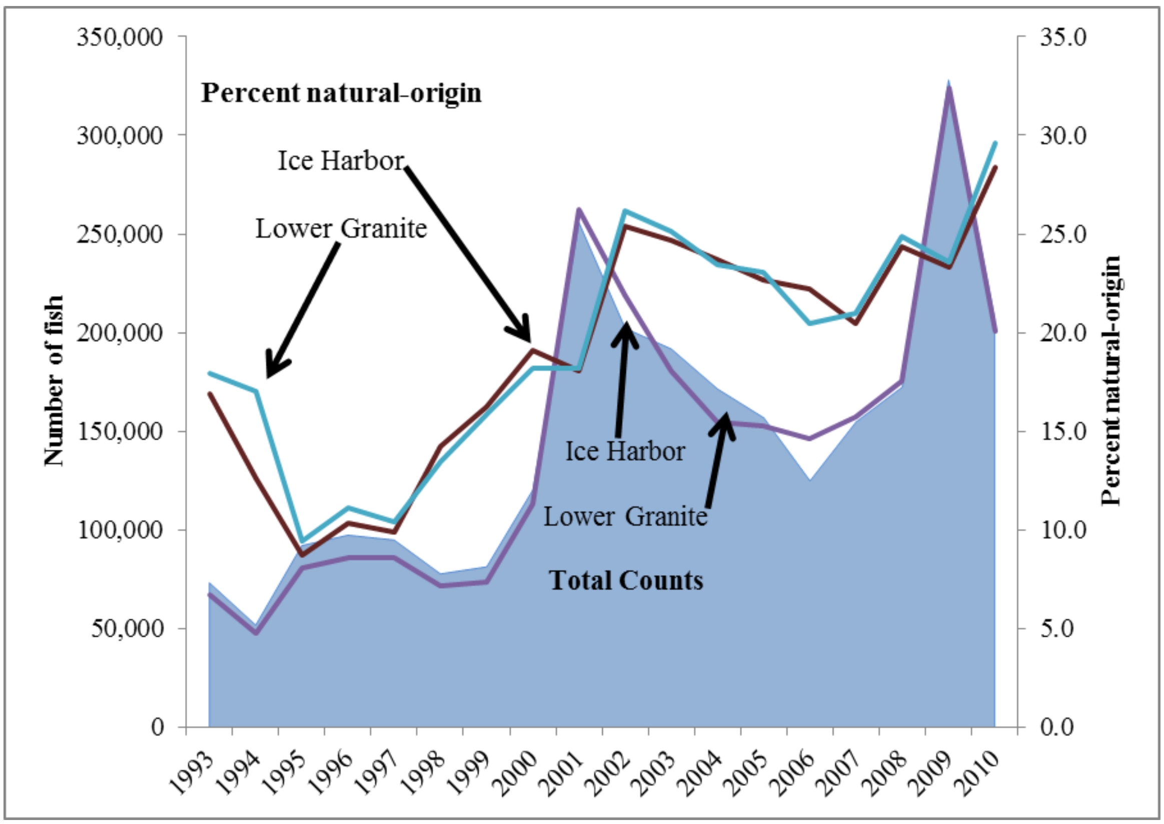


Figure B-12. Snake River Steelhead Counts at Ice Harbor and Lower Granite dams, depicting an index of natural-origin run contribution (natural-origin percentages may include some unknown number of unmarked hatchery-origin fish; DART, 2010)

The trend of steelhead counts over the Snake River dams is very encouraging and is generally believed to be related to increased hatchery production, increased survival through the hydrosystem, favorable ocean conditions, and habitat improvement in the tributaries.

Steelhead Genetic Structure in the SEWMU

Blankenship et al. (2007, 2009) investigated genetic variation over time within several of the SEWMU steelhead populations. They conducted a temporal analysis of allele frequencies at 14 microsatellite loci for sample collections replicated over a period of eight brood years. They compared the triad of two natural-origin summer steelhead populations (Tucannon and Touchet rivers) with a single hatchery population (Lyons Ferry Hatchery (LFH) stock). They found that the allele frequencies for the two natural summer steelhead populations were stable over seven brood years, and the phylogenetic relationships are constant for temporally stratified samples from a single location. In contrast, they found that yearly allele frequency estimates from LFH samples were generally divergent from each other. This information suggests that LFH samples may have a lower N_e, as compared to the natural population samples.

They also investigated several management specific questions; 1) are steelhead caught in the lower and upper Tucannon River trap genetically different, 2) are steelhead that migrate after 1 year in freshwater divergent from those that chose to migrate after 2 or more years in freshwater, and 3) is there evidence for LFH introgression into the Tucannon, Touchet, and Walla Walla Rivers? They found no evidence that steelhead trapped in the lower or upper trap are different genetically. They also found no evidence that freshwater age 1 individuals are more related to LFH steelhead, or are genetically different from freshwater age 2-3 steelhead. Based on phylogenetic data and individual assignment analysis they concluded LFH introgression into the Tucannon River, but not the Touchet or Walla Walla Rivers. Additionally, there was specific concern for introgression of LFH steelhead into Coppei Creek (Touchet tributary). They found no evidence for LFH introgression to this spawning aggregate.

B.2.2 Abundance, distribution, and productivity of individual subbasins and populations

Tucannon River Population

Abundance and Productivity

As stated previously, specific information on the Tucannon River population is limited, however, Bumgarner and Dedloff (2011) used smolt trap estimates of natural-origin steelhead, in conjunction with adult PIT tag detections, to estimate the total number of natural-origin adults returning to the Tucannon River basin (Figure B-13). Bumgarner and Dedloff (2011) estimate that between 150 and over 750 (average 354) Tucannon basin steelhead have passed over Ice Harbor Dam between 2000 and 2009 run years (Figure B-13). Until the 2008 migration (2010 spawn year), the trend had been decreasing. The number that enters the Tucannon River to spawn may be approximately 50% of what passes Ice Harbor Dam (see discussion below under *Adult Distribution*).

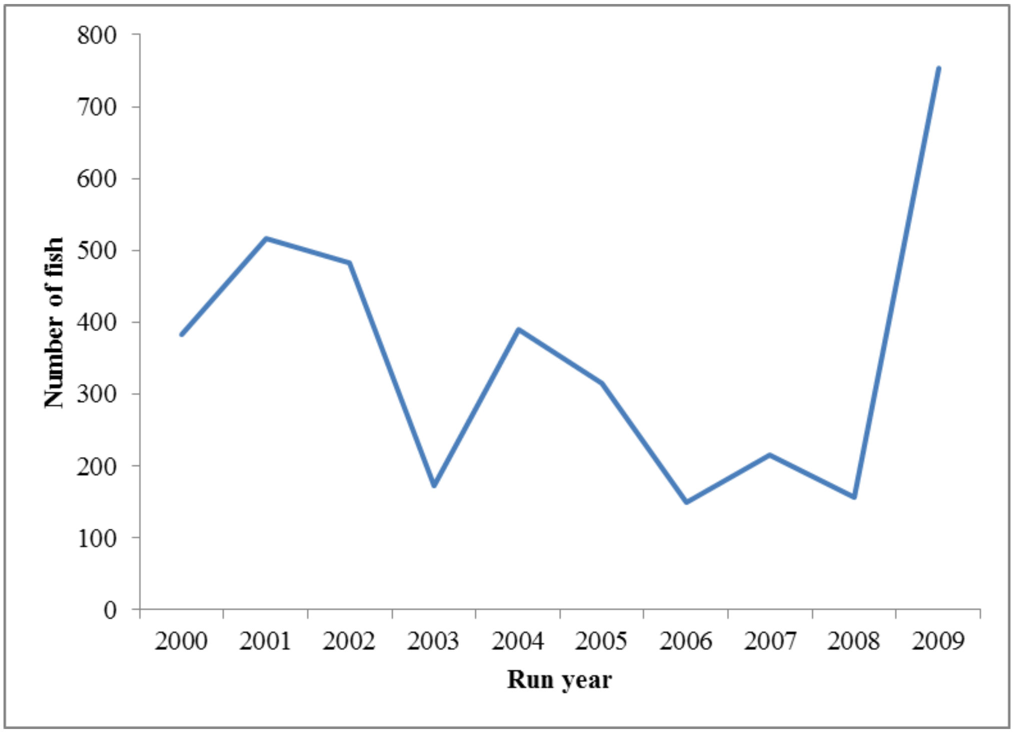


Figure B-13. Estimated number of Tucannon River basin natural-origin adult steelhead passing Ice Harbor Dam (2000-2009 run years). Actual number entering Tucannon River is estimated at 50% of what is shown (based on PIT tags detected at Lower Granite Dam - see *Adult Distribution* below); Bumgarner and Dedloff 2011).

Redd surveys have been undertaken in the Tucannon River since the mid-1980s. However, these have not been reported in recent reports because WDFW is in the process of standardizing the survey results across all SEWMU basins and have not completed the Tucannon River redd surveys yet (Bumgarner and Dedloff 2011).

Adult distribution

Based on PIT tag detections at the lower four Snake River dams, it appears that over half of the returning adult summer steelhead bypass the Tucannon River, and pass upstream of Lower Granite Dam. Bumgarner and Dedloff (2011) report that for endemic stock hatchery fish, Lyons Ferry stock hatchery fish, and natural origin fish that were all PIT tagged as juveniles, on average 65.6%, 66.3%, and 63.4%, respectively, were detected migrating upstream over Lower Granite Dam. In recent years, some of these fish have been detected in Asotin and Alpowa creeks upstream of Lower Granite Dam. It is not completely clear at this time how many of those descend and eventually enter the Tucannon, but according to the PIT tag data it would appear that between 10-25% eventually make it back to the Tucannon River. Co-managers have proposals for funding to further investigate the extent and potential mechanisms that may be causing these fish to bypass the Tucannon River.

In WDFW index area surveys, they have found that the highest density of redds occurs in the Marengo-Cummings Creek Bridge section (Table B-10), based on 2007 data (Bumgarner and Dedloff 2009). In more recent years, it appears that more fish may be spawning downstream of the Highway 12 Bridge (Bumgarner and Dedloff 2011). Redds and adult steelhead have also been documented in the lower Tucannon River below index spawning survey areas, though many of these are likely to be Lyons Ferry stock origin steelhead, as all Lyons Ferry hatchery smolts have been released below the index spawning areas in recent years. Redds and adult steelhead have also been documented in Deadman, Pataha and Penawawa creeks, which are included as part of the Tucannon steelhead population   However, it should be noted that redd distributions have varied over the years based on stream flow and hatchery release locations.

Table B-10. Spawning distribution of steelhead in index areas of the Tucannon River, 2007 (Bumgarner and Dedloff 2009).

Section	Rkms	Number of redds	Percent of Total Redds	Density of redds (# redds/km)
Highway 12 bridge - Marengo	19.2	37	27.4	1.9
Marengo - Cummings Cr. Bridge	16.9	53	39.3	3.1
Wooten Wildlife Area to Wilderness Boundary	19.5	13	9.6	0.7
Cummings Cr. (Old Mine to Mouth)	11.0	32	23.7	2.9

Hatchery fraction

The origin of adult steelhead entering (and spawning) in the Tucannon River is not currently available. With the recent deployment of the PIT tag array in the lower Tucannon, and enough juvenile steelhead (both wild and hatchery origin) being tagged, WDFW hopes to be able to have a clearer understanding of the origin of returning adults in the future.

Juvenile Abundance and Production

The number of natural-origin steelhead smolts emigrating from the Tucannon River basin has been estimated from smolt trapping near the mouth of the river (Figure B-14). Overall, it appears that the number of smolts has been declining in the last 10 years. The potential reasons for this are unclear, but could be related to hatchery production, shifts in hatchery release locations, spawning distribution of both hatchery and wild origin fish, and estimated low returns of natural origin fish back to the Tucannon River.

Juvenile steelhead densities were estimated by WDFW in the Tucannon River from electroshocking sampling, which stopped in 2005. Between 2003 and 2005, juvenile steelhead were sampled in five primary index areas within the mainstem Tucannon and Cummings Creek. Based on these index surveys, juvenile rearing appears primarily in the mainstem Tucannon between Rkms 20.1 and 74.5 (Table B-11). Cummings Creek regularly produces juvenile steelhead also, and in 2005, additional surveys were conducted in the lower 20 km of the mainstem of the Tucannon River, and over 20,000 age zero fish were estimated to be rearing in that area.

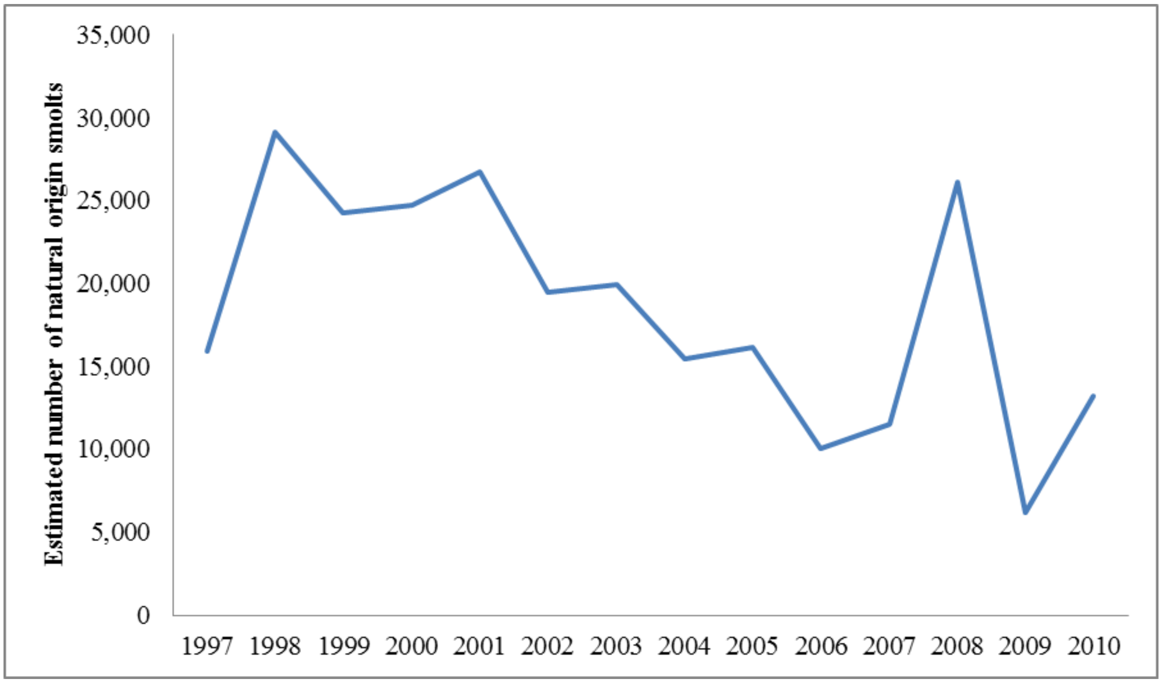


Figure B-14. The estimated number of natural-origin steelhead smolts emigrating from the Tucannon River, 1997-2010 Migration Years. (Joe Bumgarner, WDFW, personal communication).

Table B-11. Estimated number and density (fish/100m^2) of juvenile steelhead sampled in index areas of the Tucannon River between 2003 and 2006 (Bumgarner et al. 2004, 2006, Bumgarner and Dedloff 2007, 2009).

	Lower (Rkm 0-20.1)		Marengo (Rkm 20.1-39.9)		Hartstock (Rkm 39.9-55.5)		HMA (Rkm 55.5-74.5)		Wilderness (Rkm 74.5-86.3)		Cummings Cr. (Rkm 0-11.0)	
Metric/year	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**
Number of fish												
2003			54,310	8,103	47,717	14,606	30,658	14,859	6,389	8,706	12,779	7,398
2004			2,699	6,035	11,618	15,507	14,601	18,108	2,335	11,312	4,568	6,497
2005	20,084	98	8,956	2,889	10,989	4,609	11,547	10,994	NA	NA	4,747	2,864
2006	NA	NA	NA	NA	NA	NA	34,954	6,484	NA	NA	NA	NA
Density of fish												
2003			26.6	4.0	29.7	9.1	14.7	7.1	8.4	11.4	48.9	28.3
2004			2.3	5.1	6.9	9.2	6.4	7.9	2.8	13.5	17.7	25.1
2005	9.4	0.1	4.5	1.5	5.7	2.4	5.5	5.3	NA	NA	19.7	11.9
2006	NA	NA	NA	NA	NA	NA	14.5	10	NA	NA	NA	NA

Asotin Subbasin

Abundance and Productivity

There is more specific information on the Asotin Creek population than the Tucannon population since 2005 when more intensive monitoring began. However, it is important to note that the weir in Asotin

Creek is at Rkm 4.7, upstream of its major tributary, George Creek.[26] Therefore, the information presented below is for the area upstream of the weir, and does not include George Creek (unless specified) or the 4.7 km downstream of the weir. Therefore, for future status reviews, it will be necessary to expand the current information downstream of the weir and include abundance and productivity from George Creek, and other areas, like Alpowa and Almota Creeks that are part of the Asotin Creek population (Table B-12).

Table B-12. Counts of steelhead in Alpowa and George Creeks 2008-2010 and common sources of strays (Glen Mendel, WDFW, personal communication).

	George Creek			Alpowa Creek		
Year	**Total number of fish captured**	**Total hatchery-origin fish captured (%)**	**Hatchery Strays (Origin; based on CWT recoveries)**	**Total number of fish captured**	**Total hatchery-origin fish captured (%)**	**Hatchery Strays (Origin; based on CWT recoveries)**
2008				170	95 (55.9)	24 LFH stock from Touchet, Walla Walla and Tucannon, and 20 Tucannon endemic hatchery stock
2009	91	18 (19.8)	NA	410	265 (64.5)	33 LFH stock from Touchet, Walla Walla and Tucannon, and 63 Tucannon endemic hatchery stock
2010	178	8 (4.5)	1 (Tucannon FH)	505	198 (39.2)	87 (13% LFH; 2% Touchet release; 17% Tucannon FH; 64% Tucannon endemic, 1% each of Dworshak, Umatilla, and Pahsimeroi)

Between 2005 and 2009, the estimated number of natural spawners decreased in Asotin Creek until 2010, when there was a large increase. The percentage of hatchery origin fish observed at the weir increased between 2005 and 2008, but has decreased the last two years (Table B-13; Figure B-15). It is important to note that while most hatchery fish can be removed at the weir, endemic steelhead from the Tucannon hatchery program are protected under ESA and were not removed until after mid to late April of 2010. Also, natural-origin steelhead from the Tucannon River that were PIT tagged at the screw trap have also been observed at the Asotin weir, and these fish are allowed to pass upstream too because of ESA protection (Mark Schuck, WDFW, personal communication).

[26] A weir was installed in George Creek in 2009, and information pertaining to George Creek will be forthcoming in future years.

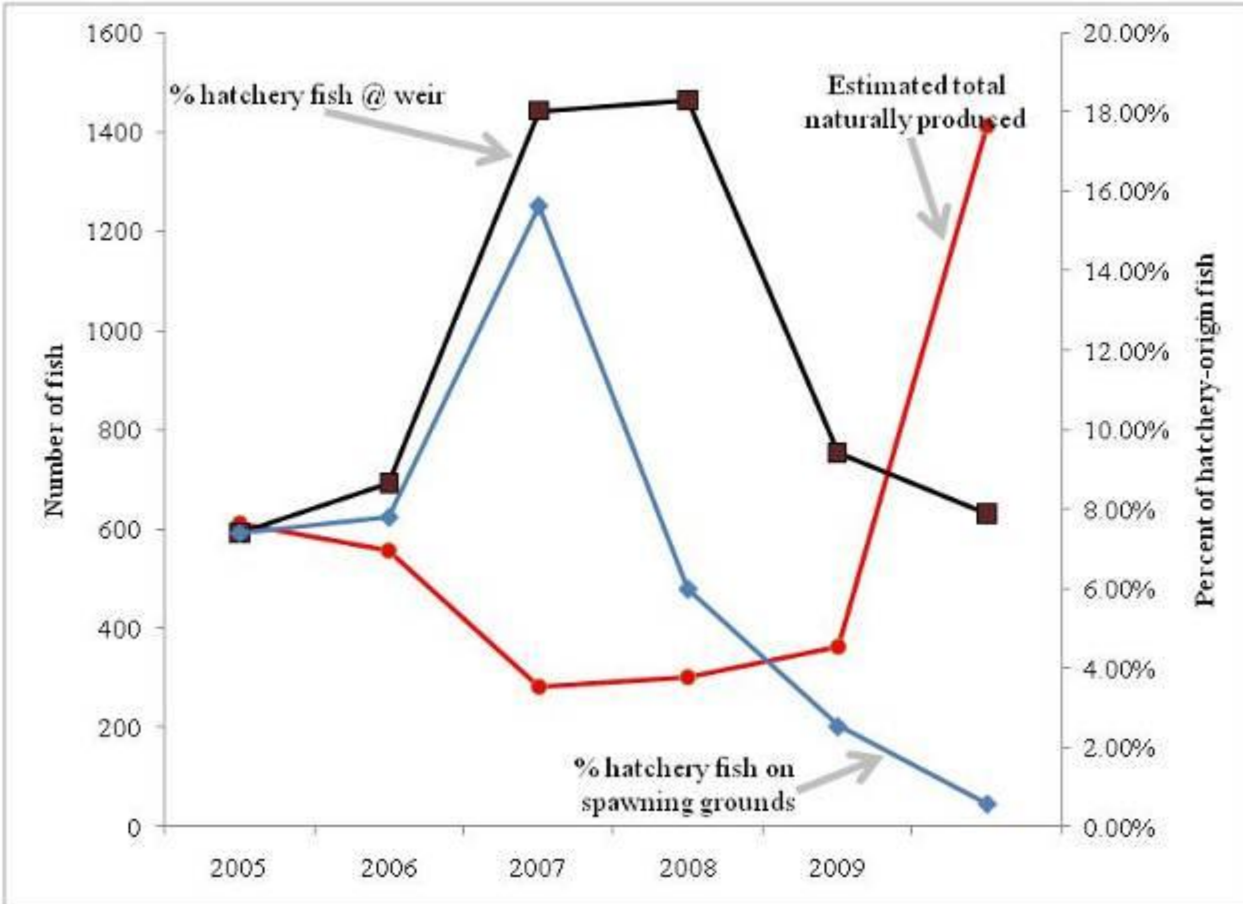


Figure B-15. The number of steelhead spawners estimated in Asotin Creek (upstream of the George Creek) and percentage of hatchery fish observed at the weir, 2005-2010 (E. Crawford, WDFW, personal communication).

Table B-13. Summary of adult steelhead trapped at the Asotin Creek weir from 2005-2010 (E. Crawford, personal communication).

Year	Total captured	Number of Hatchery origin fish captured	Number of hatchery origin fish passed upstream	% Hatchery origin fish @Weir	% Hatchery origin fish escapement	% natural origin fish @ weir	Natural origin fish spawning escapement estimate
2005	513	38	38	7.41	7.41	92.59	611
2006	474	41	37	8.65	7.81	91.35	555
2007	294	52	46	17.69	15.65	82.31	283
2008	350	64	21	18.29	6.00	81.71	300
2009	393	37	10	9.41	2.54	90.59	363
2010	1,180	93	7	7.88	0.59	92.12	1,411
Average	534	54	27	11.55	6.67	88.45	587

Since the late 1980s, the number of redds has fluctuated between 200-900, and averaged 386 (Figure B-13, Table B-14).

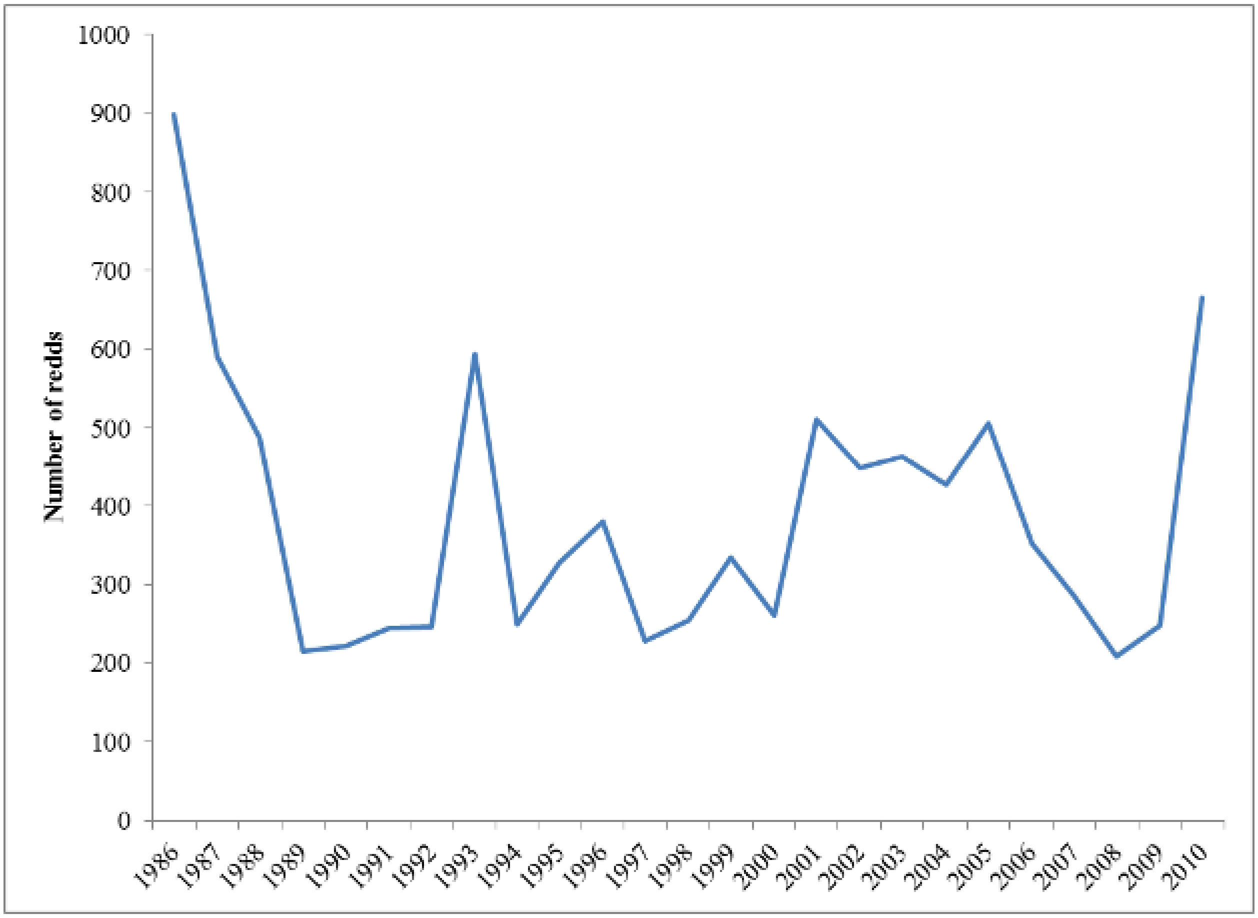


Figure B-16. The number of steelhead redds estimated in an index area of the Asotin Creek basin, upstream of George Creek, 1986-2010 (Bumgarner and Dedloff 2011).

Table B-14. Number and distribution of steelhead redds in index areas of the Asotin Creek basin, 1986-2010 exclusive of George Creek drainage and the lower Asotin downstream of the adult trap (Bumgarner and Dedloff 2011).

	Mainstem		North Fork		South Fork		Charley Creek		
Year	**Redds**	**Percent**	**Redds**	**Percent**	**Redds**	**Percent**	**Redds**	**Percent**	**Total**
1986	354	39.4	295	32.8	173	19.2	77	8.6	899
1987	182	30.8	229	38.7	89	15.1	91	15.4	591
1988	199	40.8	154	31.6	87	17.8	48	9.8	488
1989	122	56.5	50	23.1	28	13.0	16	7.4	216

Year	Mainstem		North Fork		South Fork		Charley Creek		
	Redds	Percent	Redds	Percent	Redds	Percent	Redds	Percent	Total
1990	125	56.3	43	19.4	33	14.9	21	9.5	222
1991	138	56.3	58	23.7	29	11.8	20	8.2	245
1992	120	48.8	56	22.8	30	12.2	40	16.3	246
1993	335	56.4	149	25.1	63	10.6	47	7.9	594
1994	165	66.0	52	20.8	18	7.2	15	6.0	250
1995	185	56.4	79	24.1	38	11.6	26	7.9	328
1996	215	56.4	73	19.2	63	16.5	30	7.9	381
1997	129	56.3	69	30.1	13	5.7	18	7.9	229
1998	144	56.5	55	21.6	38	14.9	18	7.1	255
1999	174	52.1	105	31.4	33	9.9	22	6.6	334
2000	120	46.0	71	27.2	46	17.6	24	9.2	261
2001	300	58.7	116	22.7	42	8.2	53	10.4	511
2002	241	53.8	131	29.2	40	8.9	36	8.0	448
2003	285	61.4	103	22.2	36	7.8	40	8.6	464
2004	281	65.7	89	20.8	5	1.2	53	12.4	428
2005	372	73.5	74	14.6	19	3.8	41	8.1	506
2006	227	64.3	62	17.6	32	9.1	32	9.1	353
2007	160	55.9	38	13.3	44	15.4	44	15.4	286
2008	130	62.2	35	16.7	32	15.3	12	5.7	209

Year	Mainstem		North Fork		South Fork		Charley Creek		
	Redds	Percent	Redds	Percent	Redds	Percent	Redds	Percent	Total
2009	149	59.8	50	20.1	28	11.2	22	8.8	249
2010	384	55.5	95	23.6	46	11.6	36	9.2	665
Average	209	55.4	93	23.7	44	11.6	35	9.3	386
Minimum	120	30.8	35	13.3	5	1.2	12	5.7	209
Maximum	372	73.5	295	38.7	173	19.2	91	16.3	899

As previously mentioned, when NMFS reviews the status of the Asotin Creek population, all MaSAs (Asotin Creek and Alpowa Creek (possibly George Creek)) and MiSAs (Tenmile, Almota, Tammamay, Steptoe, Couse, and Tenmile Canyon creeks) will need to be included. Information on these other areas has been collected sporadically since the early 2000s. If NMFS is going to be able to use the information in their MPG assessments, then more regular information will need to be collected. WDFW has secured funding and intends to annually estimate adult abundance at traps in George Creek, Alpowa, Tenmile and Couse Creeks, as well as periodic annual trapping of adults in Almota Creek for estimating adult abundance and proportion of hatchery fish in the Asotin steelhead population.

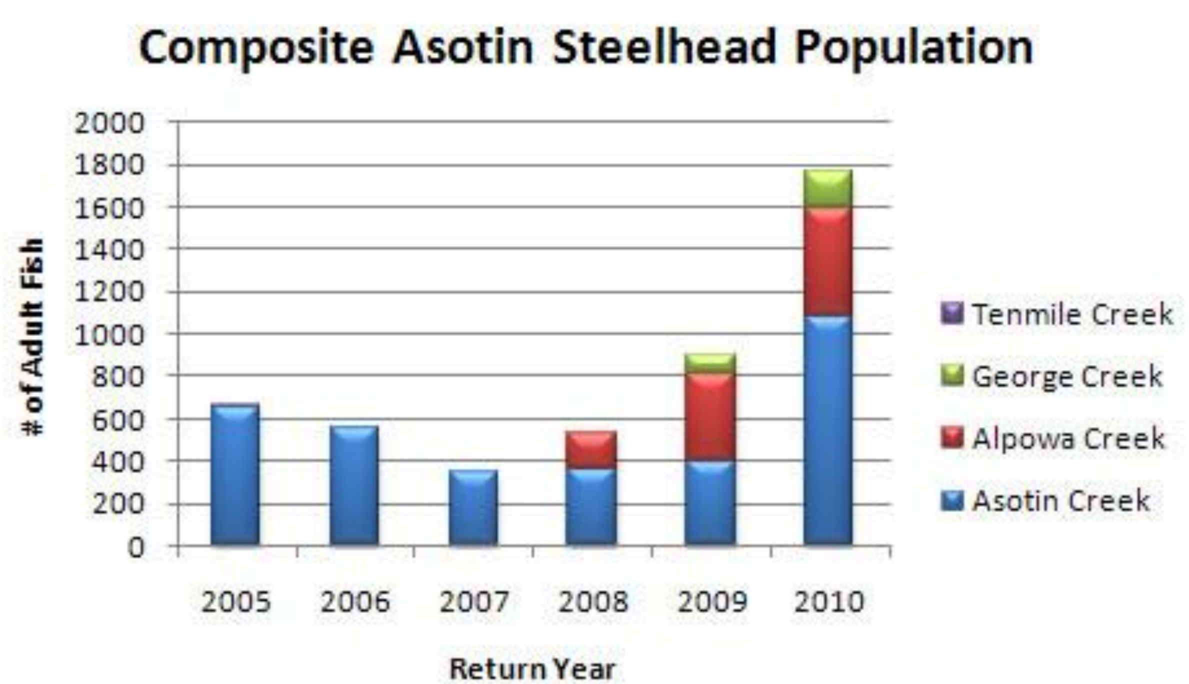


Figure B-17. Number of natural origin fish counted ascending Asotin Creek population including supporting MaSAs other than Asotin Creek (Snake River Recovery Board: http://www.snakeriverboard.org/).

Adult distribution

Based on redd surveys in the index areas upstream of the weir, it appears most of the steelhead spawn in mainstem, with the North Fork, South Fork, and Charley Creek contributing in descending order (Table B-15; Figure B-18). The mainstem and North Fork account for over 70% of the spawning distribution (Figure B-18). As previously mentioned, WDFW has also periodically conducted spawning surveys in other watersheds that are part of the Asotin Creek population (e.g., Almota Creek), but the information is limited to a few years.

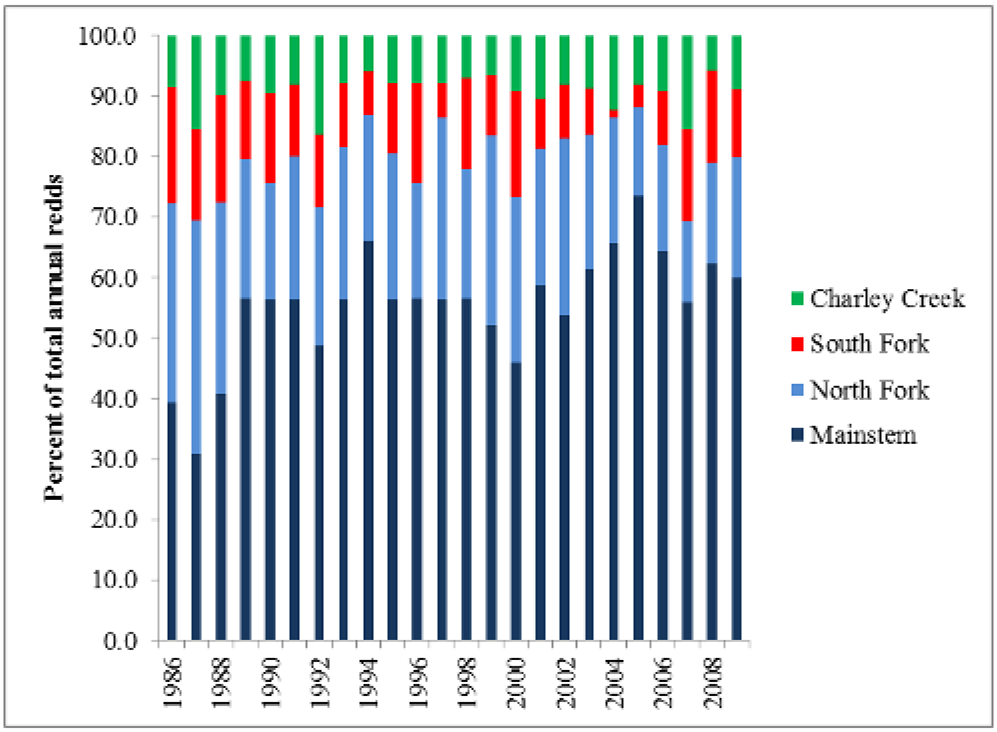


Figure B-18. Steelhead spawner distribution in Asotin Creek, in the index area, upstream of the weir only (Bumgarner and Dedloff 2011).

Hatchery fraction

The Asotin Creek drainage is currently managed for natural production only, but some hatchery steelhead return to this stream, averaging about 12% (Table B-13; Figure B-15) and the other streams associated with the Asotin population. Alpowa Creek, in particular, has a substantial percentage of hatchery steelhead entering to spawn.

Juvenile Abundance and Production

Juvenile steelhead have been sampled in various areas within the Asotin basin upstream of the weir since the late 1990s. Estimates of parr (age zero and one) suggest that most of the rearing occurs in the mainstem Asotin Creek (Table B-15).

Table B-15. Estimated number and density (fish/100m^2) of juvenile steelhead sampled in Asotin Creek, upstream of the weir, between 2003 and 2006 (Bumgarner et al. 2004, 2006, Bumgarner and Dedloff 2007, 2009).

	Mainstem		**North Fork**		**South Fork**		**Charley Creek**	
Metric/year	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**	**Age 0**	**Age 1**
Number of fish								
2003	92,574	27,701	36,400	18,440	38,535	16,687	19,900	13,240
2004	72,913	35,153	24,917	23,241	6,102	18,107	16,598	9,411
2005	70,345	39,708	18,718	10,542	7,050	6,523	4,062	11,329
2006	NA	NA	NA	NA	34,621	5,424	15,107	5,172
Density of fish								
2003	51.86	15.52	36.96	18.72	83.64	36.22	57.67	38.37
2004	41.4	20.14	25.38	24.73	12.51	31.13	48.0	27.21
2005	41.2	23.3	31.1	17.5	15.3	13.9	12.0	33.4
2006	NA	NA	NA	NA	64.3	11.9	44.8	15.3

In more recent years, emigrant abundance has been estimated at the smolt trap in the lower basin. These estimates suggest that the emigrant abundance from the index area has fluctuated between approximately 25,000-50,000 (Figure B-19).

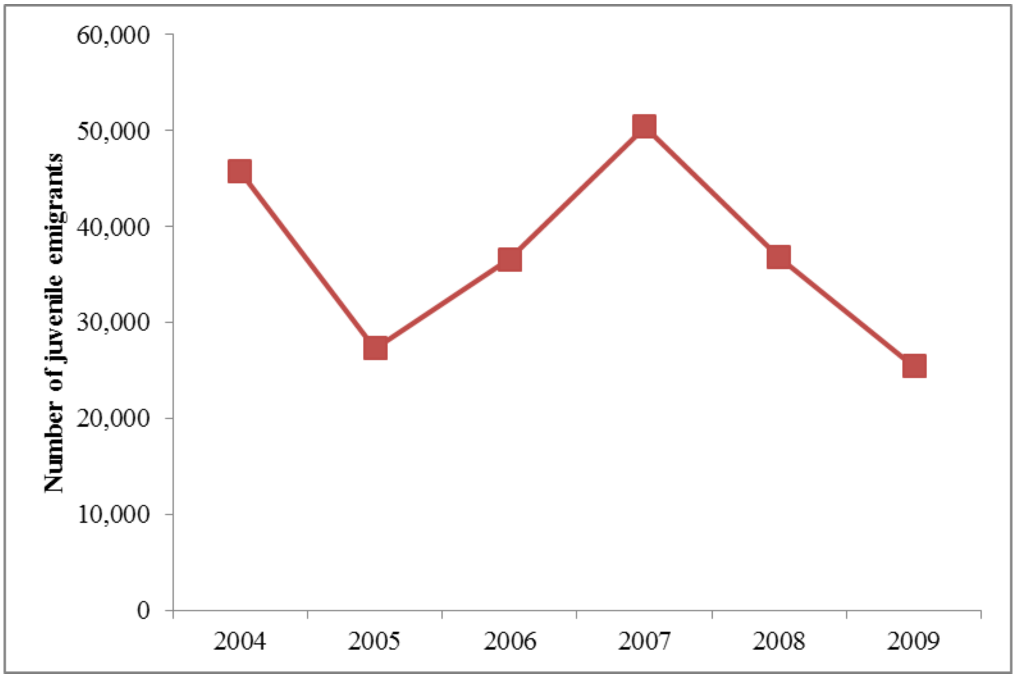


Figure B-19. Estimated number of juvenile steelhead emigrants based on observations at the smolt trap in the lower basin (Mayer et al. 2010). Note the precision around the estimates is large.

MPG Viability

Overall, the Ford et al. (2010) rated the Lower Snake River steelhead MPG at high risk of extinction for the Tucannon population and Asotin Creek populations (Figure B-20). In the five-year status update (Ford et al. 2010), NMFS has acknowledged that escapement estimates suggest that the population may be above the minimum abundance threshold in Asotin Creek, but the information is not from a long enough time period to demonstrate certainty. In addition, there are no estimates of productivity. It should also be noted that population estimates in Asotin Creek are primarily based on trap counts and that spawning also occurs downstream of the trap, plus there are other tributaries (e.g., George Creek, Alpowa Creek) that are also part of the Asotin Creek population. Tucannon index estimates have been based on spawning surveys until a recent shift to use of PIT tag detections and smolt production estimates. More consistent long term data are needed for all areas included for the Asotin and Tucannon populations similar to what is shown in Figure B-17).

Spatial Structure/Diversity Risk

Abundance/ Productivity Risk		**Very Low**	**Low**	**Moderate**	**High**
	Very Low (<1%)	**HV**	**HV**	**V**	**M**
	Low (1-5%)	**V**	**V**	**V**	**M**
	Moderate (6 – 25%)	**M**	**M**	**M**	**HR**
	High (>25%)	**HR**	**HR**	**HR** **Asotin**	**HR** **Tucannon**

Figure B-20. Lower Snake River steelhead MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics (based on Ford et al. 2010). ***Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR –High Risk (does not meet viability criteria). Darker cells are at higher risk.***

Walla Walla

Abundance and Productivity

The 10 year geometric mean for abundance of naturally produced steelhead in the index area (above Nursery Bridge Dam) of the Walla Walla population is 838, with a range of 419-1,746 (Figure B-21) and trending upward (Figure B-21). NMFS (2009) estimated productivity at 1.34 recruits (adults) per spawner. It should be noted that this is only for the index area and Mill Creek, and many other tributaries are not currently included in the adult abundance average.

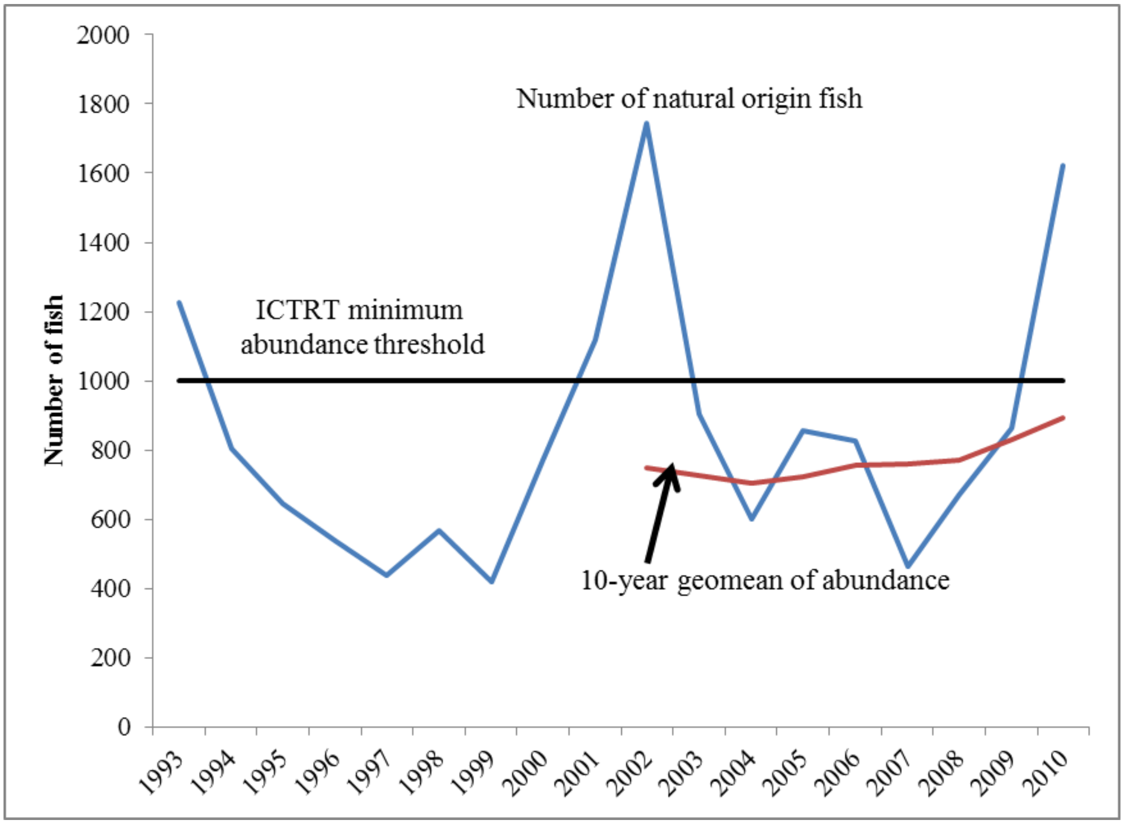


Figure B-21. Adult abundance, and 10-year geomean of abundance for Walla Walla steelhead (NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0).

Adult distribution

Most spawning for this population occurs upstream of Nursery Bridge Dam (Rkm 71.9) in Oregon and in the Mill Creek subbasin (Table B-16). Spawning has also been documented in Cottowood Creek, upper Dry Creek, Yellowhawk Creek, and in several other tributaries.

Table B-16. Counts of steelhead passing Nursery Bridge Dam (Rkm 71.9), or partial counts at the Yellowhawk Creek weir, or Mill Creek Diversion Dam (Mahoney et al. 2009, and Brian Mahoney, CTUIR, personal communication).

Year	Numbers		Percent Hatchery-Origin	
	Nursery Bridge Dam	Mill & Yellowhawk Creeks	Nursery Bridge Dam	Mill & Yellowhawk Creeks
1993	748	35	3.5	5.7
1994	426	11	0.9	0

Year	Numbers		Percent Hatchery-Origin	
	Nursery Bridge Dam	Mill & Yellowhawk Creeks	Nursery Bridge Dam	Mill & Yellowhawk Creeks
1995	367	10	7.4	20.0
1996	278	42	7.2	4.8
1997	262	10	11.8	20.0
1998	320	10	5.6	60.0
1999	231	1	3.0	0
2000	425	13	3.8	0
2001	635	15	6.3	20.0
2002	1205	57	NA	8.9
2003	545	7	NA	42.9
2004	381	84	NA	36.4
2005	590	35	NA	4.0
2006	581	22	5.5	4.5
2007	314	35	1.7	2.9
2008	459	37	2.4	10.8
2009	585	67	2.2	NA
2010	1,099	44	NA	NA
Average	525	30	4.7	15.1
Minimum	231	1	0.1	0.0

Year	Numbers		Percent Hatchery-Origin	
	Nursery Bridge Dam	Mill & Yellowhawk Creeks	Nursery Bridge Dam	Mill & Yellowhawk Creeks
Maximum	1,205	84	11.8	60.0

Hatchery fraction

Since 1993, hatchery-origin fish have made up generally between 4-12%, averaging just under 5% of the spawning aggregate upstream of Nursery Bridge Dam, and between 0 (in low run years) and 60%, averaging about 15%, of the Mill Creek spawning aggregate. It should be noted that the long-term average of hatchery fraction does not adequately reflect the reductions in releases of hatchery steelhead within the basin or the fact that hatchery releases have been moved lower in the watershed where spawning and rearing conditions are not favorable for production.

Juvenile Abundance and Production

Mahoney et al. (2009) estimated the number of juvenile steelhead migrating downstream between 2005 and 2008 based on PIT tag recaptures at the lower rotary screw trap (Rkm 15.3), which is downstream of all of the rearing habitat in the basin. Overall mean annual abundance was 32,383 for naturally produced juvenile steelhead (Table B-17).

Table B-17. Abundance estimate of natural-origin steelhead captured at the lower Walla Walla River rotary screw trap (Mahoney et al. 2009, and Brian Mahoney, CTUIR, personal communication).

Outmigration Year	Number of fish	SE
2005	52,958	5,601
2006	13,994	1,723
2007	14,684	2,343
2008	47,894	2,224
2009	39,788	8,011
2010	36,957	10,742
Average	30,251	

Touchet River

Abundance and Productivity

The number of redds in the Touchet River basin, which is estimated from redd surveys within an index area (includes the North Fork, South Fork, Wolf Fork, and Robinson Fork) and then expanded, has remained relatively constant since the late 1980s (Figure B-22). Estimates of the number of spawners in the index area described above are presented in Table B-18. Estimated spawners (natural, endemic hatchery stock, and Lyons Ferry stock on the spawning grounds) are derived from redd counts, using a standard of 0.8 females/redd, and where available, sex ratio information from the Dayton adult trap (Joe Bumgarner, WDFW, personal communication). As such, some errors in the estimates are possible as the female/redd ratio is known to fluctuate on an annual basis.

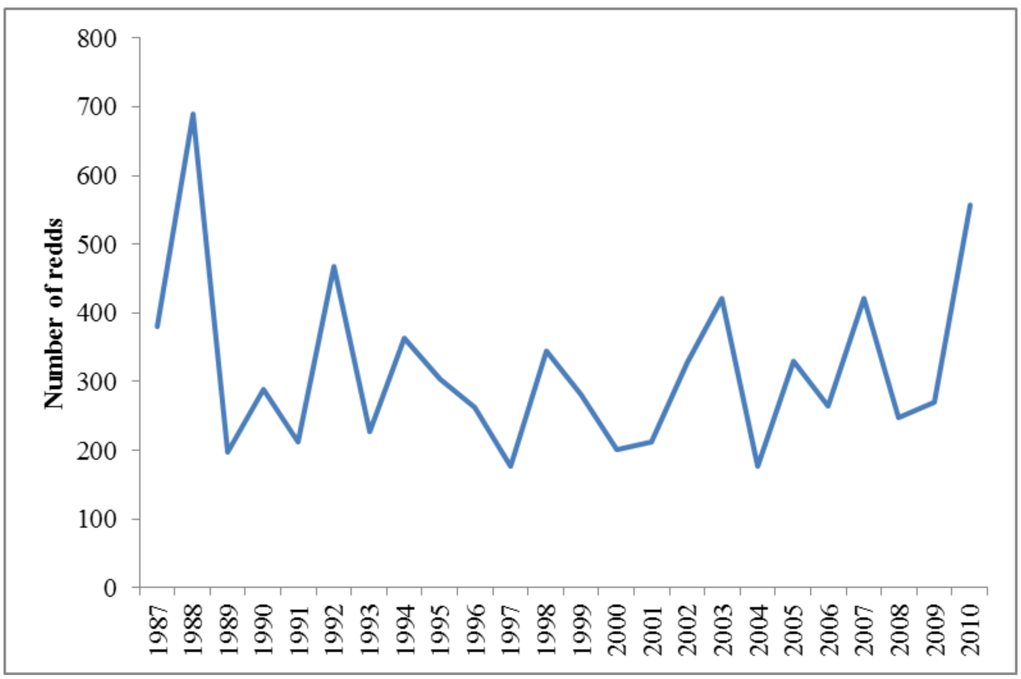


Figure B-22. The number of steelhead redds estimated in the Touchet River basin expanded from index surveys between 1987 and 2009 (Bumgarner and Dedloff 2011).

Table B-18. Estimated number of spawning steelhead (natural, endemic hatchery stock, and Lyons Ferry hatchery stock) in the Touchet River index area upstream of Dayton between 1987-2010. (Joe Bumgarner, WDFW, personal communication).

Year	Total Spawners	Natural Stock	Endemic Stock	LFH Stock	Percent Natural Stock	Percent Endemic Stock	Percent LFH Stock	Total Hatchery Percent
1987	469	408	0	61	87.0	---	13.0	13.0
1988	848	738	0	110	87.0	---	13.0	13.0
1989	244	212	0	32	87.0	---	13.0	13.0
1990	355	309	0	46	87.0	---	13.0	13.0
1991	263	229	0	34	87.0	---	13.0	13.0
1992	578	503	0	75	87.0	---	13.0	13.0
1993	282	244	0	38	86.7	---	13.3	13.3
1994	447	427	0	20	95.6	---	4.4	4.4
1995	387	310	0	77	80.0	---	20.0	20.0
1996	324	282	0	42	87.0	---	13.0	13.0
1997	217	189	0	28	87.0	---	13.0	13.0
1998	425	370	0	55	87.0	---	13.0	13.0
1999	356	305	0	51	85.7	---	14.3	14.3
2000	243	223	0	20	91.6	---	8.4	8.4
2001	259	249	0	10	96.2	---	3.8	3.8
2002	437	423	0	14	96.8	---	3.2	3.2

Year	Total Spawners	Natural Stock	Endemic Stock	LFH Stock	Percent Natural Stock	Percent Endemic Stock	Percent LFH Stock	Total Hatchery Percent
2003	457	425	4	28	93.1	0.9	6.1	6.9
2004	240	181	35	23	75.6	14.8	9.7	24.4
2005	471	343	50	78	72.7	10.7	16.6	27.3
2006	333	263	61	9	78.9	18.4	2.7	21.1
2007	475	344	112	19	72.4	23.6	4.0	27.6
2008	292	225	54	13	77.0	18.5	4.5	23.0
2009	350	216	122	12	61.7	34.7	3.5	38.3
2010	842	667	172	3	79.2	20.5	0.3	20.8

In addition, WDFW has been doing redd surveys in Coppei Creek, which are presented in Table B-19 below.

Table B-19. Summary of redd surveys in Coppei Creek basin. It is important to note that survey effort has varied over the years and comparison between years can be complicated because of it. Years with blank spaces denotes that no survey was done. (Glen Mendel, WDFW, personal communication).

Year	South Fork (RM 0-5.5) and North Fork (RM 0-4.1)	Mainstem (RM 0-8.1)
1999	31	
2000	20	11
2001		
2002		
2003	21	3
2004	18	15
2005	27	17
2006	9	0
2007	9	4
2008	30	4
2009		
2010	19	61

Productivity (recruits/spawner) has been estimated by WDFW for the Touchet River summer steelhead population using the data collected from the spawning ground survey index area only (Figure B-23). These data were estimated using redd counts, estimated number of spawners as described above, and age composition data from scale samples from natural-origin summer steelhead captured at the Dayton adult trap. Average age composition was used in years where no age data were available. Based on the calculations, the average recruits/spawner is 0.89, indicating that the stock (within this portion of the river only) may be below the replacement level.

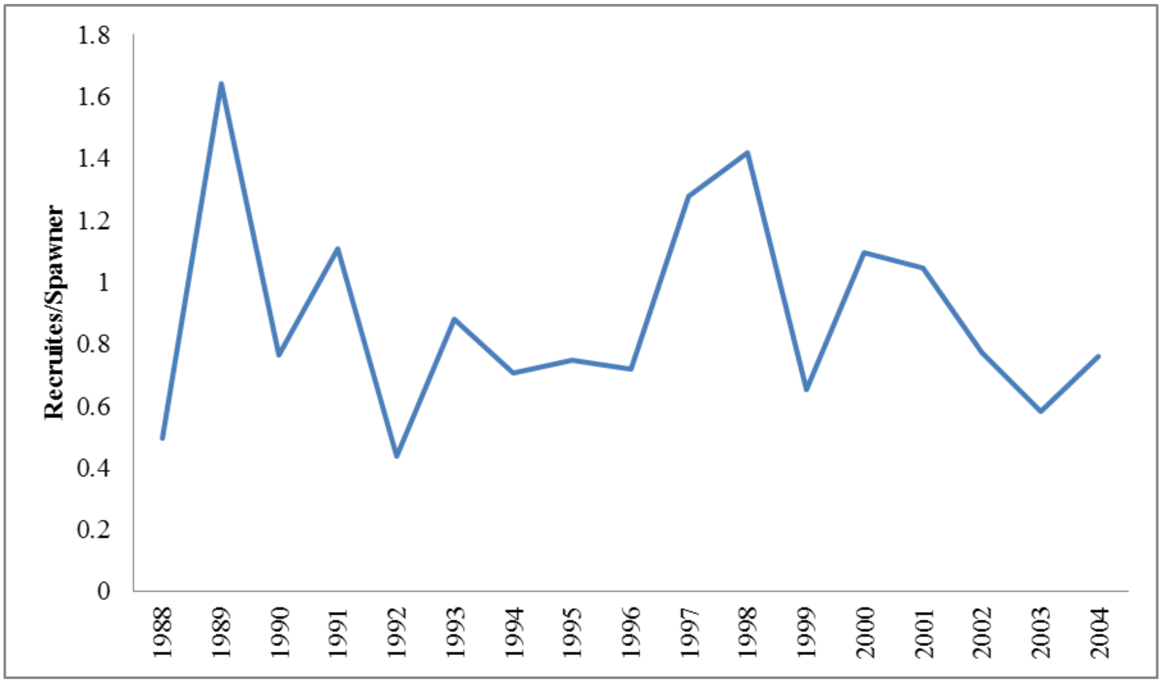


Figure B-23. Estimated recruits/spawner of Touchet River summer steelhead for the index areas only (1988-2004 brood years) (Joe Bumgarner, WDFW, personal communication).

Adult distribution

Within the Touchet Basin index area, most spawning takes place in South Fork, followed by the North Fork, Wolf Fork, and Robinson Fork (Figure B-24). The South and North forks account for an average of over 60% of the redds in the index area of the basin. As previously shown, spawning has also been enumerated (Table B-19) periodically by WDFW (Glen Mendel, WDFW, personal communication in the mainstem Coppei as well as in the South and North Forks of Coppei Creek. WDFW has also observed spawning by steelhead in upper Patit Creek, Whiskey Creek, and some of the non-index tributaries upstream of Dayton, so these adult returns are not included in stock status reviews to date.

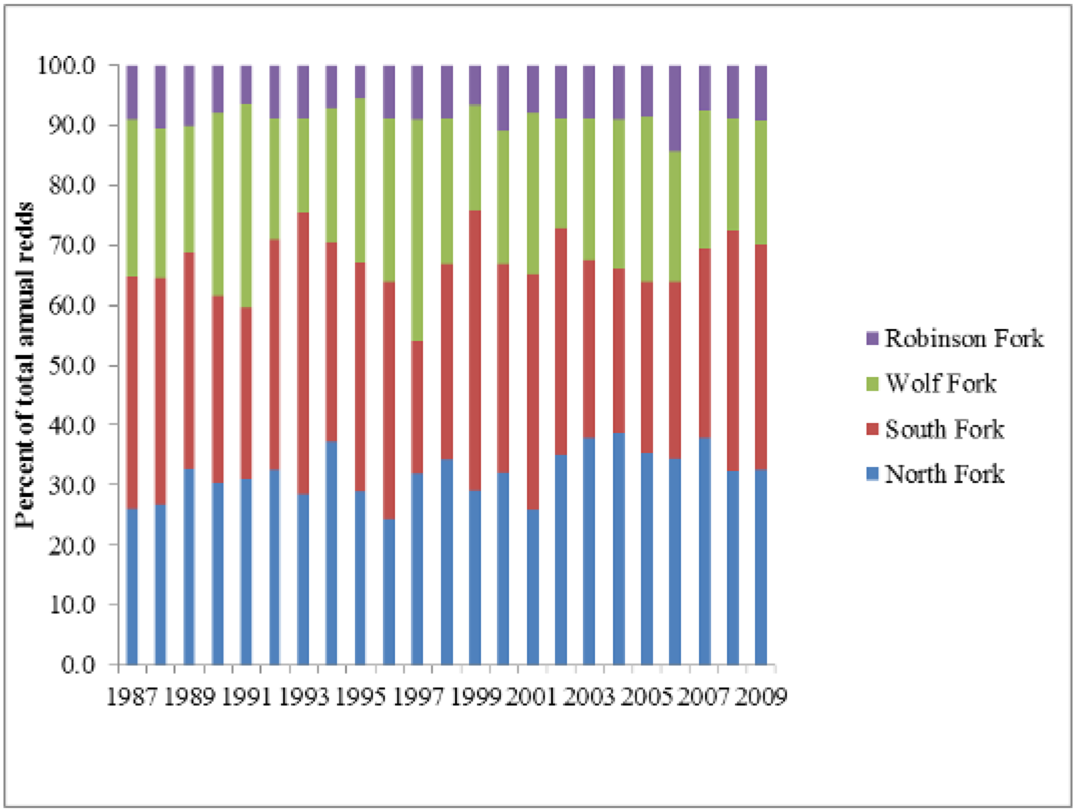


Figure B-24. Spawning distribution of steelhead in the Touchet River based on redd counts in index areas upstream of Dayton, 1987-2009 (Bumgarner and Dedloff 2011).

Hatchery fraction

The percentage of natural-origin fish averaged about 85-90% between the late 1980s and the mid-2000s (Table B-18, Figure B-25). Since 2004, the percentage of natural-origin fish has been declining, averaging just over 70%. This is most likely due to the return of endemic stock hatchery steelhead (ESA listed) that are allowed to pass upstream of the Dayton trap to spawn. In recent years, WDFW has taken a more aggressive approach to management of hatchery origin (LFH stock) steelhead that return to the Dayton adult trap. Currently, LFH stock fish that are captured are removed from the system by either placing them in the Dayton Juvenile Fishing Pond, or are immediately culled with the carcass provided to a local food bank.

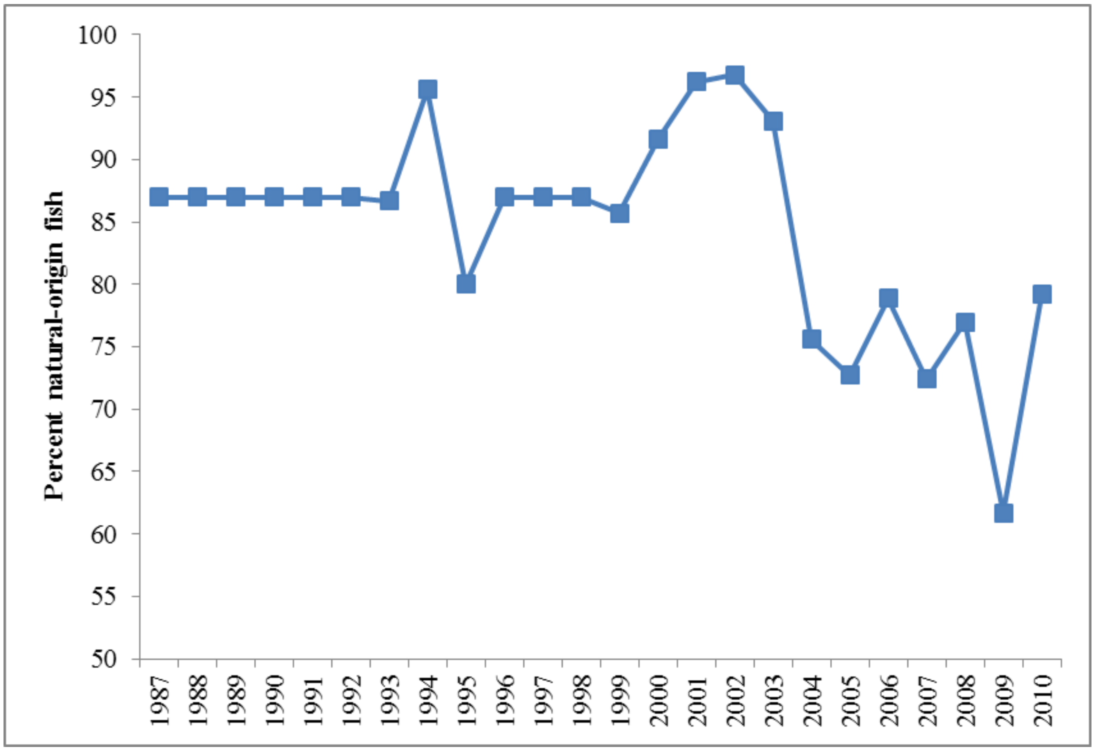


Figure B-25. The estimated percentage of natural-origin steelhead on the spawning grounds in the Touchet River, 1987-2010 (Joe Bumgarner, WDFW, personal communication).

Juvenile Abundance and Production

Juvenile steelhead have been sampled in various index areas within the basin since the late 1990s. Estimates of parr (age zero and one) suggest that most of the rearing occurs in the mainstem North Fork (Table B-20).

Table B-20. Estimated number and density (fish/100m^2) of juvenile steelhead sampled in the Touchet River between 2003 and 2006 (Bumgarner et al. 2004, 2006, Bumgarner and Dedloff 2007, 2009).

Metric/year	Mainstem		North Fork		Wolf Fork		South Fork		Robinson Fork	
	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1
Number of fish										
2003	51,330	5,845	110,488	34,083	40,494	21,249	57,516	21,678	10,988	7,604
2004	NA	NA	51,419	32,521	42,709	19,660	62,551	25,795	6,317	6,142
2005	42,369	9,831	46,871	23,093	27,548	14,935	18,430	21,267	3,972	2,505

2006	NA	NA	106,943	24,029	66,320	16,254	43,890	16,806	20,842	3,574
Density of fish										
2003	25.51	2.91	54.17	16.71	32.78	17.20	42.99	16.20	39.63	27.43
2004	NA	NA	33.53	21.20	35.01	16.11	33.81	13.94	16.38	15.93
2005	24.9	5.8	33.3	16.4	24.9	13.5	15.0	17.3	18.4	11.6
2006	NA	NA	70.4	15.8	50.2	12.3	29.5	11.3	67.6	11.6

MPG Viability

Overall, Ford et al. (2010) and the mid-Columbia recovery plan (NMFS 2009) rated the Touchet population at high risk of extinction (Figure B-26), while the Walla Walla population is at moderate risk. The primary reason for the high risk rating was because of the lack of a long term dataset and stock status uncertainty associated with the existing data at the time the ICTRT did their review. Productivity measures as provided above in Figure B-23 have been completed since that time, though a viability analysis has not been completed yet.[27] The adult trap and weir in Dayton was improved in 2008 to help determine adult steelhead abundance passing that point annually, similar to Nursery Bridge Dam as a counting point. WDFW also has installed an adult trap in Coppei Creek in 2010 to estimate abundance in that tributary of the Touchet River. New smolt traps in the Touchet River drainage will be used to estimate smolt production, and combined with PIT tagging and subsequent detections, with provide SARs and estimated adult returns to the Touchet drainage.

[27] It is important to note that when NMFS does the viability analysis, they delimit the data at the estimated 75th percentile of carrying capacity.

Spatial Structure/Diversity Risk

Abundance/ Productivity Risk		Very Low	Low	Moderate	High
	Very Low (<1%)	**HV**	**HV**	**V**	**M**
	Low (1-5%)	**V**	**V**	**V**	**M**
	Moderate (6 – 25%)	**M**	**M**	**M** **Umatilla** **Walla Walla**	**HR**
	High (>25%)	**HR**	**HR**	**HR** **Touchet**	**HR**

Figure B-26. Umatilla/Walla Walla steelhead MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics (NOAA Fisheries 2009). Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR –High Risk (does not meet viability criteria). Darker cells are at higher risk.

Grande Ronde Subbasin (within Washington State)

Abundance and Productivity

There is currently insufficient information to understand the current status of steelhead within the Lower Grande Ronde MPG. WDFW has conducted some limited spawning surveys and adult trapping in small tributaries of lower Grande Ronde (e.g. Rattlesnake Creek). Currently, there is no sampling by co-managers for steelhead using the Wenaha drainage, so little is known about steelhead in this drainage that is mostly within a designated wilderness area. Crooked Creek in particular is expected by WDFW to be a significant steelhead stream, but no data exists on abundance, distribution or production in this large watershed.

Information is available for the Joseph Creek population, and since 1980, abundance has ranged from 573-6,475, with a current 10-year geomean of 2,138 (Table B-21). Using the full data set, the average return per spawner is over 2 for Joseph Creek steelhead (or, just under 2 for the delimited data; Ford et al. (2010)).

Abundance estimates are based on expansions of redd counts from annual index area spawning surveys in tributaries of Joseph Creek (data from Oregon Department of Fish and Wildlife, Wallowa District). Index surveys represent all three of the MaSAs within the basin. No survey data are available for the MiSAs so basin averages are used to represent the MiSAs. The fish per redd estimate was determined from a study conducted on Deer Creek, a tributary to the Wallowa River.

**Table B-21.	Joseph Creek steelhead spawners, 10-year geomean of spawners and return per spawner from 1980-2009 (NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0).**

Brood year	Spawners	10-yr geomean-abundance	Return per spawner
1980	763		4.64
1981	1,414		4.2
1982	867		5.67
1983	718		7.38
1984	934		6.24
1985	6,475		0.67
1986	5,375		0.39
1987	4,374		0.21
1988	6,354		0.34
1989	5,292	2,242	0.48
1990	3,393	2,603	0.36
1991	658	2,411	1.24
1992	1,171	2,485	1.01
1993	3,228	2,888	0.67

Brood year	Spawners	10-yr geomean-abundance	Return per spawner
1994	1,820	3,087	1.47
1995	573	2,422	3.63
1996	1,084	2,064	2.13
1997	1,251	1,821	2.6
1998	3,170	1,699	1.01
1999	2,133	1,551	1.12
2000	2,020	1,473	1.06
2001	2,596	1,690	
2002	4,751	1,944	
2003	2,381	1,885	
2004	1,755	1,878	
2005	1,832	2,110	
2006	1,427	2,169	
2007	1,212	2,162	
2008	2,322	2,096	
2009	3,597	2,208	
Average	2,498		2.22
Minimum	573	1,473	0.21
Maximum	6,475	3,087	7.38

Hatchery fraction

The hatchery fraction within the Lower Grande Ronde population is not known. Joseph Creek is managed as a wild fish sanctuary and the estimated proportion of natural-origin fish on the spawning grounds is believed to be near 100%. The Nez Perce Tribe has begun adult trapping in lower Joseph Creek in fall 2010 and operates a PIT tag antenna there as well, so additional information will be available in the future.

MPG Viability

As discussed previously, only the Joseph Creek Population has enough information to empirically assess viability. Figure B-27 below shows that the Joseph Creek population is highly viable (has a < 1% risk of extinction in 100 years).

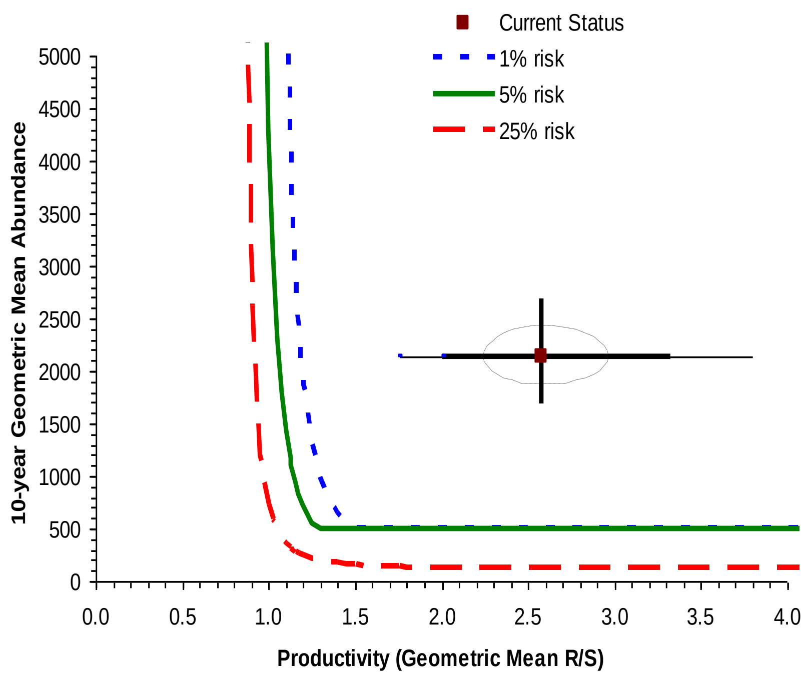


Figure B-27. Joseph Creek summer steelhead population current abundance and productivity (A/P) compared various risks of extinction within 100 years. Ellipse = 1SE. Error bars = 90% CI for A, 98% CI for P (if point estimate exceeds 1% risk curve, the uncertainty test is < 1% probability the underlying combination is at high risk; based on Ford et al. 2010).

In terms of the entire MPG, Figure B-28 shows the general risk of extinction levels for the various populations of the Grande Ronde MPG, although WDFW questions the validity of the lower Grande

Ronde assessment because of the lack of data regarding abundance, productivity or hatchery fraction (Glen Mendel, WDFW, personal communication).

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	**HV**	**HV** **Joseph**	**V**	**M**
	Low (1-5%)	**V**	**V** **Lower GR?**	**V**	**M**
	Moderate (6 – 25%)	**M**	**M** **Lower GR?** **Wallowa**	**M** **Upper GR**	**HR**
	High (>25%)	**HR**	**HR**	**HR**	**HR**

Figure B-28. Grande Ronde River MPG steelhead population risk ratings integrated across the four viable salmonid population (VSP) metrics (based on Ford et al. 2010). Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR –High Risk (does not meet viability criteria).

B.3 COMPARISON BETWEEN ICTRT AND FULL DATA SET

As discussed at the beginning of this appendix, not all data is used by the ICTRT if it exceeds the estimated 75th percentile of current carrying capacity. In Table B-22 below, a comparison is made between the 10-year geomean of abundance and the 20-year geomean of productivity (recruits per spawner) if the information is available. For the populations where the comparison can be made (Tucannon spring/summer Chinook, Wenaha spring/summer Chinook, Joseph Creek and Asotin steelhead), it shows a consistent pattern: the 10-year geomean for abundance is greater for the full data set compared to the value derived by the ICTRT. However, the opposite is true for productivity; the full data set consistently shows a lower value. This appears to validate the ICTRT approach: productivity appears to be affected when the population approaches carrying capacity, most likely due to density-dependent mortality.

Table B-22. Southeast Washington Management Unit salmonid populations: comparison of summary of abundance, productivity, risk ratings, and minimum abundance thresholds (Source: Ford et al. 2010 (five-year update), Bumgarner and Dedloff (2011), Gallinat and Ross (2009), Mayer et al. (2010), or NOAA salmon population summary SPS database: https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0). It is important to note that many of the estimates in the table do not include all of the MaSA or MiSAs, or are derived from index reaches only. ID = insufficient data. A cell that is highlighted in red denotes that the information was not found, but it may be available somewhere.

MPG/Population	*Minimum Abundance Threshold*	*Size Category*	*Recent 10-year Geomean Abundance*		*Abundance Range*	*Hatchery Fraction*	*Recent 20-year Geomean Productivity*		*A&P Risk Rating*	*SS/D Risk Rating*
			ICTRT	*Based on full data set (source reports)*			*ICTRT*	*Based on full data set (source reports)*		
Lower Snake River spring/summer Chinook salmon MPG										
Tucannon River	750	Intermediate	269	371	5-1,443	0.65	0.74	0.71	High	Moderate
Asotin Creek	500	Basic	Functionally extirpated						High	High
Grande Ronde/Imnaha spring/summer Chinook MPG										
Wenaha River	750	Intermediate	441	441	68-750	0.05	0.72	0.64	High	High
Umatilla/Walla Walla steelhead MPG										
Walla Walla Mainstem	1000	Intermediate	894	860	421-1,811	0.02	1.15	NA	Moderate	Moderate
Touchet River	1000	Intermediate	394	461	286-626	0.18	0.96	ID	High	Moderate

MPG/Population	***Minimum Abundance Threshold***	***Size Category***	***Recent 10-year Geomean Abundance***		***Abundance Range***	***Hatchery Fraction***	***Recent 20-year Geomean Productivity***		***A&P Risk Rating***	***SS/D Risk Rating***
			ICTRT	***Based on full data set (source reports)***			***ICTRT***	***Based on full data set (source reports)***		
Lower Snake River steelhead MPG										
Tucannon River	1000	Intermediate	ID	308		ID	ID		High	Moderate
Asotin Creek	500	Basic	ID	587[a]	283-1,411	0.07[a]	ID	ID	High	Moderate
Grande Ronde steelhead MPG										
Lower Grande Ronde.	1000	Intermediate	ID	ID	ID	ID	ID	ID	Low (?)[b]	Low
Joseph Cr.	500	Basic	2,186	2,208	573-6,476	0.0	1.94	1.34	Very Low	Low

[a] For Asotin Creek, 587 is the average (not geomean) between 2005-2010 for the index area above George Creek, but does not include lower Asotin, George, Tenmile, Couse, Alpowa and Almota creeks.. The hatchery fraction for Asotin Creek is based on trapping and what was allowed to pass upstream.

[b] It is important to note that ranking of the Lower Grande Ronde steelhead population as low risk should be viewed cautiously since there is little information on abundance, productivity, or hatchery fraction for this population.

B.4 BULL TROUT

B.4.1 Population Structure

For ESA listing purposes the range of bull trout has been broken into distinctive population segments (DPSs) as the base units for assessing species recovery (USFWS 2002a). DPSs are units of a population that are considered: 1) 'discrete' (to some extent separated from the remainder of the species or subspecies); and 2) 'significant' (biologically and ecologically). Bull trout DPSs are further subdivided into recovery units (RUs), core areas and local populations (Figure B-29). Recovery units were delineated based on the distribution and biology of bull trout as well as considerations for paralleling existing state fisheries management frameworks.

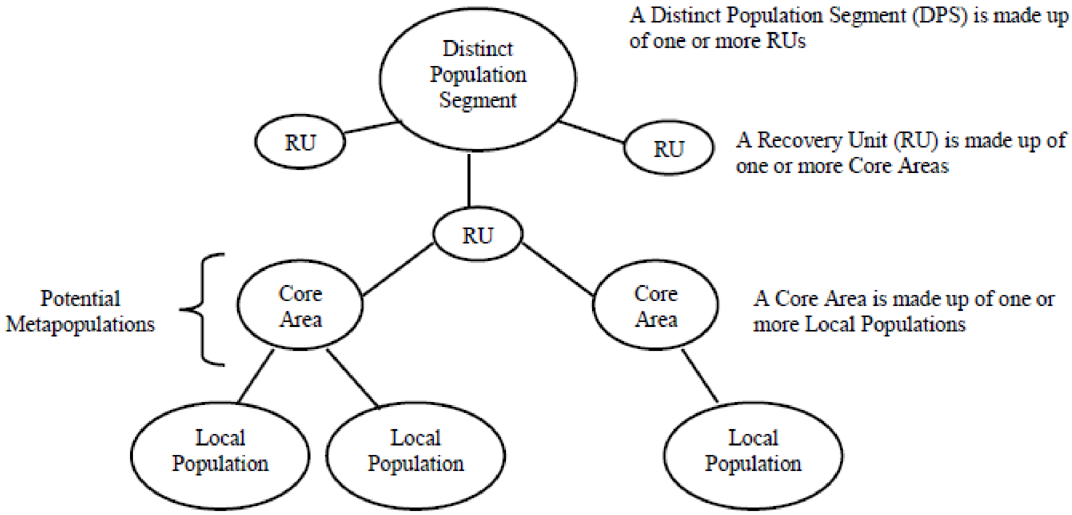


Figure B-29. Bull trout population units as defined by the USFWS (USFWS 2008a).

Core areas are defined as combinations of core habitat and core populations of bull trout that form a biologically functioning unit. Core areas were identified in an attempt to reflect existing bull trout metapopulation structure (USFWS 2002a).

Local populations are defined as groupings of bull trout that spawn within particular streams or portions of a stream system, and represent interacting reproductive units. There may be one or multiple local populations within a single core area. Variation in approaches to identification has resulted in bull trout within individual streams in some areas being designated as separate local populations (splitting), while in other areas there has been a tendency to lump tributaries together into a single local population.

Population Sub-structure

Walla Walla Basin

In 2004, the USFWS revised their initial population structure in the Walla Walla basin, separating the Walla Walla core area into upper Mill Creek and upper Walla Walla local populations, while the Touchet River core area is comprised of the three discrete populations (North Fork Touchet River, South Fork Touchet, and the Wolf Fork of the Touchet River).

The population designations by USFWS (2004) were not made with genetic data, but with limited local population studies, extensive literature review, and assessment of geographic separation of spawning areas. A microsatellite analysis by Spruell et al. (2003) on 65 populations of bull trout from the Northwestern part of the United States included samples from the Walla Walla River Basin. That analysis concluded that there was little genetic variation within bull trout populations but substantial divergence among populations. They lumped bull trout from the Walla Walla River Basin with other populations in the Snake and mid-Columbia River Basin into a broad group.

Kassler and Mendel (2007) collected samples of migratory adult bull trout from traps in the three primary drainages within the Walla Walla Subbasin (Mill Creek, Touchet River, and Walla Walla River) and samples of juvenile bull trout were collected from five locations that had both spawning and juvenile rearing (Lewis Creek, Spangler Creek, North Fork, Wolf Fork, and Burnt Fork) in the Touchet River basin. These samples along with bull trout data from two collections in the Yakima River basin were analyzed with a microsatellite DNA analysis to address the following management goals, with the results following (taken from Kassler and Mendel (2007), emphasis added):

1. Are there significant genetic differences among populations of adult migratory bull trout in the Mill Creek, Walla Walla River, and Touchet River drainages? If so, should bull trout in these areas be managed as separate populations?

Assessment of migratory adult bull trout from the Walla Walla River Basin consistently identified genetic differences among groups. Results of the tests for genotypic differentiation revealed the individual collections of adults from the Walla Walla, Touchet, and Mill Creek were all significantly different, and the FST values indicated differences among the collections per location. The neighbor joining tree supports the genotypic tests, factorial correspondence analysis, and FST tests by separating the three collection groups with high bootstrap support. ***All the results from this analysis identify that these three populations of adult bull trout in the Walla Walla River Basin are genetically distinct and should be managed as separate populations.***

2. Are there significant genetic differences among juvenile (generally less than 200 mm fork length) bull trout captured during summer from five isolated spawning areas in the Touchet River drainage; and are these juvenile populations different enough to be managed separately?

Analysis of the combined collections of juveniles revealed that all five populations were highly significantly different from one another with the genotypic differentiation tests. The FST values indicate the difference between the Burnt Fork samples to the other four collections is between 0.0716 – 0.1127, while the difference among the other four collections within the N.F. Touchet River are lower (between 0.0323 – 0.0602). The difference between the Burnt Fork group and relationship of the other four groups to each other is not surprising given that the Burnt Fork is geographically isolated as a tributary to the upper S.F. Touchet River, while the other collections are part of the N.F. Touchet River drainage. The neighbor joining tree does not separate the juvenile collections in the N.F. Touchet River with any statistical significance or support; however the Burnt Fork group is separated from those groups with 98% bootstrap support. The factorial correspondence analysis of juvenile bull trout collections; however does show strong separation between the N.F. Touchet mainstem, Wolf Fork, and Burnt Fork even though the neighbor-joining tree does not indicate separation with any statistical support. The jackknife analysis of Burnt Fork and Lewis Creek had the lowest assignment power with less than 78% of the juveniles assigning back to the correct stock-of-origin while the remaining three collections assigned over 89% of the juveniles to the correct stock-of-origin. The Burnt Fork (N = 9) and Lewis Creek (N = 13) had the smallest sample sizes and that could contribute to the lower assignment power. Results of the assignment tests for the migratory adults collected at Dayton Dam revealed over 89% of the individual samples were from the Wolf Fork and the N.F. Touchet River. Considering the escapement to each of the five locations (Mendel et al. 2006) this result may is not surprising.. ***The overall results of the genetic analyses determines the five groups can be genetically differentiated, however the small sample sizes for the Lewis Cr., Spangler Cr., and Burnt Fork limits the confidence level of differentiation for these sites.***

The combined results of multiple statistical tests in this report supports that the N.F. Touchet River mainstem, Wolf Fork, and Burnt Fork (even though the collection had a small sample size) are differentiated and should be managed as separate groups

3. Provide evidence (if possible) that bull trout in the tributaries of the Walla Walla River Basin have undergone a genetic bottleneck or are inbreeding. Calculate effective population size (Ne) for each group or collection, if possible.

Analysis to determine relatedness revealed values that suggest the possibility of full sibling pairs in the collection groups. The analysis of linkage disequilibrium and the inbreeding coefficient (FIS), however were low and did not support a conclusion that there were sibling groups in the collections. A more detailed assessment of the individual samples would be required to test for sibling relationships. The rationale for eliminating samples based on sibling relationship within sample groups would have to be considered, however no samples were removed from this analysis for that reason. If samples are randomly collected and determined to be from family groups, but they are contributing to the reproductive output of the population then the genetic identity of those samples should be included in population level analyses because they represent the population. ***The analysis to determine if the collections have undergone a bottleneck indicates the populations have not undergone any recent reductions in population size and suggests that the populations of bull trout have been small for some time. Evaluation of the effective population size was not conducted due to the small sample sizes for some collections and the lack of temporal samples; however evaluation on the collections with larger samples sizes (e.g. N. Fork Touchet, Wolf Fork, and Mill Creek) should be conducted at a later date***

4. Compare the genetic characteristics and stock structure of bull trout in another Columbia River Basin (Yakima River Basin) with the Walla Walla River Basin to determine genetic relatedness among bull trout in these two basins.

Adult bull trout that were analyzed from the Yakima River basin and compared to adult bull trout in the Walla Walla River Basin were much more different based on the results of all the statistical tests. ***The level of genetic variation and differentiation between bull trout in the Walla Walla River Basin and the Yakima River Basin identifies that the separation and isolation of these groups has been longer than the separation of bull trout within the Walla Walla River Basin.***

Asotin Creek

Kassler and Mendel (2008) collected bull trout from the upper and lower Asotin Creek and analyzed them to determine the relationship between the populations within these areas within the Asotin Creek. Bull trout samples from the North Fork Wenaha River, Walla Walla River basin and Tucannon River were also compared to the samples from the Asotin Creek. Sixteen nuclear microsatellite DNA loci that are included in the standardized suite of loci were used to examine the levels and patterns of genetic variation. Tests of population subdivision, factorial correspondence analysis, and the neighbor-joining tree suggested the collections of bull trout from the upper and lower Asotin Creek are genetically differentiated; however there are some samples from the upper Asotin Creek that appear in the lower Asotin Creek. Bull trout in both the upper and lower Asotin Creek are differentiated from samples of bull trout in the North Fork Wenaha River, the Walla Walla River basin, and the Tucannon River. Bull trout from the North Fork Wenaha were different than bull trout in both Asotin Creek and the Tucannon River.

Tucannon River

The USFWS and WDFW conducted an analysis of bull trout populations in upper reaches of the Tucannon River (DeHann et al. 2007). The number of fish samples from Cummings Creek were insufficient and were deleted from the analysis. Genetic analysis indicated clustering among the Panjab group and upper Tucannon River and Bear Creek, plus significant differences in all five reaches analyzed.

B.4.2 Current Distribution

The Washington Snake River Bull Trout Recovery Unit Team has identified the Tucannon River and Asotin Creek basins as separate core areas within the SEWMU. Local populations within the recovery unit consist of migratory and resident life history forms (USFWS 2002b, Faler et al. 2008). Migratory forms include fluvial bull trout that overwinter in the mainstem Tucannon River and fish that may overwinter in and migrate from locations in the mainstem Snake River to as far downstream as the Lower Monumental Dam pool (Faler et al. 2008).

The Grande Ronde bull trout Recovery Unit Team identified nine extant, local populations of bull trout within the Grande Ronde River subbasin. Only the Wenaha River population is within the SEWMU.

Currently, bull trout are found in two core areas within the Walla Walla subbasin: the Upper Walla Walla core area, which contains local populations in upper Mill Creek (mostly above the City of Walla Walla) and in the North and South Fork of the Walla Walla River; and the Touchet River core area, which contains local populations in the North Fork of the Touchet River, the South Fork of the Touchet River, and the Wolf Fork of the Touchet River. Fluvial and resident life history forms are found in both Walla Walla core areas.

Various studies using PIT and radio tags (Faler et al. 2008, Anglin et al. 2009) have shown fluvial bull trout using the mainstem Columbia and Snake Rivers for part of their life histories.

B.4.3 Current Abundance

Tucannon River

Both resident and migratory forms of bull trout occur in the Tucannon River basin (CCD 2004). Bull trout spawning ground surveys have been conducted intermittently since 1990 (Table 5-23). The headwater areas known to support bull trout spawning include the upper reaches of the mainstem Tucannon (from approximately rivermile 45 to 58) and upper Tucannon tributaries including lower Sheep Creek, lower Cold Creek, Bear Creek, Panjab Creek, and several tributaries of Panjab Creek, including Turkey Creek, Meadow Creek, and Turkey Tail Creek (Table B-23). Bull trout are also documented in Cummings Creek.

Within the Tucannon basin, an average of 129 redds have been counted since 1994, ranging from 23 to 225 (Table 5-23). The redd surveys have not been conducted with the same level of effort throughout the years because of funding issues so comparisons among years should be used with caution and additional data.

Table B-23. Bull trout redd counts in the Tucannon River basin, 1994-2010 (Glen Mendel, WDFW, personal communication). It is important to note that survey effort has varied over the years and comparison between years can be complicated because of it. Blank spaces denote no survey, while a "0" denotes a survey was conducted but no redds were found.

Year	Tucannon River				Sheep Cr.	Cold Cr.	Bear Cr.	Panjab Cr.	Meadow Cr.	Turkey Cr.	Turkey Tail Cr.	Grand Total
	Rivermile											
	44.6-50.7	50.7-54.2	54.2-58.0	Total	0.0-0.6	0.0-0.8	0.0-2.6	0.0-4.5	0.0-4.9	0.0-2.1	0.0-3.4	
1994	22	99		121			10					131
1995	37	63		100			5	7	2			114
1996	15	78	52	145			25	9	5			184
1997	13	25	13	51			23	4	0			78
1998	26	78		104			4	0	0			108
1999	36	57	42	135	2	2	26	16	25	8	8	222
2000	17	52	26	95			49		7			151
2001		68		68								68
2002	13	20	14	47			32	3	8			90
2003	26	37	59	122			49	11	3	3	0	188
2004	34	55	36	125	4	0	51	19	20	6		225
2005	23	63		86			48	0	13			147
2006												
2007		13		13			4	1	5			23

Year	Tucannon River				Sheep Cr.	Cold Cr.	Bear Cr.	Panjab Cr.	Meadow Cr.	Turkey Cr.	Turkey Tail Cr.	Grand Total
	Rivermile											
	44.6-50.7	50.7-54.2	54.2-58.0	Total	0.0-0.6	0.0-0.8	0.0-2.6	0.0-4.5	0.0-4.9	0.0-2.1	0.0-3.4	
2008		33		33			20	0	14			67
2009		42		42			29					71
2010		49	74	123			41	6	29			199
Average	24	52	40	88	3	1	28	6	10	6	4	129
Minimum	13	13	13	13	2	0	4	0	0	3	0	23
Maximum	37	99	74	145	4	2	51	19	29	8	8	225

Asotin Creek

Bull trout have been documented periodically over many years by WDFW staff in Charley Creek, Asotin Creek (mainstem), and the North and South Forks of Asotin Creek (ACCD 2004). Mendel et al. (2006, 2008) found bull trout spawning in the North Fork Asotin Creek and Cougar Canyon Creek. Mendel et al. (2006, 2008) found less than 10 redds during their surveys, and surveys are not conducted on a regular basis. Mayer and Schuck (2004, 2008, 2009) and Mayer et al. (2005, 2006, 2007, 2010) routinely (but not in all years) capture bull trout in a rotary screen or adult trap in the lower Asotin basin, so spawning and rearing likely occurs in most years. Note that the WDFW genetics study could not verify that the lower Asotin and upper Asotin bull trout samples were necessarily from the same population and the lower Asotin bull trout might be winter and spring foraging fish from other drainages.

Walla Walla Subbasin

There are three local populations of bull trout in the Walla Walla Subbasin: the Touchet River, Mill Creek, and the upper Walla Walla. Bull trout in the Walla Walla Basin exhibit both fluvial and resident life histories.

The Walla Walla subbasin supports at least five local populations (Kassler and Mendel 2008) of bull trout; two in the forks of the Walla Walla (North Fork and South Fork combined) and in upper Mill Creek (Upper Walla Walla core area) and three in the North Fork Touchet, the South Fork Touchet and the Wolf

Fork Touchet Rivers (Touchet River core area). All these areas appear to have fluvial and resident bull trout. Other tributary streams where bull trout occur include Spangler and Lewis creeks (tributaries of the North Fork of the Touchet), and bull trout are not confirmed to exist in Cottonwood Creek (mainstem Walla Walla tributary), Little Meadows Canyon and Big Meadows Canyon (North Fork Walla Walla River tributaries) (USFWS 2002c). Redd surveys have been conducted in various parts of the Walla Walla basin since 1990 (Table B-24).

Table B-24. Summary of the number of bull trout redds observed between 1990 and 2010 in the Walla Walla basin (Mahoney et al. 2009; Glen Mendel, WDFW, personal communication, and various reports cited in text). It is important to note that survey effort has varied over the years and comparison between years can be complicated because of it. Blank spaces denote no survey, while a "0" denotes a survey was conducted but no redds were found. Redd surveys in Burnt Fork, Lewis and Spangler creeks are omitted because of infrequent sampling.

Walla Walla Basin				
			Touchet River	
Year	**Mill Creek (fluvial)**	**Low Creek (resident)**	**Wolf Fork**	**North Fork**
1993			0	
1994	163		71	13
1995	129		16	11
1996	98	18	36	23
1997	89	20	4	30
1998	101	27	48	42
1999	133	41	93	46
2000	127	39	64	47
2001	180	33	84	46
2002	173	32	92	29
2003	106	28	101	25

Walla Walla Basin				
			Touchet River	
Year	**Mill Creek (fluvial)**	**Low Creek (resident)**	**Wolf Fork**	**North Fork**
2004	97	61	71	22
2005	95	43	57	15
2006	56	35	37	9
2007	58		38	20
2008		47	73	17
2009		39	73	21
2010			84	34
Average	109	36	57	26
Minimum	56	18	0	9
Maximum	180	61	101	47

Touchet River

Resident and fluvial populations of bull trout are common in the North Fork and Wolf Fork and upper South Fork and in Spangler, Lewis, Robinson, and Burnt creeks of the Touchet River (Mendel et al. 2003). Fluvial bull trout are documented downstream to the Waitsburg area (RM 44). Spawning in the Touchet drainage is known to occur in the North Fork Touchet River from Bluewood Creek downstream to near Spangler Creek, in Spangler Creek, the Burnt Fork of the South Fork Touchet River, Lewis Creek, and in the Wolf Fork Touchet River from Whitney Creek to 1.5 miles upstream of the Forest Service boundary, a distance of about 5.5 miles. Spawning in the Touchet River occurs from late August through early October (WDFW 1998). Bull trout in the South Fork of the Touchet appear to be primarily resident fish, although Mendel et al. (2002), using radio telemetry, documented a migratory fish in the Burnt Fork (South Fork tributary). This population may have been extirpated in the last couple of years (Mendel et al. 2004), but access has been restricted for further sampling. The populations of bull trout in each fork may be reproductively isolated from one another.

Limited sub-adult rearing also occurs in Robinson Fork (a tributary to the Wolf Fork Touchet), and in the Griffen Fork (a tributary to the South Fork Touchet). Bull trout fry were observed in the North Fork Touchet River in September 1998 and 2000. However, in August 2000, there were no fry detected at the same North Fork sites as they may not have emerged before sampling (USFWS 2002c). This appears to indicate that eggs or fry may be in the gravel year-round; hatching may be delayed by very cold water or there may be a late spawning component to the population. Fluvial bull trout are known to overwinter in the mainstem, although their abundance, distribution and use patterns are not fully understood (Mendel et al. 2002).

Within the Wolf Fork, where consistent surveys have been conducted since 1990, the average number of redds is 57, ranging from 0 to 101 (Table B-22).

Mill Creek

Because the upper portion of Mill Creek has long been a protected municipal watershed for the City of Walla Walla, it has preserved a relatively healthy bull trout population. The population consists of resident and fluvial fish which spawn and juveniles rear in the upper reaches of the drainage. However, sub-adult and adult bull trout have been documented migrating downstream in lower Mill Creek and the Walla Walla River during fall through early summer.

Spawning in Mill Creek has been documented upstream of the Umatilla National Forest boundary. Spawning surveys from the city of Walla Walla intake dam (approximately RM 11) upstream document bull trout spawning in the mainstem and tributaries upstream of Low Creek (Table 5-22), with Low Creek accounting for the highest redd densities (6 per mile) in the spawning tributaries. Low Creek is believed to be a resident bull trout population (Phil Howell, USFS, personal communication). The mainstem Mill Creek between North Fork Mill Creek and Deadman Creek had the highest densities of bull trout redds (9 per mile) (USFWS 2002c). Spawning and rearing has been documented in most mainstem reaches and tributaries above the city water intake (USFWS 2002c). Spawning in the Mill Creek system takes place from early September through October (WDFW 1998; P. Sancovich, USFWS, personal communication).

Results from radio-telemetry studies by ODFW and USFWS indicate that fluvial bull trout use the mainstem of Mill Creek between the intake dam and the City of Walla Walla, presumably to overwinter. Most of the radio-tagged fish were located in the vicinity of the intake dam. Fluvial bull trout also use Mill Creek somewhat farther downstream; an estimated 33 bull trout were observed by video camera in spring 2004 as they re-ascended the Bennington Dam ladder from downstream locations (B. Tice, USACE, personal communication). The USFWS has documented many PIT tagged bull trout passing downstream of Bennington Dam in the past couple of years.

Within Mill Creek, where consistent surveys have been conducted, the average number of redds is 109, ranging from 56 to 180. In Low Creek, the average number of redds is 36, ranging from 18 to 61 (Table B-22).

North and South Forks Walla Walla River

The majority of spawning bull trout are found upstream of Bear Creek (a tributary to South Fork Walla Walla River approximately 1 mile upstream of the Umatilla National Forest boundary) (USFWS 2002c). Bull trout spawn mainly in the South Fork Walla Walla River between Table Creek (RM 15) and the second major tributary above Reser Creek (RM 22), the lower 7 miles of Skiphorton Creek, and the lower

0.5 mile of Reser Creek. From 1992 to 2000, bull trout have been captured annually in a screen bypass trap on the South Fork Walla Walla River, approximately 2 miles upstream of the forks. The largest number of bull trout captured was 211 in 1992 (USFWS 2002c). In addition, Budy et al. (2007) captured bull trout in the South Fork Walla Walla River between 2002 and 2006 using a combination of angling, electroshocking, seine and trap nets, and minnow traps. They captured between approximately 300 and 800 fish in their efforts and estimated that the total population of bull trout in the South Fork at between 7,000 and 10,000 for fish greater than 120 mm, between 1,500 and 3,000 for fish greater than 220 mm, and about 1,000 fish average for fish greater than 370 mm (Budy et al. 2007).

The North Fork of the Walla Walla River is used year-round by bull trout subadults and juveniles and by adults during the winter and spring. The mainstem Walla Walla River from the forks downstream to Cemetery Bridge in Milton-Freewater, Oregon, provides year-round sub-adult rearing habitat. From this reach downstream to the confluence with the Columbia River is considered overwintering and migration habitat, although the presence of bull trout below McDonald Bridge (below the mouth of Mill Creek), or to the mouth of the Walla Walla River, has only recently been documented by the USFWS.

Grande Ronde River

The Grande Ronde River Recovery Unit includes nine local populations distributed through the Grande Ronde River drainage. The majority of this watershed is in Oregon. The lower portion of the Grande Ronde River, tributaries to this portion of the river, as well as tributaries to the mainstem of the Wenaha River (a major tributary to the Grande Ronde River) are located in Washington (USFWS 2002d).

USFWS (2002d) states that the Wenaha River drainage may have the most abundant and well-distributed population of bull trout in the Grande Ronde River subbasin. Bull trout in this population exhibit both resident and fluvial life history forms. All known summer rearing and holding areas in the Wenaha River and its tributaries are on U.S. Forest Service designated wilderness lands above RM 5.6 of the Wenaha. Spawning occurs in the headwater areas of the Wenaha and its tributaries. Radiotelemetry studies indicate that Wenaha bull trout below RM 5.6 appear to be moving between summer/spawning habitat and overwintering habitat in the Grande Ronde and possibly the Snake rivers.

Limited information is available on the abundance of bull trout in the Wenaha River (Table B-25)), but some bull trout spawning surveys have been conducted by WDFW in the WA portion of the North Fork and Butte Creek. Buchanan et al. (1997) considered the Wenaha fish to be at low risk of extinction. Little information is available on fish distribution or abundance, the size of these fish at spawning, age at maturation, sex ratio, fecundity, time of emergence, or survival rates.

Table B-25. Summary of the number of bull trout redds observed between 2005-2010 in the Wenaha basin (Glen Mendel, WDFW, personal communication). It is important to note that survey effort has varied over the years and comparison between years can be complicated because of it. Blank spaces denote no survey.

	Wenaha Basin	
Year	North Fork Wenaha	Butte Creek and Tribs,

	Wenaha Basin	
Year	North Fork Wenaha	Butte Creek and Tribs,
2005	153	31
2006	82	32
2007	86	
2008		
2009		
2010	112	

B.4.4 Recovery status

As discussed in Chapter 4, recovery criteria for bull trout is different than for salmon and steelhead. Original recovery criteria from the draft recovery plan, are shown in Table B-26. Populations trend estimates shown in Table B-26 do not comport with redd survey information in some instances. The population trends (taken from USFWS 2008b) may also be inaccurate because for some of the populations, there is not very much information. Regardless of potential errors (based on general figures within USFWS 2008b) additional, consistent information is needed to monitor bull trout populations within the SEWMU. Without additional monitoring effort, understanding whether bull trout are being recovered or restored is not likely.

Table B-26. Bull trout population delineation, size recovery criteria and trend for populations within the SEWMU.

<table>
<tr><th>Recovery Unit</th><th>Core Area</th><th>Population size (USFWS 2008b)[a]</th><th>Local population (within SEWMU)</th><th>Recovery Criteria (based on USFWS 2002b, c, and d)</th><th>Population Trend (USFWS 2008b)</th></tr>
<tr><td rowspan="4">Umatilla-Walla Walla</td><td rowspan="4">Walla Walla River Basin</td><td>2,500-10,000 (includes upper Walla Walla)</td><td>Mill Creek</td><td rowspan="4">Bull Trout are distributed among six or more local populations in the recovery unit, three in the Umatilla Core Area and three or more in the Walla Walla Core Area. In a recovered condition

local populations would include the upper Walla Walla complex, Mill Creek, and the Touchet complex. There is potential to further separate the population within the upper Walla Walla complex into South Fork and North Fork local populations, and the Touchet complex into North Fork, South Fork, and Wolf Fork local populations.

Estimated abundance of adult bull trout in the recovery unit is as follows: Walla Walla Core Area from 3,000 to 5,000.

Adult bull trout exhibit a stable or increasing trend in abundance for at least two generations at or above the recovered abundance level within the recovery unit. Achievement of this recovery criterion will be based on a minimum of at least 10 years of monitoring data.

Specific barriers to bull trout movement in the Umatilla-Walla Walla Recovery Unit have been addressed. Opportunities for passage within each core area are provided, ensuring opportunities for genetic exchange among local populations within each core area. In the Walla Walla Core Area, this means providing suitable habitat conditions downstream of Nursery Bridge on the mainstem Walla Walla River, ensuring</td><td>Stable</td></tr>
<tr><td rowspan="3">50-250</td><td>North Fork Touchet</td><td rowspan="3">Stable</td></tr>
<tr><td>South Fork Touchet</td></tr>
<tr><td>Wolf Fork</td></tr>
</table>

Recovery Unit	Core Area	Population size (USFWS 2008b)[a]	Local population (within SEWMU)	Recovery Criteria (based on USFWS 2002b, c, and d)	Population Trend (USFWS 2008b)
				the ladder at Nursery Bridge will successfully pass bull trout, and screening diversions that impact bull trout. On Mill Creek, barriers to be addressed include the City of Walla Walla intake dam and ensuring bull trout have the opportunity to access the Walla Walla River. In the Touchet subbasin, barriers to be addressed include screening unscreened diversions, and establishing at least seasonal connectivity between local populations and the mainstem Walla Walla River.	
Snake River	Tucannon River	2,500-10,000		Distribution criteria will be met when the total number of stable local populations has increased to 10 in the Tucannon River Core Area and to 7 in the Asotin Creek Core Area. These local populations must occur in separate streams with broad distribution throughout each core area.	Stable
	Asotin Creek	50-250		Trend criteria will be met when the overall bull trout population in each core area of the Snake River Washington Recovery Unit is stable or increasing over a period of at least 10 years, as determined through contemporary and accepted analyses of abundance trend data. Abundance criteria will be met when the Tucannon River Core Area supports an average of 1,000 spawners annually and when the Asotin Creek Core Area supports an average of 700 spawners annually. Connectivity criteria will be met when migratory forms are present in all local populations and when intact migratory corridors among all local populations in both core areas provide opportunity for genetic exchange and diversity.	Unknown
Grande Ronde	Grande Ronde	50-250	Wenaha River	In a recovered condition the recovery unit would include at least nine local populations. In the Grande Ronde Core	Stable

Recovery Unit	**Core Area**	**Population size (USFWS 2008b)[a]**	**Local population (within SEWMU)**	**Recovery Criteria (based on USFWS 2002b, c, and d)**	**Population Trend (USFWS 2008b)**
River	River			Area local populations would include the Upper Grande Ronde complex, Catherine Creek, Indian Creek, the Minam River/Deer Creek complex, The Lostine River/Bear Creek complex, Hurricane Creek, Lookingglass Creek, and the Wenaha River. Estimated abundance of bull trout among all local populations in the Grande Ronde River Recovery Unit is at least 6,000 adults. Resident and migratory life history forms are included in this estimate, but the relative proportions of each are considered a research need. As more data is collected, recovered population estimates will be revised to more accurately reflect both the migratory and resident life history components. Adult bull trout populations exhibit a stable or increasing trend for at least two generations at or above the recovered abundance level. Specific barriers to bull trout migration in the Grande Ronde River Recovery Unit have been addressed. - No passage barriers are suggested within USFWS 2002 c for the Wenaha River local population. - This also includes impact assessments of the Lower Granite and Hells Canyon dams, both in the mainstem Snake River.	

[a] The population size categories are reported based on Figure 1 of USFWS (2008b). The numbers do not comport with the redd count information shown above.

B.5 REFERENCES

Anglin, D. R., D. Gallion, M. Barrows, R. Koch, and C. Newlon. 2009. Monitoring the use of the mainstem Columbia River by bull trout from the Walla Walla Basin Annual Report 2008. Prepared for: The U.S. Army Corps of Engineers Walla Walla District 201 North 3rd Avenue Walla Walla, WA 99362 MIPR Agreement Numbers W68SVB70188554, W68SVB80164737.

Asotin County Conservation District (ACCD). 2004. Asotin Subbasin Plan. Submitted to the Northwest Power and Coordination Council. 179 pages plus appendices.

Blankenship, S. M., M. P. Small, J. D. Bumgarner, M. Schuck, and G. Mendel. 2007. Genetic Relationships Among Tucannon, Touchet, and Walla Walla River Summer Steelhead (*Oncorhynchus mykiss*) Receiving Mitigation Hatchery Fish From Lyons Ferry Hatchery. WDFW. 39 pages

Blankenship, S. M., M. P. Small, and J. D. Bumgarner. 2009. Temporal Stability of Genetic Variation within Natural Populations of Summer Steelhead Receiving Mitigation Hatchery Fish. Trans. Amer. Fish. Soc. 138:1052-1064.

Blankenship, and G. Mendel. 2010. Genetic Characterization of Adult Chinook Trapped in lower Asotin Creek. WDFW, http://wdfw.wa.gov/publications/01137/wdfw01137.pdf 12 pages.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife.

Budy, P., R. Al-Chokhachy, and G.P. Thiede. 2007. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2006. USGS Utah Cooperative Fish and Wildlife Research Unit Department of Aquatic, Watershed, and Earth Resources Utah State University, Logan, Utah. 83 pages.
http://www.cnr.usu.edu/wats/files/uploads/faculty/budy/budy_onlinedocs1_usubudyetal_bulltrout_2006annualreport.pdf

Bumgarner, J., J. Dedloff, and M. Herr. 2004. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead and Trout Report 2003 Run Year to USFWS Lower Snake River Compensation Plan Office. Report # FPA04-15.

Bumgarner, J., J. Dedloff, and M. Herr. 2006. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead and Trout Report 2004 Run Year to USFWS Lower Snake River Compensation Plan Office.

Bumgarner, J., and J. Dedloff 2007. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead Annual Report 2005 Run Year to USFWS Lower Snake River Compensation Plan Office.

Bumgarner, J., and J. Dedloff 2009. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead Annual Report 2006 and 2007 Run Year to USFWS Lower Snake River Compensation Plan Office.

Bumgarner, J., and J. Dedloff 2011. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead Annual Report 2008 and 2009 Run Year to USFWS Lower Snake River Compensation Plan Office. FPA 11-05

CTUIR. 2009. Draft Hatchery and Genetic Management Plan. Walla Walla River Spring Chinook Reintroduction. Prepared by Fisheries Program Department of Natural Resources, The Confederated Tribes of the Umatilla Indian Reservation. Submitted to NMFS May 2009.

DART (Data Access in Real Time) 2010. Website: http://www.cbr.washington.edu/dart/

DeHann, P., W. Arden, and G. Mendel. 2007 **DRAFT.** Genetic analyses of bull trout from the Tucannon River basin, WA. USFWS and WDFW. 22 pages

Faler, M. P., G. Mendel, and C. Fulton. 2008. Evaluation of Bull Trout Movements in the Tucannon and Lower Snake Rivers Project Completion Summary (2002 through 2006). Prepared for U.S. Department of Energy, Bonneville Power Administration (BPA), Project number 2002-006-00.

Ford M.J. (ed.), Cooney T, McElhany P, Sands N, Weitkamp L, Hard J, McClure M, Kope R, Myers J, Albaugh A, Barnas K, Teel D, Moran P, Cowen J. 2010. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Northwest. **Draft** U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NWFSC-XXX.

Gallinat, M. P, and L. A. Ross. 2009. Tucannon River spring Chinook hatchery evaluation program. 2008 Annual Report. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID.

Gallinat, M. P, and L. A. Ross. 2010. Tucannon River spring Chinook hatchery evaluation program. 2009 Annual Report. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID.

Gallinat, M. P, and L. A. Ross. 2011. Tucannon River spring Chinook hatchery evaluation program. 2010 Annual Report. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID.

Kassler, T. W. and G. Mendel. 2007. Genetic Characterization of Bull Trout from the Walla Walla River Basin. WDFW. 48 pages.

Kassler, T. W. and G. Mendel. 2008. Genetic Characterization of Bull Trout from the Asotin and North Fork Wenaha River Basins. WDFW. 31 pages.

Mahoney B. D., G. Mendel, M. Lambert, J. Trump, P. Bronson, M. Gembala and M. Gallinat. 2009. The Walla Walla Subbasin Collaborative Salmonid Monitoring and Evaluation Project: 2007 and 2008 Annual Report. Confederated Tribes of the Umatilla Indian Reservation and Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2000-039-00. 138 pages.

Mahoney B. D., G. Mendel, R. Weldert, J. Trump, J. Pomraning, M. Gembala and M. Gallinat. 2010. Walla Walla Subbasin Collaborative Salmonid Monitoring and Evaluation Project: 2009 and 2010 Annual Report **(DRAFT)**. Confederated Tribes of the Umatilla Indian Reservation and Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2000-039-00.

Mayer, K. and M. Schuck. 2004. Assess Salmonids in the Asotin Creek Watershed, 2003-2004 Annual Report, Project No. 200205300, 24 pages, BPA Report DOE/BP-00014059-1.

Mayer, K., Schuck, M., Wilson, S., and B. Johnson. 2005. Assess Salmonids in the Asotin Creek Watershed, 2004-2005 Annual Report, Project No. 200205300, 40 pages, BPA Report No. DOE/BP-00018229 and No. DOE/BP-00022720.

Mayer, K., Schuck, M., and D. Hathaway. 2006. Assess Salmonids in the Asotin Creek Watershed, 2005 Annual Report, BPA Project No. 200205300, 37 pages.

Mayer, K. Schuck, M., and D. Hathaway. 2007. Assess Salmonids in the Asotin Creek Watershed, 2006 Annual Report, BPA Project No. 200205300, 37 pages.

Mayer, K. and M. Schuck. 2008. Assess Salmonids in the Asotin Creek Watershed, 2007 Annual Report, BPA Project No. 200205300, 32 pages.

Mayer, K. and M. Schuck. 2009. Assess Salmonids in the Asotin Creek Watershed, 2008 Annual Report, BPA Project No. 200205300, 17 pages.

Mayer, K., M. Schuck, and P. Iversen. 2010. Assess Salmonids in the Asotin Creek Watershed, 2009 Annual Report, BPA Project No. 200205300, 29 pages.

Mendel, G., J. Trump, and D. Karl. 2002. Assessment of salmonids and their habitat conditions in the Walla Walla River basin within Washington. Project No. 1998-02000. BPA Rept. DOE/BP-00004616-1.

Mendel, G., J. Trump, M. Gembala. 2003. Assessment of Salmonids and Their Habitat Conditions in the Walla Walla River Basin within Washington: 2003 Annual Report. Report to BPA. Project 199802000. Contract # 00006502. 126 pages.

Mendel, G., J. Trump, C. Fulton, and M. Gembala. 2004. Brief assessment of salmonids and stream habitat conditions in Snake River tributaries of Asotin, Whitman, and Garfield counties in Washington. Wash. Department of Fish and Wildlife, Dayton, Washington.

Mendel, G., J. Trump, M. Gembala, and C. Fulton. 2006. Baseline Assessment of Salmonids in Tributaries of the Snake and Grande Ronde Rivers in Southeast Washington 2005 Annual Report. For Asotin County Conservation District, United States Fish and Wildlife Service, and Washington Department of Fish and Wildlife. 120 pgs.

Mendel, G., J. Trump, M. Gembala, and C. Fulton. 2008. Baseline Assessment of Salmonids in Tributaries of the Snake and Grande Ronde Rivers in Southeast Washington 2006-2007 Final Report.

For Asotin County Conservation District, United States Fish and Wildlife Service, and Washington Department of Fish and Wildlife. 183 pgs.

NMFS (National Marine Fisheries Service). 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. 260 pages.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29.

USFWS (U.S. Fish and Wildlife Service). 2002a. Chapter 1, Introduction. *In*: Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 137 pps.

USFWS (U.S. Fish and Wildlife Service). 2002b. Chapter 24, Snake River Washington Recovery Unit, Oregon. 134 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon. http://www.fws.gov/pacific/bulltrout/RP/Chapter_24_Snake%20River.pdf

USFWS (U.S. Fish and Wildlife Service). 2002c. Chapter 10, Umatilla-Walla Walla Recovery Unit, Oregon and Washington. 153 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon. http://ecos.fws.gov/docs/recovery_plan/021129_10.pdf

USFWS (U.S. Fish and Wildlife Service). 2002d. Chapter 11, Grande Ronde River Recovery Unit, Oregon and Washington. 95 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon. http://ecos.fws.gov/docs/recovery_plan/021129_11.pdf

USFWS (U.S. Fish and Wildlife Service). 2004. Designation of critical habitat for the Klamath River and Columbia River populations of bull trout. Federal Register: 69 (193):59996-60075.

USFWS (U.S. Fish and Wildlife Service). 2008a. Bull Trout Recovery: Monitoring and Evaluation Guidance. Report prepared for the U.S. Fish and Wildlife Service by the Bull Trout Recovery and Monitoring Technical Group (RMEG). Portland, Oregon. *Version 1* - 74 pp.

USFWS (U.S. Fish and Wildlife Service). 2008b. Bull trout (*Salvelinus confluentus*) 5-year review: summary and evaluation. USFWS, Portland, Oregon. 55 pages.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington State salmonid stock inventory: Bull Trout/Dolly Varden. WDFW, Fish Management.

APPENDIX C ADAPTIVE MANAGEMENT, RESEARCH MONITORING AND EVALUATION PLAN. AND EVALUATION PLAN

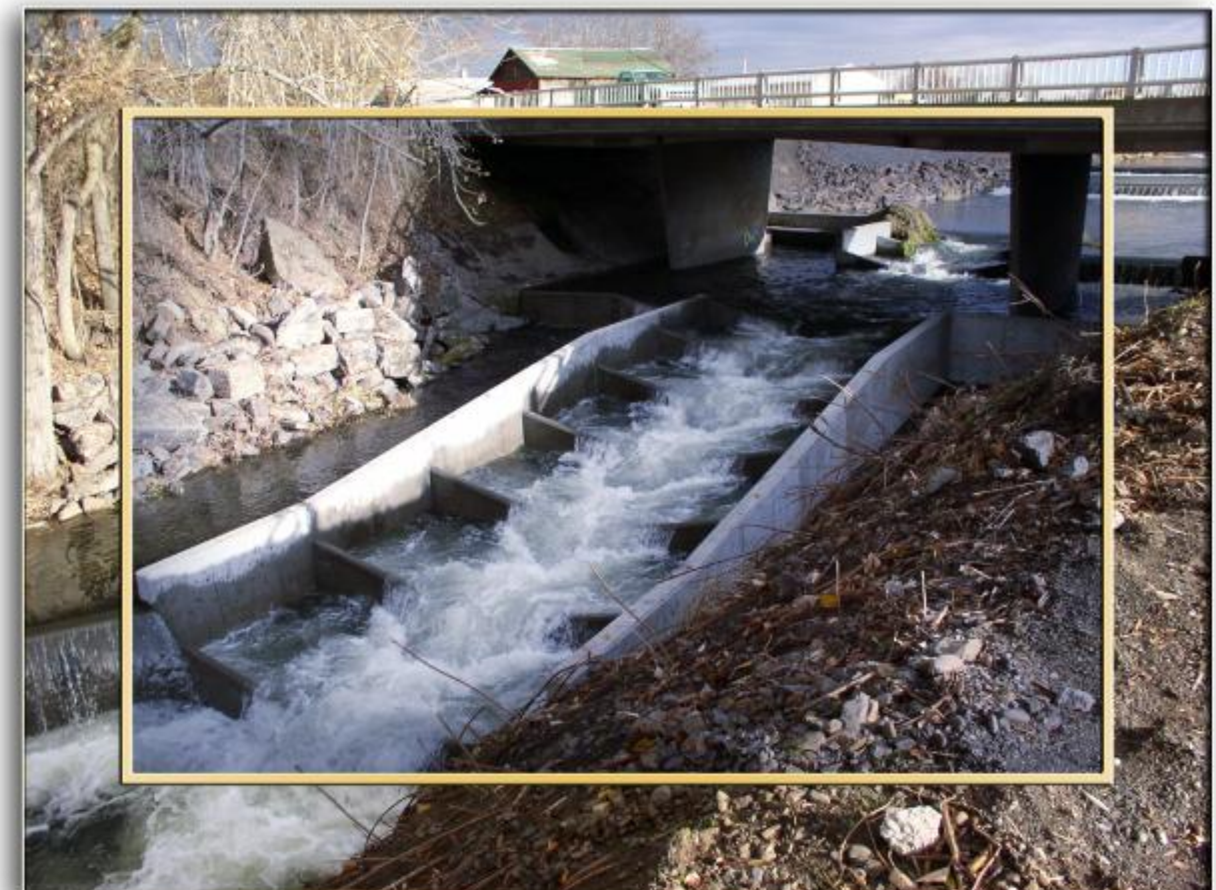


Table of Contents – Appendix C

Adaptive Management, Research Monitoring and Evaluation Plan

Table of Figures – Appendix C

List of Tables – Appendix C

APPENDIX C ADAPTIVE MANAGEMENT, RESEARCH MONITORING AND EVALUATION PLAN

C.0

C.1 ADAPTIVE MANAGEMENT

A critical component of the Southeast Washington Management Unit (SEWMU) Plan implementation is adaptive management. The actions specified in this plan were identified to make incremental improvements needed to move populations from their current status to healthy and harvestable levels. Adjustments in effort or direction will need to be made if actions do not achieve their desired goals, and to take advantage of new information, more specific objectives, and changing opportunities. The adaptive management plan will provide the mechanism to facilitate these adjustments.

Adaptive management is a structured process designed to improve understanding and management by helping managers and scientists learn from the implementation and consequences of natural resource policies (Holling 1978; Walters 1986; Lee 1993). Learning is necessary because (1) knowledge about species and ecosystem responses to different management approaches is usually incomplete and (2) changes in the environment, the economy, and social desires are inevitable (Walters 1986). The main strength of adaptive management is that managers are able to manage in the face of uncertainty and "learn by doing." As adaptive management progresses, managers develop a greater understanding of their system and which management techniques best work under a variety of conditions (Morghan et al. 2006).

The research, monitoring, and evaluation (RM&E) plan described below identifies the level of monitoring and evaluation needed to determine the effectiveness of recommended actions, and whether they are leading to improvements in population viability. The plan also identifies critical data gaps in species and habitat knowledge. The data obtained through RM&E Plan implementation will be used to assess, and if necessary make corrections to, current restoration strategies.

Oversight of the implementation of an adaptive management plan will be done by the Snake River Salmon Recovery Board (SRSRB), who would be responsible for:

Confirming goals and objectives for salmon and steelhead recovery;

Screening and ranking proposed projects to determine which of the alternative management actions and their hypothesized habitat and species benefits are potentially most effective;

Comparing monitoring results from management actions with the RM&E plan and review progress toward goals and objectives; and

Determining needed changes in strategies and/or actions to better meet goals/objectives, and revising strategies and/or actions accordingly.

A major challenge facing the development and implementation of an effective adaptive management strategy for SEWMU salmon and steelhead is the large number of organizations that implement management actions, as well as the complexity in jurisdictional and management decision authority. These organization include, but are not limited to, state agencies, tribes, counties, irrigation districts, agriculture and private forest land managers, NOAA Fisheries, U.S. Forest Service, BLM, other federal agencies, utilities, citizen groups, and others. Adding to this complexity is the fact that there is no one single decision body that holds decision authority for management actions across all sectors (habitat, hatcheries, harvest, and hydro). It is unreasonable to expect centralization of all authorities and decision processes into a single decision framework. Therefore, the intent of this adaptive management plan is to develop a collaboration and coordination process that uses the current implementation structures and allows for sharing of information and decisions that influence recovery of SEWMU Chinook salmon and steelhead.

Section 11 of the Oregon Mid-C Steelhead Recovery Plan describes in detail some of the various management decision processes and associated adaptive management plans that affect management actions for tributary habitat, hatcheries, harvest, and the hydrosystem. What follows is a brief summary of those processes and plans as they relate to the SEWMU.

C.1.2 Tributary Habitat

There are several funding sources and various entities involved with implementing tributary habitat restoration actions. In all cases these entities have well established decision-making processes for prioritizing actions. It is beyond the scope of this document to identify and describe all the processes used. Therefore, what follows are a few examples that illustrate ongoing decision processes.

C.1.2.1 Northwest Power and Conservation Council Columbia Basin Fish and Wildlife Program

The Columbia Basin Fish and Wildlife Program of the Northwest Power and Conservation Council provides funding for many habitat protection and restoration actions within the SEWMU. The program was established to mitigate the effects of the Columbia River federal power system. Proposed projects undergo a rigorous scientific review (by an Independent Science Review Panel) and revision process to ensure the implementation of scientifically sound projects that are based on best available science and use state-of-the-art restoration approaches.

C.1.2.2 The Habitat Conservation Plan for the Walla Walla Subbasin

The Walla Walla HCP targets activities related to water quality and flow for the entire Walla Walla basin. The focus is on listed populations of summer steelhead and bull trout, but it is expected to benefit other fish and wildlife species as well. The effort involves federal, state, local, and tribal governments; irrigation districts; private landowners; and watershed and environmental groups. The HCP is being coordinated with regional recovery planning, subbasin planning, development of instream flows and TMDLs, watershed resource inventory area planning, and comprehensive irrigation district management plans. Grant funding for this effort expired in 2009 with HCP related tasks and activities still underway and expected to continue as basin interests continue to work towards an HCP negotiated solution, or other cooperative solutions to instream flow and ESA fish concerns in the basin.

C.1.2.3 Salmon Recovery Funding Board

In 1999, the Washington State Legislature created the Salmon Recovery Funding Board. The board provides grants to protect or restore salmon habitat and assist related activities. The board has created an approach unique in the nation for the recovery of salmon. Local communities work together to write recovery plans that are approved by the federal government. The communities develop projects, vet them locally, and submit them to the Salmon Recovery Funding Board for technical review. This "bottom up" approach engages local communities in salmon recovery. The board also plays a key role in supporting the organizations that implement the federally approved recovery plans and in managing the state funding, which is critical to securing federal grants.

C.1.2.4 Integration and Coordination

Although there are several funding sources and implementing entities that have prioritization processes and elements of adaptive management, there is a need to integrate and coordinate adaptive management for tributary habitat restoration. Appendix A describes an implementation framework for this recovery plan. This framework is not intended to replace the other processes that are currently used. Rather, the framework is meant to improve coordination, collaboration, and sharing of information for decision making. Information, including successes and failures, will be shared throughout the framework. This will result in the implementation of cost-effective projects throughout the basins.

C.1.3 Hatcheries

C.1.3.1 Hatchery Scientific Review Group (HSRG)

In the 2000s, the hatchery scientific review group (HSRG) was first developed to review and make recommendations for hatcheries in the Puget Sound region, and then the Columbia Basin.

Their recommendations are not the only alternatives for hatchery programs to meet conservation and harvest goals. The HSRG completed their reviews and provided recommendations for populations within the SEWMU. See Appendix D for a characterization of the HSRG recommendations and the consistency between the recovery plan actions and HSRG recommendations.

C.1.3.2 Hatchery Review Team

U.S. Fish and Wildlife Service (USFWS) initiated a series of hatchery reviews in May 2005 to assure that its hatchery programs in the Northwest are part of a scientifically-sound and integrated strategy — consistent with State, Tribal, and other Federal strategies — for conserving wild stocks and managing fisheries in watersheds within the Region.

The USFWS's Hatchery Review Team (HRT) completed their reviews of the LSRCP hatchery programs and facilities in Washington, Oregon, and Idaho (USFWS 2010). The HRT applied the HSRG's scientific framework and hatchery review tools to develop reform recommendations for each hatchery program.

C.1.3.3 Hatchery and Genetic Management Plans (HGMPs)

Hatchery and Genetic Management Plans (HGMPs) are described in the final salmon and steelhead 4(d) rule as a mechanism for addressing "take" of ESA-listed species that may occur as a result of artificial propagation activities. NMFS uses the information provided by HGMPs to evaluate impacts on salmon and steelhead listed under the Endangered Species Act. In certain situations, HGMPs will apply to evaluation and issuance of ESA Section 10 take permit. Completed HGMPs may also be used for regional fish production and management planning by federal, state and tribal resource managers.

The primary goal of an HGMP is to devise biologically-based artificial propagation management strategies that ensure the conservation and recovery of ESA-listed salmon and steelhead populations.

The HGMP must provide adequate monitoring and evaluation to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of listed ESUs/DPSs. An adaptive management process is needed to provide for the evaluation of the data and include the potential to revise the assumptions, management strategies, or objectives of the hatchery program. In addition, NMFS is required to evaluate on a regular basis the effectiveness of the HGMP in protecting and achieving a level of productivity commensurate with the conservation of the listed species. If the HGMP is ineffective, NMFS will reinitiate consultation with the management entity operating the hatchery and identify ways in which the program needs to be altered.

C.1.4 Harvest

C.1.4.1 Mainstem Columbia River

The parties to the *2008-2017 United States v. Oregon Management Agreement* recognize that a research and monitoring program is needed to implement and adaptively manage the harvest regimes that are envisioned in the agreement. The objective of monitoring and research is to improve the accuracy and precision of harvest management. As identified in the agreement, these data are essential for adaptive management. A Technical Advisory Committee (TAC), which is comprised of biologists from state, federal, and tribal management agencies, develops, analyzes, and reviews data and provides reports and technical recommendations regarding harvest management. The parties to the agreement agreed to work together to maintain and seek funding for the research and monitoring programs.

Additional monitoring and adaptive management of harvest is provided by ESA Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin subject to the 2008-2017 *US v. OR* Management Agreement (hereafter, Fisheries BiOp). Several Reasonable and Prudent Measures are identified in Section 13.4 of the Fisheries BiOp that emphasize in-season management actions, which ensure that incidental take of ESA-listed species remain consistent with the BiOp. The monitoring of harvest impacts on listed species is an essential component of the Fisheries BiOp.

C.1.4.2 Recreational Fisheries Regulation Process (WDFW)

State-managed recreational fisheries that affect listed stocks in the recovery area are addressed and authorized under the Endangered Species Act 4(d) and Section 10 processes.

Within the SEWMU, the Snake River basin fisheries management area of SE Washington is known as the Snake River Management Area (SRMA) by WDFW. The SRMA includes the anadromous portions of the Walla Walla River (and tributaries) within Washington State, the Snake River and its tributaries, including the Tucannon River, Asotin Creek, and Grande Ronde River and their tributaries, again, within the State of Washington.

Recently, the Snake Basin Harvest Forum (SBHF) convened. Participants were WDFW, along with NOAA Fisheries and other co-managers. A comprehensive plan will be developed through the SBHF that describes how Washington's fisheries and associated ESA impacts in the SRMA fit within the overall prescribed take limits for the affected ESA-listed species in the near- term. after the US v Or and SBHF have conducted their work that the NOF process provides opportunity for stakeholders to recommend distribution, timing and bag limits of fisheries within the constraints of the previously identified ESA impact rates for recreational fishereies

C.1.4.3 Fisheries Management and Evaluation Plans

Take prohibitions do not apply to activities associated with fishery harvest activities provided the fisheries are managed in accordance with a NMFS-approved Fisheries Management and Evaluation Plan (FMEP), which is implemented in accordance with a letter of concurrence from NMFS. The FMEP must meet several specific criteria described in the 4(d) Rule.

NMFS developed a template for preparing FMEPs that meet the required criteria. Section 3.5 of the template requires the applicant to include a schedule and process for reviewing and modifying fisheries management under the FMEP. There are two evaluation review processes identified in the FMEP: (1) a regular review of fisheries and (2) a comprehensive assessment of the overall effectiveness of the FMEP. The evaluation must assess the effectiveness of the FMEP in meeting the stated objectives over a long time period and must account for any new information that may require revision of assumptions or management strategies.

The FMEP describes the process and schedule that is used on a regular basis (annually) to evaluate the fisheries, and, if necessary, revise management assumptions and targets. The FMEP also includes a description of the process and schedule that occurs every five years to evaluate whether the FMEP is accomplishing the stated objectives. Section 3.5 of the FMEP includes the conditions by which revisions to the FMEP will occur and how the revisions will be accomplished.

NMFS also requires that the fisheries managers notify and provide to NMFS any proposed fishery regulation changes that affect fisheries within the FMEP. NMFS then evaluates the proposed changes to determine if the changes constitute additional negative effects that were not contemplated during the review and evaluation of the submitted FMEP. Depending on the species and fishery involved, changes in regulations can occur annually or in-season.

C.1.4.4 Tribal Resource Management Plans

A tribe intending to exercise a tribal right to fish or undertake other resource management actions that may impact threatened salmonids could create a Tribal Resource Management Plan (TRMP) that would assure that those actions would not appreciably reduce the likelihood of survival and recovery of the species.

NMFS issued a final rule to modify the ESA section 9 take prohibitions to apply to threatened salmon and steelhead. The modification created a section 4(d) limitation on those prohibitions for tribal resource management plans (TRMPs), where the TRMP demonstrates that it will not appreciably reduce the likelihood of survival and recovery of the listed species. The rule is intended to harmonize statutory conservation requirements with tribal rights and the Federal trust responsibility to tribes.

C.1.5 Mainstem Hydrosystem

Mainstem hydro issues for the SEWMU are primarily under the jurisdiction of the Federal Columbia River Power System (FCRPS) and are discussed within the scope of the FCRPS biological opinion (BiOp) below.

C.1.6 Federal Columbia River Power System Biological Opinion (FCRPS BiOp)

The 2008 FCRPS BiOp requires the federal action agencies (Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation; hereafter, AAs) to collaborate with states and tribes in the implementation of Reasonable and Prudent Alternatives (RPAs), progress reporting, and adaptive management using regional forums. RPAs 1 through 3 identify the general requirements governing the AA's development of implementation plans and reporting requirements. The AAs are required to submit implementation plans to NMFS in December of 2009, 2013, and 2016 that describe their commitments to implement RPAs. The AAs are also required to submit Annual Progress Reports to NMFS for the period 2009 through 2018. In addition, in 2013 and 2016, the AAs will submit Comprehensive RPA Evaluation Reports to NMFS. These reports will review all implementation activities through the end of the previous year and compare them to scheduled completion dates in the BiOp, or as modified through the Implementation Plans. The Comprehensive Evaluation will also describe the status of the physical and biological factors identified in the RPA, and compare these with the expected survival improvements identified in the Comprehensive Analysis. Included in the Comprehensive Evaluation will be a plan to address any shortcomings of current survival improvements as compared to the original survival estimates identified in the Comprehensive Analysis.

The FCRPS BiOp (NMFS 2008a) includes RPAs (50 through 73) for research, monitoring, and evaluation (RME). RME is required in the following areas: fish population status and trend monitoring, hydropower RME, tributary habitat RME, estuary and ocean RME, harvest RME, hatchery RME, and predation management RME. Data from RME will provide information needed to support planning and adaptive management, and to demonstrate accountability related to the implementation of hydropower and offsite actions.

A Regional Implementation and Oversight Group (RIOG) will provide a high-level policy forum for discussing and coordinating the implementation of the FCRPS BiOp and related BiOps. The purpose of the group is to inform federal, state, and tribal agencies engaged in recovery efforts. The group will serve as a forum where policy issues and concerns related to the implementation of the BiOps will be discussed in a collaborative manner, and to provide a forum for enhanced accountability and transparency. Importantly, the RIOG does not supplant existing federal, state, or tribal decision-making authorities. Indeed, no agency or sovereign is compelled to participate in the RIOG. Participation is by interest and choice.

The RIOG is supported by Senior Technical Teams for hydro, habitat, hatcheries, and RME integration and by additional Technical Teams. Technical information and recommendations flow from the Technical Teams to the Senior Technical Teams to the RIOG. Policy guidance and technical assignments flow from the RIOG to the Senior Technical Teams and Technical Teams. The RIOG and technical groups ensure that actions required by the FCRPS BiOp are implemented effectively, performance standards are achieved, disputes are resolved, and other regional processes are considered during the period of the BiOp.

C.1.7 Consistency With Regional Plans and Documents

This Plan was developed to guide monitoring and evaluation in the SEWMU to determine whether progress is being made towards recovery of ESA listed populations and achieving mitigation goals. Therefore, it necessarily covers viable salmon population metrics, hatchery and habitat effectiveness, out-of-basin effects, and a suggested approach to data management. In addition, current efforts are underway by the Northwest Power and Conservation Council (NPCC), NOAA Fisheries, and other stakeholders throughout the Columbia River basin to develop coordinated approaches to monitoring to increase efficiency and ensure that the information collected will assist in understanding the status of populations and the factors that limit them. This Plan is consistent with basin-wide efforts and will assist NOAA Fisheries, state and tribal co-managers, and the Board in determining whether the focus populations are approaching recovery and restoration. Below, specific efforts are highlighted and incorporated as guidance into the framework of this Plan.

C.1.7.1 Monitoring, Evaluation, Research, and Reporting (MERR) Plan

This Plan is consistent with, and builds on the Northwest Power and Conservation Council's draft *Columbia River Basin Monitoring, Evaluation, Research, and Reporting (MERR) Plan*.[28] The MERR is necessarily more comprehensive than this Plan because the NPCC's scope is broader than recovery of anadromous fish, but the questions and framework are complimentary.

The MERR ensures the Council's Columbia River Basin Fish and Wildlife Program (Program) goals, objectives, and actions are monitored, evaluated, and reported in a manner that allows assessment and reporting of Program progress. To facilitate Program assessment and reporting, the MERR Plan consists of a Strategic Plan, Implementation Framework, and Implementation Strategies for anadromous fish, resident fish, and wildlife.

Upon adoption by the Council, the MERR Plan will provide expectations for, and guidance on, how RM&E and reporting are conducted under the Program. This guidance will assist the Council and other partners in the Basin with:

- Prioritizing implementation of the Program's RM&E actions and projects;
- Reducing duplication of RM&E efforts by facilitating communication and coordination among project proponents and funding agencies within the Basin;
- Adaptively managing the Program;
- Reporting on Program progress for accountability purposes; and
- Providing guidance for the Independent Science Review Panel's review of projects and of the Program.

[28] The MERR can be found at: http://www.nwcouncil.org/library/2010/2010-10.pdf.

C.1.7.2 Columbia Basin Coordinated Anadromous Salmonid Monitoring Strategy (ASMS)

This Plan is consistent with the *Anadromous Salmonid Monitoring Strategy*[29] draft that was developed through a collaborative process involving co-managers, the Action Agencies, and other stakeholders. This Plan has all of the elements that are covered within the Basin-wide strategy and the approach suggested herein is complimentary to the basin-wide approach, in particular, Appendices B and D of the ASMS: *Mid-Columbia River sub-regional monitoring strategy and Snake River sub-regional monitoring strategy, respectively*.

The focus of the ASMS is to meet the monitoring and adaptive management needs of the NPCC's Program, ESA Recovery Plans, the Federal Columbia River Power System Biological Opinion (BiOp), and federal, state, and tribal fish and wildlife programs in a cost-effective manner. The goal of the ASMS is to provide an efficient and effective monitoring strategy that integrates VSP criteria, habitat effectiveness, and hatchery effectiveness across multiple programs and geographic scales.

C.1.7.3 Guidance For Monitoring Recovery of Pacific Northwest Salmon and Steelhead

This Plan is consistent with NOAA Fisheries' draft *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead* (Crawford and Rumsey 2009).[30] This Plan has all of the elements that are covered within the guidance document and the approach suggested herein is complimentary to the document and relies on the same suggested protocols, and general approach.

The guidance document was developed to better assist those involved with ESA salmon recovery in the Pacific Northwest in understanding the recovery monitoring needs at the regional, local, and project level and the levels of certainty that may be needed.

The recommendations within the guidance document are for federal and state agencies, Indian tribes, local governments and watershed organizations in Oregon, Washington and Idaho which are actively developing recovery plan monitoring programs, or are modifying existing monitoring for ESUs and DPSs.

Recommendations include monitoring that addresses all of the VSP criteria and the listing factors and threats. It is NMFSs' intention that the recommendations within the document will be considered the needed level of monitoring to be conducted and provide a consistency across ESU domains in the Pacific Northwest. Although the guidance document is focused on listed species, it can be applied to other Pacific

---

[29] The ASMS can be found at: http://www.cbfwa.org/ams/files/Anadromous%20Salmonid%20Monitoring%20SubFramework-July%206%202010.pdf

[30] Crawford and Rumsey (2009) can be found at: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/upload/Draft-RME-Guidance.pdf

Northwest populations that currently are not listed. The unlisted species could benefit from monitoring that will reveal their status/trends and any management actions underway to reduce their limiting factors and threats. Within the draft document, NOAA recommends monitoring priorities (Table C-1):

Table C-1. NOAA Fisheries recommended monitoring priorities (Crawford and Rumsey 2009).

Criteria	Monitoring Priority[31]	Confounding Effects or Sources of Error	Comments
VSP CRITERIA			
VSP Adult Abundance (specific evaluation of spawners in natural production areas)	Highest	• Unidentified hatchery spawners • Estimation methods • Inaccurate harvest or abundance estimates • Conversion and confusion between spawners and escapement • Estimates without accuracy and precision • Exclusion or inclusion of jacks • Confusion about conversion of escapement to spawners	• It must be recognized that tracking spawning populations is at the heart of VSP criteria. Measurements at other levels (e.g., run to the Columbia River, total natural production) may also contribute to assessments. • Measuring adult abundance for the populations within the ESU could be sufficient to determine recovery but may take a considerable number of years to be confident that the listing factors are apparently no longer threats to the continued existence of the species.
VSP Juvenile Abundance	Very High	• Trapping efficiencies • Migrating hatchery releases • Rainbow – steelhead interfaces • Supplementation programs • Variable age at migration	• Juvenile migrant abundance estimates are critical in order to estimate freshwater production and survival. • Juvenile parr estimates provide spatial distribution and correlate habitat quality to fish abundance.
VSP Productivity	Very High	• Juvenile and adult supplementation • Hatchery spawners • Hatchery density dependent impacts in the estuary and marine environment • Age class structure	• Productivity is only accurate if the estimates of adult abundance and (where employed) juvenile abundance are accurate. As used by the TRT, productivity is defined in terms of spawner to spawner ratios, juvenile info is valuable where available, but it is not available for many populations.
VSP Spatial Distribution	High	• Lack of a periodic census or valid spatially balanced sampling program • Low abundance can lead to risky conclusions regarding spatial structure.	• Spatial distribution tends to be a collection of one time site records developed over time.
VSP Diversity	High	• Inadequate baseline information for phenotype and genotype diversity • Hatchery effects • Harvest effects • Changes to habitat	• Many diversity traits can be tracked through harvest sampling and spawner surveys. • The region needs some standardization for appropriate reference conditions for phenotype and genotype diversity.

[31] Monitoring priorities for state, tribal, and local governments

Criteria	Monitoring Priority[31]	Confounding Effects or Sources of Error	Comments
LISTING FACTORS AND THREATS			
Threats Due to Curtailment or Destruction of Habitat or Range	High	• Lack of Adequate habitat sampling program. Need to know the status/trends of multiple key habitat attributes. • Only tracking the number of restoration projects completed does not necessarily indicate net improvement in salmon habitat	• The loss of freshwater and estuarine habitat is of major importance in the decline of salmon and steelhead. Quantifying status/trends of habitat conditions continues to be underfunded and sparsely applied
Threats Due to Hydropower	High	• Numerous licenses and consultations with differing standards	• Hydropower is a major source of mortality and loss of range in some watersheds
Threats Due to Overutilization (Harvest)	Very High	• Poor stock identification techniques for naturally produced adults in the fisheries including lack of GSI measurements • Unmarked hatchery adults in the fisheries • Unknown compliance with harvest regulations (unaccounted losses) • Assumptions regarding long term survival of marked fish	• Although harvest is considered a threat, it is integral to calculating productivity and potential spawner abundance. • Since it is probably the threat that can be controlled to the greatest extent, estimating accurately its impact to recovery is crucial.
Threats due to Hatcheries	High	• Lack of spawning ground survey data on hatchery straying into natural production areas • Lack of GSI measurements • Lack of marking of all hatchery fish • Competition	• It will probably not be feasible to determine the effectiveness of hatchery management plans in all locations, but specific studies will be needed.
Threats due to Predation and Disease	Medium	• Actual salmon mortality due to predators is not well documented • Hatchery contributions to disease	
Threats due to Regulatory Actions	Medium	• Unknown compliance with zoning and other land use regulations	• An audit of state and local land use and environmental laws and regulations should be completed periodically to test for effectiveness.
Threat due to Climate and other Conditions	Low	• Spatial and temporal patterns difficult to discern	• This factor is already monitored by the NWFSC and universities, with several models in development. • Marine survival of salmon and steelhead is a direct measure of ocean and climate conditions and is essential for determining viability of salmon. • More focused information is needed at the ESU/DPS scale

C.2 RESEARCH MONITORING AND EVALUATION PLAN

One of the purposes of this research, monitoring, and evaluation plan (Plan) is to guide existing studies and future study plan development to ensure that the information that is needed to determine the status of SEWMU salmonid populations is being collected.

This chapter relies to a great extent on NMFS (2008b).

C.2.2 Background

As discussed in Chapter 4, the Snake River Salmon Recovery Board (SRSRB), in consultation with the regional technical team (RTT), has defined salmon recovery at two levels: *recovery* and *restoration*. *Recovery* is defined as meeting ESA de-listing requirements based on viable salmonid population (VSP) criteria and ameliorating threats. The goal of *restoration* in addition to meeting VSP criteria is attainment of healthy, harvestable, and stable populations that meet mitigation goals.

In general, the desired outcome of the recovery plan is the long-term persistence of viable populations of naturally produced Chinook salmon and steelhead distributed across their native range. In order to determine if the desired outcome has been achieved, monitoring is needed to assess the status of the populations and their limiting factors. In the absence of monitoring, there is no reliable method to determine if the recovery plan has been successful, or is meeting its goals. Without monitoring, it will be very difficult for NOAA Fisheries to determine if the populations/ESU/DPS have met recovery criteria and can be removed from ESA listing, or whether mitigation goals are being met.

It is important that this monitoring plan have proper context. Within the SEWMU of the Snake River basin, much of the current monitoring that is taking place is guided and funded to evaluate hatchery programs, which have historically been primarily segregated harvest programs (especially for steelhead). However, many of these programs are in the process of undergoing modifications or changes recognized by stakeholders and co-managers as actions to "reform" certain hatchery practices to be more consistent with conservation needs. Therefore, many of the questions that guide SEWMU monitoring incorporate not only questions needed to see if the naturally reproducing populations are trending toward recovery objectives (through VSP and "threats" monitoring), but also mitigation and restoration goals.

C.2.3 Monitoring Questions and Types of Monitoring

There are two major questions that need to be answered in order for the NOAA Fisheries to determine if the recovery plan is working for ESA recovery.

Is the status of the population/ESU/DPS improving?

1) ***Is the status of the population/ESU/DPS improving?***
2) ***Are the primary factors limiting the status of the population/ESU/DPS increasing or decreasing?***[32]

In addition to the two main questions that NOAA Fisheries needs to have answered, the SRSRB and co-managers in SEWMU also need to understand the following question:

3) ***Are hatchery programs meeting specific mitigation goals?***

Answers to these questions will guide decisions regarding the reclassification or delisting of the ESU, DPS, or populations, and also understand whether mitigation goals are being met. Additional questions, which are less important in guiding decisions regarding ESA reclassification or delisting, but are nevertheless important to the SRSRB, funding entities, and management agencies, include:

4) ***Are the actions identified in the recovery plan and mitigation programs being implemented correctly and according to the implementation schedule?***
5) ***Which actions are effective and should be continued?***
6) ***How will the data be managed and curated?***

These six questions require different types of monitoring. Questions 1 - 3 require ***Status and Trend Monitoring***. This type of monitoring describes the status or condition of the populations and their limiting factors, and tracks their changes over time. There are two general categories of criteria that must be evaluated before ESUs/DPSs can be reclassified or de-listed; (1) biological viability criteria and (2) limiting factors criteria (Figure C-1). The first category includes metrics associated with Viable Salmonid Populations (i.e., abundance, productivity, spatial structure, and diversity), while the second includes metrics associated with habitat, hydropower, harvest, hatcheries, disease and predation, regulatory mechanisms, and natural limiting factors. It is important that the monitoring plan include metrics that can be used to evaluate delisting criteria. Also, it is important to note that this plan emphasizes monitoring that assists co-managers and stakeholders in understanding whether hatchery programs are contributing to recovery or not limiting recovery, and for determining if either segregated or integrated hatchery programs are meeting mitigation goals.

---

[32] The federal agencies determine if a population/ESU/DPS is no longer in danger of extinction by evaluating both the status of the population/ESU/DPS and the extent to which the threats facing the population/ESU/DPS have been addressed. This monitoring plan does not attempt to monitor "threats." Rather, this plan measures the "limiting factors" that directly or indirectly affect the status of the population/ESU/DPS. Although threats cause a factor to be limiting, it is actually the factor that limits the population. For example, forest roads and landslides (threats) may increase recruitment of fine sediments (limiting factor) to a stream channel, thereby limiting survival of juvenile steelhead. Simply monitoring threats will not tell us if the limiting factor is decreasing. Therefore, it is important to monitor changes in the limiting factors.

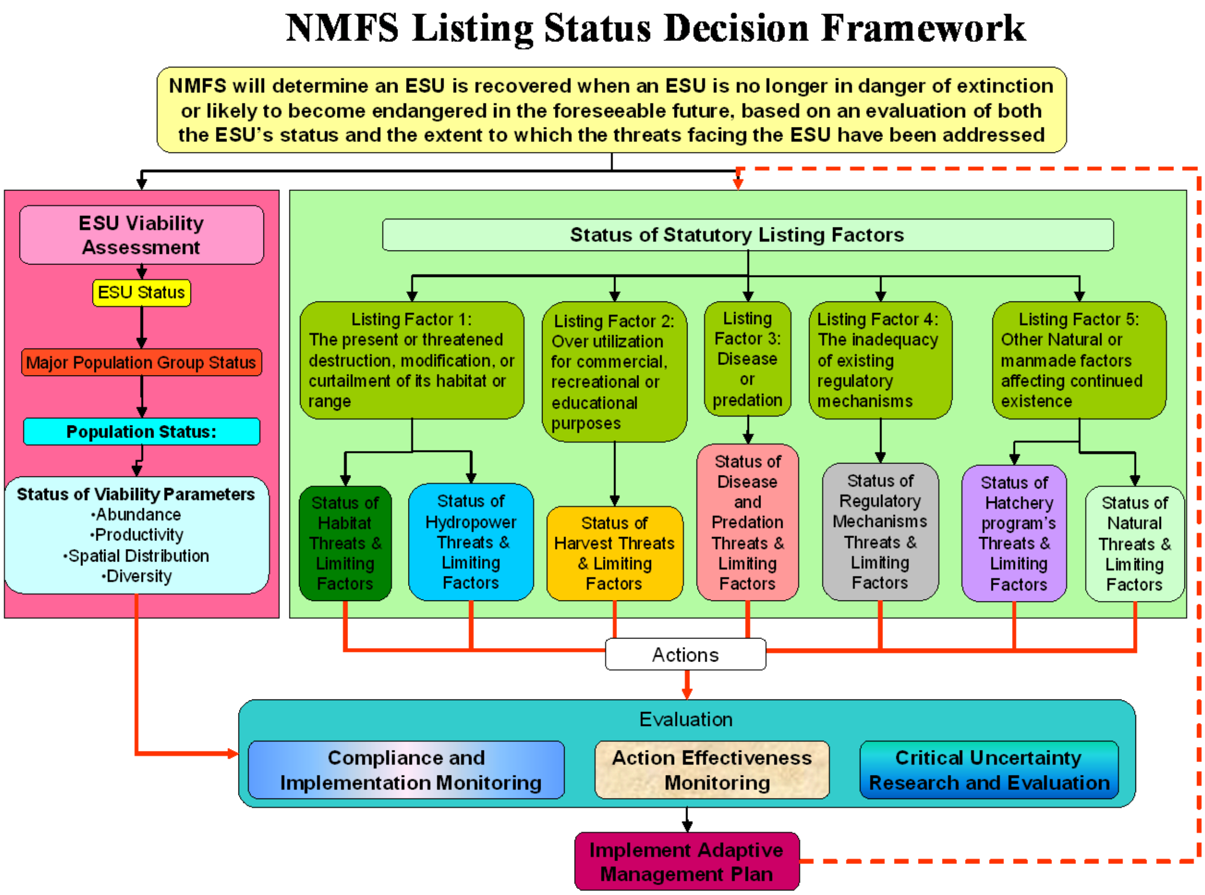


Figure C-1. Flow diagram outlining the decision framework used by NOAA Fisheries to assess the status of biological viability criteria and limiting factors criteria. This information is needed to determine if an ESU/DPS is recovered and no longer in danger of extinction.

Question 4 requires ***Implementation and Compliance Monitoring***. This type of monitoring simply checks on whether activities were carried out as planned, and whether specific criteria were met as a direct result of an implemented action. This is generally carried out as an administrative review and does not require any parameter measurements. Information recorded under this type of monitoring includes the types of actions implemented, how many were implemented, where they were implemented, and how much area or stream length was affected by the action. Indicators for implementation monitoring will include visual inspections, photographs, and field notes on numbers, location, quality, and area affected by the action. Success will be determined by comparing field notes with what was specified in the plans or proposals (detailed descriptions of engineering and design criteria). Thus, design plans and/or proposals will serve as the benchmark for implementation monitoring. Implementation monitoring sets the stage for effectiveness monitoring by demonstrating that the restoration actions were implemented correctly and followed the proposed design.

Question 5 requires ***Effectiveness Monitoring***. This type of monitoring addresses cause-and-effect. That is, effectiveness monitoring is designed to determine whether a given action or suite of actions achieved the desired effect or goal. This type of monitoring is research oriented and therefore requires elements of experimental design (e.g., controls or reference conditions) that are not critical to other types of monitoring. Consequently, effectiveness monitoring is usually designed on a case-by-case basis.

Although this type of monitoring is not necessary for guiding decisions on reclassification and delisting, it is important to funding entities and management agencies. Effectiveness monitoring provides funding entities with information on benefit/cost ratios and resource managers with information on what actions or types of actions improved physical/environmental and biological conditions.

The final question; "How will the data be managed and curated?" is concerned with transferring raw data from their varied origins into a common format that can be organized, checked, analyzed, and shared. There will be a large volume of data collected as part of the recovery plan and other efforts in the Snake River Basin. It is crucial that these data be summarized on how, when, and where they were collected. It is also important that data management support a range of analytical methods, such as hypothesis testing, time series analyses, structural equations, and mapping. A regional data management strategy will make both raw data and processed (derived) data available to other scientists and to the public. This is required for data collected as part of a project that is supported by public funds (e.g., federal or state grants and contracts).**Monitoring Framework**

The six questions identified above and their associated monitoring types provide the basis for developing the monitoring plan. It is important to note that several specific questions attend each of the six questions. In addition, monitoring objectives, indicators (measured and derived variables), sampling/statistical designs, and analytical decision rules are associated with most of the specific questions. This section identifies the specific questions and their associated parts and subparts. The specific questions were adapted from the ICTRT (2005). The following sections describe monitoring plans for steelhead and Chinook salmon populations within the SEWMU. Bull trout monitoring plans will be modified after the U.S. Fish and Wildlife Service provides guidance on monitoring requirements for bull trout, however, many of the monitoring and questions for steelhead and Chinook salmon should be relevant for bull trout too.

Question 1: *Is the status of the population/ESU/DPS improving?*

The status of a population is determined by measuring (or estimating) the four Viable Salmonid Population (VSP) parameters described in Chapter 4 of this Plan. Those parameters are adult abundance, population productivity or growth rate, population spatial structure, and diversity. The status of these parameters is compared to the population-specific recovery criteria (identified in Chapter 4) to arrive at an overall conclusion on the status of the population/ESU/DPS. The specific questions associated with VSP are:

1.1 Is the abundance of naturally produced adult fish trending to the recovery and restoration criteria for each population?

This question deals with the number of naturally produced fish that spawn within each population. Recovery criteria in the recovery plan are based on the 10-year geometric mean (GM) of naturally produced spawners.

1.2 Is the population productivity of naturally produced fish trending to the recovery and restoration criteria for each population?

This question addresses population productivity, which is the ratio of naturally produced recruits to naturally produced spawners. Recovery criteria in the recovery plan are based on the 20-year GM of recruits per spawner.

1.2.1 Is juvenile productivity of naturally produced fish increasing within each population?

This question deals with freshwater productivity. It is calculated as number of juveniles or smolts per ed. It provides an index of productivity within spawning and rearing areas and is not influenced by factors outside the population, ESU, or DPS. This index should be more sensitive to tributary restoration actions than recruits per spawner. At this time, the recovery plan has not identified recovery targets for juvenile productivity. Recovery targets for juvenile productivity should be addressed under research needs.

1.3 Is the spatial structure of the populations trending to the recovery and restoration criteria for each population?

This question deals with factors that affect the distribution and spatial complexity of the population. Spatial structure of a population is maintained by not destroying habitat (or their functions) at rates faster than they are created or restored, by maintaining suitable habitats (major and minor spawning areas) even if they contain no listed species, and by addressing man-made barriers to fish migration and movement. This question is answered by addressing each of the following questions.

1.3.1 Does the number and spatial arrangement of spawning areas meet recovery and restoration criteria for each population?

This question deals with the number and spatial arrangement of major and minor spawning areas that are occupied within the geographic area of each population. Spatial arrangement refers to the distribution of spawning areas (e.g., linear structure, dendritic, trellis, etc.).

1.3.2 Does the spatial extent or range of the population meet recovery and restoration criteria for each population?

This question deals with the proportion of the historical range that is currently occupied and the presence of spawners in major spawning areas.

1.3.3 Do the gaps or continuities between spawning areas meet recovery and restoration criteria for each population?

This question is concerned with the distance (stream km) between spawning areas.

1.4 Is the phenotypic and genotypic diversity of the population trending to the recovery and restoration criteria for each population?

This question deals with factors that affect both phenotypic (morphology, behavior, and life-history traits) and genotypic (genetic) within-population diversity. Diversity is maintained by managing or minimizing factors that alter variation in traits such as run timing, age structure, size, fecundity, morphology, behavior, and molecular genetic characteristics. The following questions capture these traits.

1.4.1 Are all the major life-history strategies that occurred historically still expressed within the population?

Major life-history strategies include adult run timing, juvenile migration patterns, and resident or anadromous life-history forms. This question addresses the occurrence of these strategies within the population and their distribution.

Note that questions relating to the "historic condition" cannot be answered definitively for populations in the southeast Washington State recovery area (). The major life-history strategies used by populations historically cannot be determined because of past management actions. Therefore, we assume that life-history strategies based on information from other similar populations may apply to SEWMU populations. This should be addressed under research needs.

1.4.2 Is the morphological, life history, and/or behavioral differentiation within and between populations consistent with the historic condition or a suitable reference condition?

This question deals with the average condition, amount of variability, and presence or absence of phenotypic traits. The focus is on spawn timing, size at age, and fecundity at age. *A reference condition for phenotypic variation is needed to determine if this goal is achieved.*

1.4.3 Is the genetic differentiation within and between populations consistent with the historical condition or a suitable reference condition?

This question is concerned with the amount of molecular genetic variation within and between populations. *A reference condition for genotypic variation is needed to determine if this goal is achieved.*

How does the origin of natural spawners affect the populations' ability to trend towards recovery and restoration criteria?

This overarching question has five sub questions concerning the specific make up of the natural spawners and their potential affect on population viability:

1) Is the proportion of natural spawners within the population that is derived from a local (within population) hatchery brood-stock program, which is using best management practices,[33] trending to the recovery and restoration criteria for each population?

[33] The ICTRT (2005) indicates that hatchery programs that conform to the principles described in recent publications (e.g., Flagg et al. 2004; Olson et al. 2004; HSRG 2004; Mobrand et al. 2005) could be considered to have "best management practices." Main components of the program to be considered include broodstock selection, efforts to minimize within-population homogenization, actions to prevent domestication or other in-hatchery selection, breeding protocols, and other efforts to minimize effects on population structure and fitness.

This question deals with the number (or fraction) of natural spawners that are made up of hatchery fish derived from within the population. There is theoretically less risk to the population if the hatchery fish were raised in a program using local (within population) broodstock and best hatchery management practices.

2) Is the proportion of natural spawners within the population that is derived from a local brood-stock program, which is not using best management practices, trending to the recovery and restoration criteria for each population?

Like the last question, this one deals with the number (or fraction) of natural spawners that are made up of hatchery fish derived from within the population. However, this question is concerned with the number of hatchery fish from programs that do not use best hatchery management practices.

3) Is the proportion of natural spawners within the population that is derived from a within-MPG brood-stock program trending to the recovery and restoration criteria for each population?

This question deals with the number (or fraction) of natural spawners that are made up of hatchery fish derived from outside the population, but within the major population grouping.

4) Is the proportion of natural spawners within the population that is made up of exogenous,[34] out-of-MGP strays trending to the recovery and restoration criteria for each population?

This question deals with the number (or fraction) of natural spawners that are made up of hatchery or naturally produced[35] fish derived from outside the major population grouping, but within the ESU.

5) Is the proportion of natural spawners within the population that is made up of exogenous, out-of-ESU strays trending to the recovery and restoration criteria for each population?

This question deals with the number (or fraction) of natural spawners that are made up of hatchery or naturally produced fish derived from outside the ESU.

---

[34] "Exogenous" includes all fish of hatchery origin and all natural-origin fish that are present because of unnatural, anthropogenically-induced conditions, but would not normally be present within the population (ICTRT 2005).

[35] Detecting naturally produced fish from outside the MPG or ESU requires unique tags or genetic analysis.

1.4.5 Is the distribution of spawners across naturally occurring habitat types within the geographic area of the population trending to the recovery and restoration criteria for each population?

This question deals with the presence of spawners in all ecoregions (Level IV; Omernick 1987) that were used by the population historically.

1.4.6 Are there ongoing anthropogenic activities that are causing selective mortality or habitat change within or outside the boundaries of the population?

This question is concerned with the factors that intentionally or unintentionally affect natural levels of variation within the population.

At this time, the mechanisms and magnitude of each selective influence on the genotypic and phenotypic traits are not understood. Additional input from the ICTRT, RIST, or other entities is needed to identify what data are needed to rate this metric adequately. Therefore, this document does not provide a specific monitoring plan for determining if anthropogenic activities have a selective mortality on SEWMU populations.

Collecting data that can be used to answer these specific questions will help federal agencies determine if the ESU and DPS are moving toward, and ultimately achieve, recovery criteria.

Question 2: *Are the primary factors limiting the status of the population/ESU/DPS increasing or decreasing?*

Before the ESU/DPS can be reclassified or de-listed, the federal agencies must evaluate if the existing and ongoing institutional measures are sufficient to address the threats and ensure that the populations/ESU/DPS remain viable. This will be accomplished by monitoring the status and trend of factors limiting the viability of the populations/ESU/DPS. Answers to the following questions will help the federal agencies determine if the institutional measures are sufficient to address the threats.

2.1 Are the limiting factors associated with habitat being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 1 (the presence or threatened destruction, modification, or curtailment of its habitat or range; Figure 1). The recovery plan identifies specific habitat limiting factors for each population. Primary limiting factors include connectivity (fish passage and unscreened diversions), water quality, water quantity, channel morphology and complexity, and habitat fragmentation. Where these limiting factors occur, they need to be monitored for status and trend. In addition, non-limiting factors need to be monitored to ensure that they do not become limiting in the future.

2.2 Are the limiting factors associated with hydropower being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 1 (the presence or threatened destruction, modification, or curtailment of its habitat or range; Figure 1). Specific limiting factors associated with hydropower include fish passage survival, fish passage timing, straying, water quantity, water quality, and habitat alterations. The limiting factors identified in the recovery plan need to be monitored for status and trend.

2.3 Are the limiting factors associated with harvest being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 2 (over utilization for commercial, recreational or education purposes; Figure 1). The specific limiting factors associated with harvest include the incidental and illegal take (poaching) of SEWMU listed species. The take of listed species needs to be monitored over time.

2.4 Are the limiting factors associated with hatcheries being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 5 (other natural or manmade factors affecting continued existence; Figure C-1). Limiting factors associated with hatcheries in the SEWMU include ecological interactions between hatchery origin and natural origin fish, including predation and competition for limited resources, potential genetic effects resulting from interbreeding between hatchery and natural origin fish, and straying. The status of these factors needs to be monitored over time.

2.4.1 Are hatchery programs meeting specific mitigation goals?

Because of the nature of hatchery programs within the SEWMU, it is important to not only evaluate the hatchery programs as discussed above, but also whether they are meeting their intended goals; to mitigate for the construction and operation of the lower Snake River Federal hydroprojects. As discussed in the Hatchery Appendix (Appendix D), one of the main goals of the hatchery programs is to provide fish for harvest opportunities in the SEWMU and to some extent, downstream of the SEWMU.

2.5 Are the limiting factors associated with disease and predation being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 3 (disease or predation; Figure 1). Disease and predation by birds, fish, and mammals are limiting factors addressed in this question. Predation by introduced fish species (e.g., bass and walleye) and northern pikeminnow (native species) also affects the viability of listed species in the SEWMU. These factors need to be monitored for status and trend.

2.6 Are the inadequacies of existing regulatory mechanisms being ameliorated such that they do not limit the desired status of the population?

This question addresses Statutory Listing Factor 4 (the inadequacy of existing regulatory mechanisms; Figure 1). Federal, state, tribal, and local regulatory mechanisms are included in this question. Enforcement of existing regulations[36] is a limiting factor in the SEWMU. Monitoring the status of enforcement of existing regulations is needed over time.

2.7 What natural factors limit the desired status of the population?

This question addresses Statutory Listing Factor 5 (other natural or manmade factors affecting continued existence; Figure 1). Drought and poor ocean conditions are natural factors that limit populations in the SEWMU. The status of these factors needs to be monitored over time.

Question 3: ***Are hatchery programs meeting specific mitigation goals?***

This question is not directly focused on recovery, but on the basis and original purpose of the hatchery programs within the SEWMU. Mitigation goals were established through the Lower Snake River Compensation Program and are outlined in Appendix D of this Plan. Specific questions related to this question are:

3.1 Did the hatchery program return enough adults to meet the mitigation goal?

Each hatchery program within the SEWMU has adult return goals associated with them. Answering this question directly links to those adult return targets.

3.2 Did the hatchery program achieve the smolt-to-adult return rate goal?

Each hatchery program within the SEWMU has smolt-to-adult return goals associated with them. Answering this question directly links to those targets.

Question 4: ***Are the actions identified in the recovery plan and mitigation programs being implemented correctly and according to the implementation schedule?***

[36] These regulatory mechanisms are usually in the form of (from UCSRB 2007):

- Comprehensive Plans (land use, water, wastewater, stormwater, solid waste, etc.)
- Implementing regulations (zoning, critical areas, shorelines, development standards, etc.)
- Permitting processes (conditional use, substantial development, building, variance, exemptions, etc.)
- Code enforcement/compliance
- Environmental review (SEPA and NEPA)

This question contains two parts: (1) were actions implemented according to the implementation schedule and (2) were actions implemented correctly. Each component has the following specific questions.

4.1 Were actions implemented according to the implementation schedule?

In order for the recovery plan to meet its proposed timeframe for recovery, the actions need to be implemented according to the implementation schedule. This question deals with whether or not recovery actions are tracking with the implementation schedule. If the implementation of recovery actions does not track the implementation schedule (i.e., actions actually implemented lag behind the implementation schedule), the time to recovery may be delayed.

4.1.1What types of actions were implemented this year?

Types of actions include fish screening, fish passage, instream flow, instream structure, off-channel wetland, riparian sediment reduction, upland agriculture, upland vegetation, upland wetland, water quality improvement, land protection, and nutrient enrichment project types (Table C-2).

4.1.2 How many actions of each type were implemented this year?

There are many different kinds of projects that fit under a given project type (Table C-2). This question addresses the number of projects of each type that are implemented in a given year.

4.1.3 Did the number of actions implemented this year meet the target number identified in the implementation schedule or adaptive management plan?

It is the intent of the implementation schedule to identify near-term and out-year projects and project categories needed to make progress towards meeting the objectives stated in the recovery plan but implementation requires project sponsors, landowner agreements, and funding. These constraints can affect the number of actions implemented in any single year.

4.1.4 What factors prevented the target number of actions from being implemented?

This question deals with why a proposed project was not implemented. Factors such as inadequate funding, lack of appropriate permits, landowner denial, requires an assessment, or unfavorable scientific review may preclude the implementation of a project.

4.2 Were actions implemented correctly?

This question deals with the types of actions implemented, where they were implemented, and how much area or stream length was affected by the action. All proposed actions should have detailed descriptions of engineering and design criteria. These design plans are used to determine if the projects were implemented correctly.

4.2.1 Were the actions implemented in the proper locations?

4.2.2 Were the actions implemented according to the design plans?

4.2.3 What was the total area or stream length affected by the action?

As noted earlier, answers to these questions are not needed in making decisions about reclassification or delisting. They are important, however, to the Board, funding entities, and management agencies, who are responsible for tracking funds and the implementation of recovery actions. These questions also set the stage for effectiveness monitoring by demonstrating that the restoration actions were implemented correctly and followed the design.

Table C-2. List of types of habitat actions and specific actions associated with each type (table modified from Katz et al. 2006).

Habitat Action Types	Specific Habitat Actions
Fish Screening	Fish Screen installation and replacement
Fish Passage	Fish Ladder Improvement and Installation Fishways (ladders, chutes, or pools) Barriers (dams or log jams) Diversion Dam or Push-Up Dam Removal Road Crossings (bridges) Culvert Improvements, Upgrades, Installation, or Removal Weirs (log or rock)
Instream Flow	Water Banked, Leased or Purchased Irrigation Practice Improvement (delivery improvements and on-farm efficiencies) Water Storage Change Point-of-Diversion Gravel Aquifer Recharge
Instream Structure	Channel Connectivity Channel Reconfiguration (includes channel roughening) Deflectors or Barbs Log (Control) Weirs Off-Channel Habitat Non-native Plant Removal or Control Rock (Control) Weir Spawning Gravel Placement Large Woody Debris Boulders Rootwads

Habitat Action Types	Specific Habitat Actions
	Log Structure or Log Jam Beaver Introduction
Off-Channel Wetlands	Wetland Creation, Improvement, or Restoration Wetland Invasive Species Removal Levee or Dike Set Backs
Floodplain reconnection	Levee or Dike Set Backs Side Channel Development Channel Reconfiguration (including channel roughening)
Riparian Habitat	Livestock Off-stream Water Development Water Gap Development Fencing Forestry Practices or Stand Management Native Plantings Livestock Exclusion Conservation Grazing Management Weed Control
Sediment Reduction	Road Relocation in Riparian Areas Road Stream Crossing Improvements (rocked ford) Road Drainage System Improvements Road Obliteration Erosion Control Structures for Cropland Sediment Control
Upland Agriculture	Livestock Management Agriculture Management (BMPs; e.g., long-term direct seeding, etc) Fencing for Grazing Management Water Development
Upland Vegetation	Planting Invasive Plant/weed Control Vegetation or Stand Management Slope Stabilization
Upland Wetlands	Wetland Creation, Improvement, or Restoration Wetland Vegetation Planting Wetland Invasive Species Removal
Water Quality Improvement	Return Flow Cooling Refuse Removal

Habitat Action Types	Specific Habitat Actions
	Sewage Clean-Up Toxic Clean-Up
Land Protection, Acquisition, or Lease	Streambank Protection Upland Protection Wetland Protection
Nutrient Enrichment	Fertilizer Carcass Analog Carcass Placement
Project Maintenance	Site Maintenance

Question 5: *Which actions are effective and should be continued?*

Of all the questions, this one is the most difficult to answer. This is because it is very difficult to tease out the effects of a given action or suite of actions from among all the factors affecting a population, including the effects of other recovery actions (an issue of multiple treatment effects). Actions within all sectors (harvest, hatcheries, hydro, and habitat) are needed to recover the populations/ESU/DPS. This means that different actions within all sectors, all intending to affect VSP parameters of the populations, will be implemented within a relatively short time period. Trying to assess the effects of different actions on VSP parameters will require well designed studies with long-term control over the experiments. Answers to the following questions will aid in the selection and design of effectiveness monitoring plans.

5.1 Which actions are most important to managers and funding entities?

There are several types of actions that will be implemented within and outside the SEWMU. Not all of these actions can or should be monitored for effectiveness at the population scale. However, a representative suite of actions should be monitored for effectiveness. Some harvest, hydro, and hatchery actions will be monitored for effectiveness because monitoring is required through regulatory or funding mandates (e.g., LSRCP, U.S. v OR, BiOps, etc.). Monitoring of hatchery programs (LSRCP and BPA funds) and whether they are meeting mitigation goals is a priority in the SEWMU, in addition to monitoring for achievement of recovery or restoration. Monitoring plans have already been developed for most of these actions. Other actions, such as specific habitat actions, will be selected for monitoring based on assurance of implementation (including adequate funding, landowner acceptance, possession of required permits, and favorable scientific review), the assumed size of their treatment effect (large signal-to-noise ratio), and the presence of adequate controls/references that can be maintained for the life of the monitoring study.

5.2 What exactly do managers and funding entities need to know?

Before one designs effectiveness monitoring plans, it is important to know exactly what managers and funding entities need to know to make informed decisions. This plan recognizes three basic needs, each requiring a different monitoring approach:

5.2.1 Did the project affect the environmental parameters (physical/chemical variables) that were the target of the action?

This question requires the most basic type of effectiveness monitoring (what Hillman (2005) called Level 1 Effectiveness Monitoring or Project Monitoring). It simply documents the changes in habitat conditions (environmental variables) before and after implementation of the project. Measuring changes in biological variables (e.g., fish abundance and survival) is not emphasized at this level of monitoring. This question is primarily answered through analyses of photographs (before-after photographs taken from fixed locations. It is inexpensive and does not require a high level of scientific expertise.

5.2.2 Did the project affect environmental and biological parameters at a reach or habitat scale?

This question requires a monitoring plan that collects more detailed information on changes in environmental and biological variables. Hillman (2005) called this Level 2 Effectiveness Monitoring. It is also referred to as the "Bottom-Up" approach (Jordan et al. 2003) and focuses efforts on measuring desired environmental and biological effects at small spatial scales (reach or habitat scale). It is designed to assess the effects of specific projects in isolation of other restoration actions. That is, results from this type of effectiveness monitoring should not be confounded by actions occurring elsewhere in the basin.

5.2.3 Did the project affect the biological parameters at a population scale or achieve mitigation goals?

This question requires the most intensive monitoring at larger spatial scales (e.g., watershed or subbasin) over longer time periods. Hillman (2005) called this Level 3 Effectiveness Monitoring. It has also been referred to as the "Top-Down" approach (Jordan et al. 2003). If a single type of action is implemented within the geographic area of the population, the approach for assessing the effects on the population are straightforward (the assessment is not confounded by multiple treatment effects). However, if several different types of actions are implemented, the assessment becomes much more complex. This scenario requires intensive and extensive sampling of several environmental and biological parameters within the geographic area of the population. In some cases the effects of individual actions on fish populations may not be assessed unequivocally, but their cumulative effects can be measured.

Information for each of these three questions will be collected in the SEWMU. If, in a well-planned study, effectiveness monitoring determines that a given action had no effect detected or is statistically significant, that action may not be continued and a new action would be implemented. Thus, effectiveness monitoring is an important component of the "adaptive management" process.

Question 6: *How will the data be managed and curated?*

Data management is a critical part of any monitoring plan. Rarely do researchers devote the same amount of time and energy to data organization, management, and curation that they do to collection, analysis, and publication. It is important, therefore, to develop a data management strategy that will address the following questions.

6.1 Where will the data be stored?

A central data storage location is needed so that agencies, funding entities, managers, researchers, and the public can easily access information generated from the implementation of the monitoring plans. It is not necessary that all data collected within the SEWMU be in one place; however, all databases holding information from monitoring activities in the SEWMU should be linked. On potential example is NOAA Fisheries database for data collected under the Integrated Status and Effectiveness Monitoring Program (ISEMP). NOAA Fisheries Science Center in Seattle currently houses this database, although other options may be available for the SEWMU.

6.2 In what form will the data be stored?

A database should do more than just store raw data. Any spreadsheet (flat file) can be used to store data. The database should also contain metadata (these are “data about the data” and describe key attributes of the dataset), have established QA/QC guidelines, generate summary or derived metrics, produce data summary reports, direct field data collection, prescribe data elements for specified sets of variables, and accommodate large volumes of data from diverse sources. The database should support all sorts of data types, including geospatial data that describe watershed characteristics (from remote sensed data, DEMs, or other datasets).

6.3 Who will manage the database?

Maintaining a regional database requires long-term funding and a commitment by someone to manage and maintain the database.

6.4 How will the data be screened for errors, outliers, and missing data?

A database is only as good as the information stored in it. If the information contained in a database is full of errors, than management decisions based on those data are suspect. It is important, therefore, that information loaded into the database be screened for errors, outliers, and missing data. Managing errors, outliers, and missing data require QA/QC guidelines and data screening procedures.

6.5 What derived metrics will be calculated?

Although it is not necessary, it would be convenient if the database calculates metrics that are needed to determine if the populations/ESU/DPS are moving toward recovery criteria.

Examples include 10-year GMs for abundance and productivity, distribution (spatial structure) metrics, means and variances for habitat and biological variables, and survival estimates (e.g., egg-smolt, smolt-adult, etc.). These derived metrics, not the raw data, are often used in statistical hypothesis-testing and decision making.

C.2.5 Prioritization

It is important to understand that not all basins can be monitored at the same intensity. In the development of the ASMS, it was recommended that at least one population per MPG have “fish-in, fish-out” monitoring occurring, in other words, monitoring of the number of adults moving into the stream, and the number of juvenile emigrants leaving the stream. Within the SEWMU, the Tucannon River is suggested for spring Chinook, and Asotin Creek for steelhead. This does not mean that monitoring should not occur in other watersheds, but all monitoring cannot occur in every watershed because of logistical and monetary concerns.

The monitoring that is described in this Plan is substantial and comprehensive. The primary focus is to be able to answer all questions associated with understanding whether SEWMU populations are achieving, or trending toward recovery and eventually restoration, as well as meeting mitigation goals. There are also questions and associated monitoring to determine effectiveness of ameliorating threats that have lead to the factors that limit population viability.

Because funding of RM&E is limited, it will not be possible to answer all of the questions in all areas. As such, it will be necessary to prioritize RM&E activities to ensure that the minimum amount necessary is incurring so the SRSRB and other stakeholders understand whether this plan is being successful.

At the end of each objective, a summary statement is made on the level of priority, based on the priorities identified by Crawford and Rumsey (2009; Table C-1) and summarized at the end of each type of monitoring (e.g., population status and trend, limiting factors status and trend, etc.).

It is not possible at this time to develop a monitoring and evaluation plan that addresses all the questions identified in Section C-2.2 because of logistical and monetary concerns. This monitoring and evaluation plan is specific to Chinook salmon and steelhead populations/ESUs/DPSs in the SEWMU and is under the auspice of the Snake River Salmon Recovery Board, which does not have authority or funding to monitor all activities identified in Section C-2.2. Therefore, the following prioritization scheme was established for monitoring recovery in the SEWMU (Table C-3). The priorities in the following table are similar to those established by NOAA Fisheries (see Table C-1).

Table C-3. Suggested priorities for monitoring in the Southeast Washington SEWMU.

Category	Criteria	Monitoring Priority	Comments
Viable Salmonid Population Status Monitoring	Adult abundance	Highest	This plan includes methods for estimating naturally produced spawners in most populations (but inadequately for the Lower Grande Ronde steelhead, as well as some other steelhead populations).
	Juvenile abundance	Very high	This plan includes methods for estimating naturally produced smolts in Asotin, Tucannon, Walla Walla and Touchet rivers.
	Population productivity	Very high	This plan includes methods for estimating spawner to spawner ratios (this will be especially challenging for steelhead).
	Spatial structure	High	This plan includes methods for estimating metrics for the three spatial structure questions for most populations.
	Population diversity	High	This plan includes methods for estimating metrics for the ten diversity questions.
Listing Factors Status Monitoring	Habitat	High	This plan includes methods for estimating tributary habitat quality and quantity.
	Hydropower	Medium	This plan identifies possible metrics and methods for assessing changes in the hydrosystem.
	Harvest	Very high	This plan identifies possible metrics and methods for assessing changes in harvest within the SEWMU.
	Disease and predation	Medium	This plan identifies possible metrics and methods for assessing changes in disease and predation.
	Regulatory mechanisms	Very High	This plan identifies possible metrics and methods for assessing changes in regulatory mechanisms.
	Hatchery programs	High	This plan includes methods for estimating effects on listed populations of the hatchery programs, as well as evaluating achievement of mitigation goals.
	Natural factors	Low	This plan identifies possible metrics and methods for assessing changes in natural factors.

This monitoring and evaluation plan will focus on the High - very High priority monitoring activities. This does not mean that criteria ranked as medium or low are not important to monitor. Rather, it means that the Snake River Salmon Recovery Board and partners will focus limited resources on monitoring those aspects of recovery that are most important to their needs and commitments. Monitoring of medium and low priority criteria will occur as resources are available or under other venues with differing mandates (e.g., LSRCP, US v OR, FCRPS BiOp obligation, etc.). However, this plan does offer possible metrics and methods for monitoring medium and low priority criteria.

It is important to point out that this plan focuses primarily on monitoring the status and trend of VSP parameters (abundance, productivity, spatial structure, and diversity), the effectiveness of hatchery programs to meet conservation and mitigation (through harvest) goals, and changes in habitat and hatchery limiting factors. It places less emphasis on monitoring the status and trend of limiting factors associated with hydropower, disease and predation, and natural factors. This plan also emphasizes implementation monitoring.

In addition, this Plan does not provide plans for monitoring the effectiveness of specific actions, nor does it provide research plans. It does, however, provide a framework for establishing valid effectiveness monitoring plans. The framework can also be used to guide the development of valid research plans. Designing research plans should be left to the creative minds of those involved with addressing the critical uncertainties identified in the recovery plan.

This plan is specific to Chinook salmon and steelhead populations within the SEWMU. Although the recovery plan addresses actions that should result in the delisting of bull trout, this monitoring and evaluation plan does not address bull trout. Bull trout monitoring plans may be developed and added to this appendix after the U.S. Fish and Wildlife Service provide guidance on monitoring objectives, methods, sampling designs, and analyses.

Finally, this monitoring and evaluation plan is a working document, which means that it will change as new information becomes available, as the implementation schedule is modified, and as the adaptive management process cycles through its decision-making process.

C.2.6 Current Monitoring

Although there is a significant amount of monitoring already occurring within the SEWMU, additional information is needed to assess changes in VSP parameters and listing factors. Much of the current fish monitoring efforts are targeted at determining whether the hatchery programs are meeting mitigation goals and what effects the hatcheries are having on natural populations. Population status and trend monitoring for naturally produced steelhead is often funded incidentally to the mitigation monitoring, but it is much more integral for the Chinook salmon populations because adult abundance information is easier to measure than steelhead. Only two populations in southeast Washington are currently adequately monitored to provide estimates of adult escapement; Asotin Creek steelhead and Tucannon spring Chinook salmon. Steelhead escapement abundance in southeast Washington is also available for most years from redd surveys in index areas in portions of the Touchet and Tucannon rivers, and fall Chinook salmon escapement is estimated for Tucannon. Other redd counts are periodically collected in other geographic areas to provide distribution and relative abundance information. However, currently there are no means to compile the information obtained from the current monitoring efforts consistently that would allow appropriate analyses to determine if recovery and restoration criteria are being met at the population and MPG level.

The following is a summary of the primary current monitoring efforts underway in the SEWMU (Table C-4). This table will need to be updated on a regular basis because some projects may be completed, while new ones will be implemented in the future.

Table C-4. Current monitoring projects in the SEWMU and relationship to VSP (modified and updated from Table 9-1 from SRSRB 2006).

								Monitoring addresses:						
									VSP					
Basin	**Project**	**Description**	**Project Status**	**Lead Entity**	**Funding Source**	**Priority**	**Location**	**Habitat**	**Abundance**	**Productivity**	**Spatial Structure**	**Diversity**	**Hatchery Effects**	**Harvest Effects**
All (or more than one)	Bull Trout monitoring in SE WA	Initial study to determine bull trout distribution and relative abundance in the upper Tucannon drainage and the Wenaha basin within WA. Data is being collected through electroshocking and spawning surveys and genetic analysis	Active, Partially Funded	WDFW	USFWS Section 6 Funding	**High** (this information is needed to assess recovery of bull trout)	Tucannon, Touchet, Grande Ronde (Wenaha River)		•		•	•		
	Resident Fish Monitoring	Baseline effort to monitor resident fish populations and plan in SE Washington.	Conceptual	WDFW	WDFW and USFWS		Recovery		•		•			

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Anadromous Fish Monitoring	Baseline effort to monitor anadromous fish populations and plan in SE Washington.	Active, Partially Funded	WDFW, CTUIR	BPA, LSRCP, USACOE, PSMFC	**Very High** (This project should be fully funded to ensure that all information on populations within these streams is collected consistently and over a large enough time frame so it can be included in population assessments of NMFS).	Walla Walla, Mill Creek, Upper Touchet, Coppei, Upper Tucannon, Alpowa, Deadman, Asotin, George, Charley, Almota, Pataha, Penawawa, etc.		•	•	•	•		
	Anadromous Fish Planning	Funds are used for anadromous fish population and recovery planning, stock status reviews, etc.	Active and ongoing	WDFW	WDFW	**High** (important to maintain funding so WDFW can participate in local and regional planning efforts, etc.)	Snake River and tribs and Walla Walla Basin	•	•	•	•	•	•	•
	Spring Chinook Creel Surveys	Conduct creel surveys to determine number of spring Chinook caught in sport fisheries.	Active and ongoing	WDFW	WDFW	**Very high** (information is important for run reconstruction and ESA take levels)	Snake River and tribs		•				•	•

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Spring Chinook - Hatchery Supplementation and Mitigation Evaluation	Evaluate hatchery effects on natural spring Chinook populations; determine the relative reproductive success of natural vs. hatchery spring Chinook; estimate juvenile productivity (survival rates by life stage and smolt production estimates).	Active and ongoing	WDFW for the Tucannon R and CTUIR for the Walla Walla River	LSRCP, and BPA for CTUIR	**Very high** (without proper monitoring managers and other stakeholders will not be able to determine 1 if mitigation goals are being met, and 2) whether there are deleterious effects of the hatchery programs).	Snake River and tribs		•	•	•	•	•	
	Fall Chinook - Hatchery Supplementation/Mitigation /stock recovery evaluation	Determine the effects hatchery fall Chinook have on wild fall Chinook population.	Active	WDFW, NPT	LSRCP	**Very high** (See *Spring Chinook - Hatchery Supplementation and Mitigation Evaluation)*	Snake River and tribs						•	•

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Steelhead - Evaluation of Harvest Mitigation and Supplementation Programs	Endemic broodstock development; determine hatchery steelhead behavior (juvenile residualism, adult straying), juvenile productivity (survival rates by life stage and smolt production estimates).	Active	WDFW	LSRCP	**Very high** (See *Spring Chinook - Hatchery Supplementation and Mitigation Evaluation)*	Snake River and tribs and Walla Walla Basin		•	•	•	•	•	•

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Snake River Fall Chinook Relative Reproductive Success	Utilize DNA samples from hatchery endemic Snake River fall Chinook and wild Snake fall Chinook to assess the applicability of a technique to assign parental origin to outmigrant fall Chinook smolts. The technique is being assessed on the Snake River, a system far too large to conduct a more traditional genetic parentage assignment study, to determine if the relative reproductive success of hatchery and wild Chinook can be accurately measured in a large river system.	Conceptual	WDFW et al.	BPA	**Medium** (BPA will eventually be sending out a targeted solicitation to satisfy its responsibility under RPAs 64 and 65 of the FCRPS BiOp)	Snake River and tribs					•	•	
	Watershed Planning	Setting instream flows and allocation recommendations.	Active	WDOE	WDOE		Snake tributaries in SE WA	•						

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Tucannon/Asotin Watersheds Macro Invertebrate Study	Project provides baseline information on species and population diversity within the Tucannon Watershed. Study of species as an indicator of the healthy water conditions.	Conceptual	USFS	USFS		Asotin/ Tucannon Rivers and Tribs	•	•	•		•		
Walla Walla	Walla Walla Basin (within WA) Salmonid Population and Habitat Assessment (2000-039-00)	Assess habitat conditions, fish distribution and relative abundance (adult and juvenile), and salmonid genetic characterization.	Active	WDFW and CTUIR	BPA	**Very High** as it provides adult abundance and productivity for naturally produced steelhead and reintroduced salmon	Walla Walla	•	•	•	•	•	•	•
		Natural production monitoring - Monitor adult and juvenile abundance, distribution, age and growth, outmigration and survival.	Active	WDFW and CTUIR	BPA	**Very High** (continue funding)	Walla Walla				•	•		

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Walla Walla Fish Passage Project (1996-011-00)	Evaluating fish passage conditions in Mill Creek and other locations in the basin.	Active	TSS, , WWCC, IEAC, WDFW	SRFB BPA Accords	**Very High** (continue funding)	Walla WallaMill Creek, Yellowhawk, Spring Creek, Touchet	•	•		•			
	Walla Walla Flow Enhancement Feasibility Evaluation	Determine the need and opportunities for increasing stream flow.	Active	CTUIR USACE	BPA USACOE		Walla Walla	•						
	Walla Walla IFIM Study	Conduct and IFIM evaluation of stream flow, and in the Walla Walla River basin.	Active	Conservation District			Walla Walla	•						
	Walla Walla Mainstem Bull Trout Evaluation	Monitor bull trout abundance and usage of mainstem habitat in the Walla Walla.	Active ongoing	USFWS	USFWS	**Moderately High**	Walla Walla	•	•	•	•	•		
	Walla Walla Bull Trout Abundance and Life History	Determine bull trout abundance/life history data in Oregon portion of Walla Walla.	Mostly completed	Utah State University/ USFWS	USFWS	**High** (this information is needed to assess recovery of bull trout)	Walla Walla		•	•	•	•		

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Upper Mill Creek Bull Trout Study	Determine abundance, distribution, spawning of bull trout in Upper Mill Creek.	Active ongoing	ODFW/ USFS, WDFW	BPA		Walla Walla (Mill Creek)		•	•	•	•		
	Video Monitoring of Adult Passage (Walla Walla River)	Conduct video dam counts of adult passage at Bennington Dam and Yellowhawk Diversion (Mill Creek).	Active and ongoing	CTUIR	USACE	**Very High** (this information is needed for stocks assessment)	Walla Walla (Mill Creek)		•		•		•	
	Walla Walla Water Budget	Develop a water-budget for the Walla Walla River. Project is inventorying all water sources including springs, wells, and surface flows.	Active	Walla Walla Watershed Council	WDOE, QWEB (Oregon watershed enhancement board)		Walla Walla	•						
	Walla Walla TMDL Study	WDOE is conducting a TMDL evaluation of the Walla Walla River basin.	Completed	WDOE/OWR	WDOE/OWR		Walla Walla	•						
	Watershed Planning	Setting instream flows and allocation recommendations.	Completed	WDOE	WDOE		Walla Walla							

								Monitoring addresses:						
									VSP					
Basin	**Project**	**Description**	**Project Status**	**Lead Entity**	**Funding Source**	**Priority**	**Location**	**Habitat**	**Abundance**	**Productivity**	**Spatial Structure**	**Diversity**	**Hatchery Effects**	**Harvest Effects**
Tucannon	Tucannon Bull Trout Telemetry	Study the behavior of bull trout in the Tucannon and Snake rivers, and determine numbers and movements of bull trout from the Tucannon into the Snake River to evaluate the effects of the COE hydrosystem on this species	Completed	WDFW and USFWS	BPA	**Medium** (this information will supplement information that has already been collected)	Tucannon		•		•	•		
	Tucannon Captive Brood Project	Development and implementation of a captive broodstock program for one generation of Tucannon Spring Chinook to buoy the population through a bottleneck. A comparison of captive, supplementation and wild productivity, genetics and life stage performance will be documented.	Complete after 2011	WDFW	BPA	**Low** (this program has phased out;)	Tucannon		•	•	•	•	•	

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:							
									VSP						
								Habitat	Abundance	Productivity	Spatial Structure	Diversity		Hatchery Effects	Harvest Effects
	Tucannon Bull Trout Genetics Sampling	Collaborative effort between WDFW and USFWS to characterize genetics of the Tucannon bull trout populations in various reaches of the upper Tucannon drainage	Active	WDFW / USFWS	WDFW / USFWS	**Medium** (this information will supplement information that has already been collected)	Tucannon					•			
	Tucannon Cobble Embeddedness Assessment	Assess habitat conditions pertaining to percent fines and sediment using Wolmans' Pebble counts and embeddeness transects on Tucannon mainstem and its tributaries. Study will compare current conditions to those collected previously.	Active	USFS and CCD	BPA		Tucannon	•		•					

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Tucannon Watershed Sediment and Temperature Monitoring	Project provides baseline information on fish and habitat conditions in the Tucannon River and its tributaries. Hobos to monitor temperature and ISCO sediment samplers for turbidity are placed for continuous assessment of project activity effects.	Active	USFS, CCD, WDFW, WDOE	USFS, WDOE, BPA		Tucannon	●						
	Snake River TMDL Study	WDOE is conducting a temperature TMDL evaluation of the Tucannon basin.	Complete	WDOE	WDOE		Snake tributaries in SE WA	●						
Asotin	Asotin Creek Road Abandonment Program and Culvert Replacement Program	See habitat actions table – Study to develop lists of roads and culverts that with removal will increase the quality/quantity of salmon habitat.	Active and ongoing	Nez Perce/ USFS	BPA/USFS		Asotin Creek	●						

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Asotin County Sediment and Temperature Monitoring	Project provides baseline information on fish and habitat conditions in the Asotin Creek and its tributaries. Hobos to monitor temperature and ISCO sediment samplers for turbidity are placed for continuous assessment of project affects.	Partial active	USFS/ACCD Watershed Planning	USFS/BPA WDOE		Asotin Creek	•						
	Assess Salmonids in the Asotin Creek Watershed (2002-053-00)	This project implements the RM&E criteria specified in the Asotin Subbasin Plan by providing estimates of abundance, productivity, survival rates, and temporal and spatial distribution of ESA-listed species.	Active	WDFW	BPA	**Very High** (This information is essential in estimating VSP parameters in Asotin Creek for steelhead; ensure continued funding).	Asotin Creek	•	•	•	•	•	•	•

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses:						
									VSP					
								Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
	Asotin Creek IMW	This project implements rigorous habitat and juvenile salmonid abundance baseline sampling with intensive habitat manipulation to address limiting factors and document if there is population response	Active	SRSRB, Ecologic	NMFS	**Very High** (This is one of a small number of IMW watersheds dedicated to understanding the effects of habitat restoration.	NF Asotin SF Asotin Charley Cr.	●			●			
	Asotin Creek Water Quality Analysis	Determine water quality in Asotin Creek.	Conceptual	Conservation District			Asotin Creek	●						

Basin	Project	Description	Project Status	Lead Entity	Funding Source	Priority	Location	Monitoring addresses: Habitat	Monitoring addresses: VSP: Abundance	Monitoring addresses: VSP: Productivity	Monitoring addresses: VSP: Spatial Structure	Monitoring addresses: VSP: Diversity	Monitoring addresses: Hatchery Effects	Monitoring addresses: Harvest Effects
Grande Ronde	Grande Ronde Supplementation program M&E (NPPC 1998-007-03)	Develop, implement, and evaluate integrated conventional and captive brood hatchery projects to prevent extinction and stabilize populations of threatened spring Chinook salmon and summer steelhead populations in the Grande Ronde River.	Active	In Oregon only CTUIR	BPA		Grande Ronde		•	•	•	•	•	
	Life Studies of Spring Chinook (NPPC 1992-026-04)	Investigate the abundance, migration patterns, survival, and life history strategies of spring Chinook salmon and summer steelhead from distinct populations and implement fish population and habitat monitoring in the Grande Ronde and Imnaha River basins.	Conceptual	In Oregon only ODFW	BPA		Grande Ronde	•	•	•	•	•		

C.2.7 Population Status/Trend Monitoring Plan

This section outlines status/trend monitoring plans for VSP parameters for populations of Chinook salmon (spring Chinook in the Tucannon, Asotin, and Wenaha) and steelhead (Walla Walla, Touchet, Tucannon, Asotin, Joseph Creek, and Lower Grande Ronde) in the SEWMU. As noted in Section C-2.2, bull trout monitoring plans will be developed after receiving direction from the U.S. Fish and Wildlife Service.

For each population, we recommend a monitoring plan that should answer each of the questions identified under Question 1 in Section C-2.2 (except question 1.4.10, which is addressed in the Limiting Factors section). Each question or set of questions was translated into a monitoring objective. Thus, there are 10 objectives that need to be addressed for each population. Under each objective, a sampling design is recommended that could be used to address the objective (e.g., census or some type of probabilistic sampling); the spatial/temporal scale of the objective and sampling design; what variables could be measured in the field; what methods or protocols could be used to measure the variables; what metrics could be derived from the measured variables; what statistical method if any could be used to analyze the data; who is likely to fund the monitoring; and who could oversee implementation and coordination of the study.

Because different entities or agencies will likely implement the monitoring plans across the SEWMU, we outlined independent plans for each species separately, because sampling designs, methods, and protocols are essentially similar across populations. This should make it easier for the entities responsible for monitoring a specific population to implement the plan. To the extent possible, the Board and monitoring entities will need to coordinate activities across subbasins to ensure efficient use of funds.

C.2.8 SEWMU Spring Chinook

Most of the information needed to monitor the status of SEWMU spring Chinook salmon is currently collected under the LSRCP by WDFW. This plan will supplement the existing program so that the status and trend of the SEWMU spring Chinook salmon populations can be compared with recovery criteria.

Objective 1: ***Determine if the abundance of spring Chinook spawners within the SEWMU Populations meet recovery and restoration criteria.***

Monitoring Questions:

- Is the 10-year GM (with uncertainty expressed as 1 SE and 95% CI)[37] of spring Chinook spawners greater than or equal to the recovery or restoration criteria:

Population	Recovery (natural-origin)	Restoration (natural- and hatchery origin)
Tucannon	750	2,400-3,400
Asotin[a]	500	500
Wenaha	750	1,335

[a] Even though Asotin Creek is functionally extinct, the ICTRT and SR RTT have developed criteria.

Sampling Design:

- Redds—Complete census of all redds observed during spawning surveys.
- Carcasses—Complete census of all hatchery and natural origin carcasses observed during spawning surveys (number of carcasses sampled should be no less than 20% of the estimated spawning escapement).
- Trapping-Enumerate the number and origin of fish used for broodstock and passed upstream of the weir.
- Sex Ratios—Sample all fish collected at broodstock collection sites (currently at Tucannon Hatchery Adult Trap – river kilometer (rkm) 59 on the Tucannon River) or recovered as carcasses. Sexual characteristics may be difficult to determine during broodstock capture for spring Chinook salmon).
- Telemetry study - Determine fate of Tucannon River spring Chinook[38]

Spatial/Temporal Scale:

- Redds & Carcasses—The entire distribution of the population is surveyed annually.
- Redds & Carcasses—Sampling is conducted at least once per week throughout the spawning season (August-September).

---

[37] Follows the dual comparison approach developed by the ICTRT (2007).

[38] A telemetry study has been proposed to attempt to determine the fate of Tucannon River fish that continue migrating upstream of the Tucannon River. Goals and objectives will need to be developed, and it will need to be determined if the co-managers and other stakeholders will need to understand how many of the fish that migrate upstream of Lower Granite Dam eventually move back into the Tucannon River, or, in addition to that, fully understand the final fate of the fish during spawning season, since it will affect the scope of the study.

- Sex Ratios—Run is sampled at broodstock collection sites (currently at Tucannon Hatchery Adult Trap – river kilometer (rkm) 59 on the Tucannon River; as mentioned above, sex may be difficult to determine at broodstock capture).

Measured Variables:

- Redds—Number of redds.
- Origin—Number of hatchery and naturally produced fish sampled as carcasses on spawning grounds in conjunction with origin determination of fish passed upstream of the adult trap.
- Sex—Number of males and females sampled at broodstock collection sites and on the spawning grounds.
- Harvest—Number of hatchery and naturally produced fish harvested.
- Strays-Number of fish determined to have bypassed the Tucannon River.
- Strays – number of spring/summer Chinook of origin other than the target population in spawning population.

Measurement Protocols:

- Redds & Carcasses—Stream surveys conducted by walking and/or floating all streams within the distribution of the population (Gallinat and Ross 2009).
- Origin—Examination for marks or tags on carcasses (Gallinat and Ross 2009).
- Sex Ratio—Identification of sex of fish collected for broodstock and or carcasses (using morphological characteristics, dissection, and/or possibly ultrasound) (Gallinat and Ross 2009).

Derived Variables:

- Estimate spawners per redd.
- Estimate total number of naturally produced spawners.
- Calculate 10-yr GM for abundance of naturally produced fish.

Analysis:

- Estimate the standard error (SE) and 95% confidence interval (CI) for the abundance estimates (ICTRT 2007).
- Combine the abundance estimate with the productivity estimate (from Objective 2) and plot it with SE and 95% CI on the viability curve (ICTRT 2007).
- If greater than 1% extinction risk on the viability curve, calculate the probability that the population has greater than 5% extinction risk on the viability curve (ICTRT 2007).
- Compare the 10-yr GM (with estimates of uncertainty) to the abundance criterion.
- Track the trend in 10-yr GM abundance estimates.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- BPA and NOAA Fisheries may contribute additional funds.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:[39]

- Field work is implemented and coordinated primarily by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded programs and comparison of data to recovery metrics.

This is a highest priority objective for Tucannon spring Chinook and for the mainstem Wenaha and the Butte Creek area within WA for the Wenaha population. This may become a highest priority for spring Chinook in Asotin when reintroduction efforts begin.

Objective 2: ***Determine if the productivity of naturally produced spring Chinook spawners and juveniles[40] within SEWMU Populations meet recovery and restoration criteria.***

Monitoring Questions:

- Is the 20-year GM of productivity (spawner/spawner; with uncertainty expressed as 1 SE and 95% CI)[41] of naturally produced spring Chinook in SEWMU subbasins greater than or equal to the recovery criteria:

Population	Recovery of natural-origin	Restoration (natural- and hatchery origin)
Tucannon	2.75 (1% risk)	> 1.0
Asotin[a]	1.9 (5%)	> 1.0
Wenaha	1.76 (5%)	> 1.0

[a] Even though Asotin Creek is functionally extinct, the ICTRT and SR RTT have developed criteria.

- Has the number of juveniles (emigrants) increased, and emig**rants** per redd increased?

Sampling Design:

- From Objective 1 for adults.
- Census (based on mark-recapture to calibrate trapping efficiency) of smolts and emigrants through trapping for juvenile migrants.

[39] Implementation and coordination in the context of this RM&E portion of the recovery plan is meant as an indication of which agency may assist in procuring funding and tracking implementation.

[40] While juvenile productivity is not a VSP parameter, it is one of the only measures of success of habitat restoration projects and is therefore an important component of this Plan.

[41] Follows the dual comparison approach developed by the ICTRT (2007).

Spatial/Temporal Scale:

- Redds & Carcasses—Objective 1.
- Sex Ratios—Objective 1.
- Annual estimates of the number of juveniles emigrating.

Measured Variables:

- Redds—Number of redds (from Objective 1).
- Origin—Origin of carcasses (hatchery or naturally produced fish) (from Objective 1).
- Sex—Sex ratio of broodstock collected over the run (from Objective 1).
- Age—Age composition from both broodstock and carcasses (scale analysis/tag recovery).
- Harvest—Number of naturally produced fish harvested (from Objective 1).
- Strays-Number of fish determined to have bypassed the Tucannon River (from Objective 1).
- Number of juveniles (smolts and parr [not appropriate for all populations]).

Measurement Protocols:

- Redds & Carcasses—Objective 1.
- Age Structure—Collect and read scales/CWT from all carcasses and broodstock sampled for Objective 1 (Gallinat and Ross 2009).
- Sex Ratio—Objective 1.
- Count smolts and emigrants using smolt traps following methods in Bumgarner et al. (2000), Gallinat et al. (2001), Mayer et al. (2010), and Mahoney et al. (2009).

Derived Variables:

- Calculate the age structure of the spawning population.
- Calculate the number of NORs [number of natural origin recruits (spawners and other fish taken in harvest) by brood year for naturally produced parents, includes estimates of pre-spawning mortality].
- Calculate productivity or recruits per spawner as the ratio of NORs to total spawners by brood year.
- Calculate 20-yr GM for productivity of naturally produced fish.
- Calculate 20-yr intrinsic population productivity, which limits the return per spawner time series for escapements that exceed the estimated 75% threshold associated with carrying capacity (ICTRT 2007).
- Number of juveniles (smolts and parr) per redd.

Analysis:

- Estimate the standard error (SE) and 95% confidence interval (CI) for the productivity estimate (ICTRT 2007).
- Combine the productivity estimate with the abundance estimate (from Objective 1) and plot it with SE and 95% CI on the viability curve (ICTRT 2007).
- If less than 5% extinction risk on the viability curve, calculate the probability that the population is really greater than 5% extinction risk on the viability curve (ICTRT 2007).
- Compare the 20-yr GM (with estimates of uncertainty) to the productivity criterion.
- Track the trend in 20-yr GM productivity estimates (for all natural spawners and for natural-origin spawners separately).
- Analyze annually based on brood year.
- Analyze as a time series (initially as a 5-year period).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- BPA or NOAA Fisheries may contribute additional funds.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a highest priority objective for Tucannon spring Chinook and spring Chinook salmon. It is a lower priority for the Wenaha salmon, if feasible there.

Objective 3: ***Determine if the number and spatial arrangement of spring Chinook spawning areas within SEWMU subbasins meets recovery and restoration criteria.***

Monitoring Questions:

- What is the spatial arrangement of the occupied spawning areas used by SEWMU spring Chinook?

Sampling Design:

- Complete census of all major spawning areas.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.

Measured Variables:

- Redds—Number and locations of spring Chinook redds.
- Carcass origin – wild and hatchery origin fish.

Measurement Protocols:

- Redd Surveys—Objective 1.

Derived Variables:

- Number and distribution of redds throughout major spawning areas.
- Proportion of hatchery and wild origin fish spawning in spatial reaches of SEWMU subbasins.

Analysis:

- Analyze as distribution data (linear, dendritic, trellis, etc.).

- Analyze as a time series to determine if major spawning areas meet the occupancy standards.[42]

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 4: ***Determine if the spatial extent or range of the spawning population meets recovery and restoration criteria.***

Monitoring Questions:

- Are all historical major spawning areas used by SEWMU spring/summer Chinook salmon meeting occupancy standards?[43]

Sampling Design:

- Redd Surveys—Objective 1.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.

Measured Variables:

- Redds—Number and locations of spring Chinook redds.

Measurement Protocols:

- Redd Surveys—Objective 1.

---

[42] Occupied areas are those in which two or more redds from natural origin spawners have been observed in all years of the most recent brood cycle (one generation) and for at least half of the most recent three brood cycles. For major spawning areas there must be two or more redds in both the upper and lower halves of the weighted intrinsic potential area (ICTRT 2007).

[43] There must be two or more redds in both the upper and lower halves of the weighted intrinsic potential area (ICTRT 2007).

Derived Variables:

- Number and distribution of redds throughout the presumed historical range of the species.

Analysis:

- Analyze as distribution data (goodness of fit).
- Analyze data over time to determine if distributions meet the occupancy standards.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 5: ***Determine if the distance (gaps) between spring Chinook spawning areas is increasing.***

Monitoring Questions:

- Are 75% or more of the major spawning areas occupied?
- If relevant for the specific basin or population, have unoccupied major spawning areas caused gaps of 10 km or more between spawning areas?
- Has the loss of minor spawning areas at the lower end of the population caused an increase in distance to an adjacent population of more than 25 km?

Sampling Design:

- Redd Surveys—Objective 1.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.

Measured Variables:

- Redds—Locations of spring Chinook redds.

Measurement Protocols:

- Redd Surveys—Objective 1.

Derived Variables:

- Percent of major spawning areas occupied.
- Distance (km) between occupied major spawning areas.
- Distance between populations.
- Population demographics of spawning areas (variable distribution of hatchery and wild)

Analysis:

- Compare current gap to presumed historical gap.
- Track gaps between major spawning areas and between populations over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

Objective 6: ***Determine if the major life history strategies used by spring Chinook in SEWMU subbasins are similar to those used historically.***

Monitoring Questions:

- Are all the major life-history strategies (adult run timing; and juvenile migration patterns) that occurred historically still expressed within the spring Chinook population?

Sampling Design:

- Adult run timing—Continuous sampling at hydroelectric dams (adult fish ladders) and broodstock collection sites (Adult fish traps).
- Adult scale and tag analysis—Sample all fish collected at broodstock collection sites, at stock assessment sites, and from carcasses on spawning grounds to determine if yearling smolt migration is still the major life-history pattern.
- Juvenile migration patterns—Continuous (during normal operational time) operation of rotary traps.
- Juvenile migration patterns—Juvenile spring Chinook will be PIT tagged and their movements detected near the mouths of the major tributaries. These fish can also be detected at Columbia River hydroelectric projects during their migrations to and from the ocean.

Spatial/Temporal Scale:

- Adult run timing—Annual sampling will occur at mainstem dams and at the broodstock collection sites throughout the migration period.
- Adult scale and tag analysis— Annual sampling will occur for collected broodstock and carcasses recovered on the spawning grounds.
- Juvenile migration patterns—Annual sampling at the rotary traps.
- Juvenile migration patterns—PIT tag sampling will occur annually.

Measured Variables:

- Adults—Number and time of adults passing counting, collection, or detection stations.
- Adults—Age at smolting (from scale analysis).
- Juveniles—Number and time of juveniles collected at collection stations.

Measurement Protocols:

- PIT tagged adults will be counted at mainstem Columbia and Snake River dams, and at remote PIT tag array sites.
- Collect and read scales and tags from all carcasses and broodstock sampled (Gallinat and Ross 2009).
- Juveniles will be counted at rotary traps using methods described in Gallinat and Ross (2009) and at remote PIT tag detection sites.

Derived Variables:

- Adult migration timing—Calculate beginning, peak, and end of run timing.
- Estimate adult abundance from proportion of juvenile migrant population PIT tagged for in-season estimates of abundance.

- Adult scale and tag analysis—Calculate the percent of adult returns that are from yearling smolt migrants.
- Juvenile migration timing—Calculate the beginning, peak, and end of yearling smolt migration.
- Juvenile migration—Calculate the percent of spring Chinook smolts that migrate out of the Tucannon as yearlings.
- Using information from Objectives 1 and 2, calculate SAR and smolts per redd.[44]

Analysis:

- Compare adult migration timing to the assumed historical or reference condition.
- Track changes in migration timing of adults and juveniles over time.
- Compare juvenile migration patterns to the assumed historical or reference condition.
- Track changes in the percentage of spring Chinook smolts that migrate as yearlings and the percentage of adults returning that migrated as yearling smolts.[45]
- Track changes in SAR and smolts per redd over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- Adult monitoring at mainstem dams is implemented and coordinated by the Corps of Engineers, and PIT tag data maintained through PITAGIS.
- The Snake River Salmon Recovery Board will coordinate activities between the existing programs and comparison of data to recovery metrics.

This is a high priority objective.

Objective 7: ***Determine if morphological/behavioral and life-history traits of spring Chinook in SEWMU subbasins are changing relative to presumed historical conditions.***

Monitoring Questions:

[44] Although SAR and smolts per redd are not directly related to the Objective 6, the information does provide calculation of productivity statistics.

[45] At this time no effect sizes have been identified for these two analyses. That is, it has not been determined how large a difference in migration timing or percentage of yearling and subyearling smolts would be considered detrimental. In addition, at this time no reference condition has been established for these analyses.

- Are spawn timing, size at maturity, fecundity, and juvenile migration patterns of naturally produced spring Chinook changing relative to a reference condition (which may or may not be in the natal stream) in SEWMU populations?

Sampling Design:

- Adult spawn timing—Complete census surveys of spawning activity on the spawning grounds.
- Size at maturity—Complete census of fish sampled as carcasses on spawning grounds and fish collected for broodstock.
- Fecundity—All females used for broodstock collection.
- Age structure—Complete census of fish sampled as carcasses on spawning grounds and fish collected for broodstock (from Objective 2).
- Juvenile migration patterns—from Objective 6.
- Compare current to presumed 1980s baseline
- Tag juvenile fish

Spatial/Temporal Scale:

- Adult spawn timing—Annually sample all available naturally spawning adults (as carcasses) across the entire spawning distribution (sampling conducted weekly during August-September).
- Size at Maturity—Annually sample all fish collected for broodstock and all available naturally spawning adults (as carcasses) across the entire spawning distribution.
- Fecundity—Annually sample the fecundity of fish collected for broodstock.
- Age structure—Annually collect scales and CWT from all fish collected for broodstock and from carcass surveys (from Objective 2).
- Juvenile migration patterns—Objective 6.

Measured Variables:

- Beginning (10^{th} percentile), peak (mode), and end (90^{th} percentile) time (Julian date) of spring Chinook redd construction.
- Age-specific post-orbital to hypural (POH) and fork length (mm) of carcasses encountered during spawning ground surveys.
- Age-specific fork length (mm) of fish collected for broodstock.
- Age-specific fork length (mm) on a subsample of fish passed at broodstock collection sites.
- Count of eggs per female spawned by age class.
- Age composition from scale analysis and CWT.
- Juvenile migration from Objective 6.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all known spawning areas within the distribution of the population (see Objective 1).
- Lengths collected from all carcasses sampled during spawning surveys and from all fish sampled at broodstock collection sites (TFH adult trap).
- Fecundity estimated by using the weight-per-count method (Gallinat and Ross 2009).
- Age structure from Objective 2.
- Juvenile migration from Objective 6.

Derived Variables:

- Tenth percentile, mode, and 90th percentile Julian date of spawning.
- Average size (POH and fork length) per age class.
- Average number of eggs per female by age class.
- Percentage of smolts that overwinter in spawning tributaries and percentage that overwinter in the mainstem (if proper tagging study is implemented).

Analysis:

- Assess relationship between fecundity and female size (regression analysis).
- Compare fecundity at age to the assumed historical or reference condition. [46]
- Assess relationship between age and size (regression analysis).
- Compare size at age to the assumed historical or reference condition (see footnote).
- Track changes in fecundity at age and size at age over time.
- Compare juvenile migration patterns to the assumed historical or reference condition.
- Track changes in juvenile migration patterns over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the USFWS funded program and comparison of data to recovery metrics.

This is a medium priority objective.

Objective 8: ***Determine if the within-population genetic variation of SEWMU spring Chinook is consistent with low risk for viability.***

Monitoring Questions:

- What is the genetic variation within the SEWMU spring Chinook populations?

Sampling Design:

- Adult sampling through broodstock and carcasses.
- Temporal Sampling—Systematic sampling throughout the migration and spawning period.
- Samples size = 100 naturally produced adult Chinook and 100 hatchery produced adult Chinook (sample sizes may not be achieved during years with low escapements).

Spatial/Temporal Scale:

[46] At this time no historical or reference conditions have been identified for analyses requiring comparisons of present conditions with historical or reference conditions.

- Samples collected from all major spawning areas.
- Samples collected once every five years.

Measured Variables:

- Microsatellite genotypes

Measurement Protocols:

- Tissue samples collected from carcasses sampled during spawning ground surveys.
- Microsatellite or SNP technology.

Derived Variables:

- Allele frequency

Analysis:

- Within collection genetic diversity (using GENETIX)
- Among collection genetic differentiation (randomized chi-square using FSTAT)
- Individual assignment (partial Bayesian procedure)

Possible Funding Entities:

- Spawning surveys and genetic analyses are funded with BPA funds through USFWS via the LSRCP.
- Additional funding from state and/or federal agencies may be needed to compare results with recovery criteria.

Implementation and Coordination:

- Genetic sampling will be implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 9: ***Determine if the proportion of hatchery and exogenous spring Chinook spawners in SEWMU subbasins meets recovery and restoration criteria.***

Monitoring Questions:

- What proportion of spring Chinook spawners in SEWMU populations is derived from hatchery fish produced within the population using best management practices (BMPs)?
- What proportion of the spring Chinook spawners in SEWMU populations is derived from hatchery fish produced outside the population (and source) but within the MPG or ESU (includes within-population programs not using BMPs)?
- What proportion and origin of the spring Chinook spawners in SEWMU population is derived from hatchery fish produced outside the Snake River ESU?

Sampling Design:

- Carcass Surveys—Objective 1.
- Genetic differentiation between unmarked hatchery origin fish and natural origin fish (see Galliant and Ross 2009).

Spatial/Temporal Scale:

- Carcass Surveys—Objective 1.

Measured Variables:

- Number of hatchery (and source) and naturally produced fish.
- Number of marked or tagged fish.

Measurement Protocols:

- Carcass Surveys—Objective 1.
- Adult trapping - Objective 1.

Derived Variables:

- Origin of marked or tagged fish.
- Expansion factors for carcass sampling rate and percentage of each mark group that is tagged.
- Proportion of spawning population made up of different origin fish.

Analysis:

- Use current-year data along with previous estimates to calculate the average percentage of total escapement within each of the three categories over an appropriate timeframe. The timeframe may change depending on how and when hatchery practices change, but should include one generation to conclude moderate risk or two to three generations to achieve a low-risk rating (ICTRT 2007).
- Direct comparison with recovery criteria.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

Objective 10: ***Determine if the distribution of spring Chinook spawners across the different ecoregions within SEWMU subbasins meets recovery and restoration criteria.***

Monitoring Questions:

- Have there been substantial shifts in spring Chinook distribution across the basin-specific ecoregions?

Sampling Design:

- Redd Surveys—Objective 1.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.

Measured Variables:

- Redds—Locations of spring Chinook redds.

Measurement Protocols:

- Redd Surveys—Objective 1.

Derived Variables:

- Number of redds within each ecoregion.
- Percent of occupied spawning area within each ecoregion.

Analysis:

- Compare current to historic and calculate the percent change in each of the ecoregions to determine if it is "substantial" (defined as at least 67 percentage points) (ICTRT 2007).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP.
- State and/or federal funds may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a low priority objective.

C.2.9 Southeast Washington Recovery Area Steelhead (Walla Walla, Touchet, Tucannon, Asotin Creek, Joseph Creek, and Lower Grande Ronde River).

As with SEWMU spring Chinook, most of the information needed to monitor the status of steelhead in the SEWMU is currently collected under the LSRCP hatchery monitoring and evaluation program and through a separate contract with BPA in Asotin Creek (and associated populations, e.g., Alpowa Creek; Bumgarner and Dedloff 2009 and Mayer et al. 2010), and Mahoney et al. (2009) for the Walla

Walla subbasin. In most cases, however, these programs do not derive the metrics (e.g., 10-yr GM) needed to assess recovery. This plan will supplement the existing programs so that the status and trend of the SEWMU steelhead population can be compared with recovery criteria. In addition, new studies, such as PIT tag analysis from various tributary remote arrays and parental-based tagging at Lower Granite Dam will improve basin-specific information.

It is extremely important to note that for most Snake River steelhead populations (and in some mid-Columbia DPS populations) it is difficult to obtain population-specific information, such as the number of returns or spawners, spawner composition (hatchery- or natural-origin), and life history traits. While new efforts are being pursued through various venues, the SRSRB supports increased funding and efforts that will assist managers and other stakeholders in obtaining the necessary information.

Objective 1: ***Determine if the abundance of steelhead spawners within the SEWMU populations meet recovery and restoration criteria.***

Monitoring Questions:

- Is the 10-year GM (with uncertainty expressed as 1 SE and 95% CI)[47] of steelhead spawners greater than or equal to the recovery or restoration criteria?

Population	Recovery (natural-origin)	Restoration (natural- and hatchery origin)
Walla Walla	1,000	1,875-3,395
Touchet	1,000	1,563-2,205
Tucannon	1,000	1,823-3,400
Asotin	500	2,776-3,114
Joseph Creek	500	2,149-5,909
Lower Grande Ronde	1,000	1,855-5,101

Sampling Design:

- Adult traps or redd Counts— Complete census or index areas are surveyed each year.
- Sex Ratio—Complete census of all fish collected or observed at broodstock collection and sampling sites (Tucannon; adult trap at TFH, Walla Walla; Mill Creek, Coppei Creek, Dayton, and Nursery Bridge dams; Asotin Creek; adult trap, Joseph Creek, and Lower Grande Ronde; Cottonwood Creek adult weir).
- Origin Ratio (naturally produced fish to hatchery fish)—Determined at adult collection and sampling sites.
- Stray rates-Determine stray rates from coordinated data collection between regions.
- Adult and smolt traps and PIT tag arrays

[47] Follows the dual comparison approach developed by the ICTRT (2007).

- For upstream of LGR, ID is doing parental based tagging

Spatial/Temporal Scale:

- Adult trapping - throughout the season of adult returns.
- Redd Counts—Survey all index areas. Every year sampling is conducted periodically (if weather and stream conditions permit) throughout the spawning season (March-May).
- Sex Ratio—Annually sample adults collected for broodstock or sampled and passed upstream of adult traps throughout the migration period.
- Origin Ratio—Annually sample adults collected for broodstock and sampled and passed upstream of adult traps throughout the migration period, timing of which is dependent on the location of the trap (July-May).

Measured Variables:

- Adult abundance -
- Redds—Number of steelhead redds within index areas.
- Sex—Number of males and females sampled at broodstock collection sites.
- Origin—Number of naturally produced and hatchery produced steelhead counted at adult traps.
- Harvest—Number of hatchery and naturally produced fish harvested.
- Strays-Number of hatchery and naturally produced fish determined to spawn in non-target areas.
- Number of adults at traps

Measurement Protocols:

- Redds—Stream surveys conducted by walking and/or floating all streams within the index reaches (Bumgarner and Dedloff 2009, Mayer et al 2010, Mahoney et al. 2009).
- Sex Ratio—Identification of sex of fish collected for broodstock and/or sampled and passed upstream of adult traps.
- Origin Ratio—Identify hatchery fish (missing adipose fins, eroded fins, and/or CWT, PIT, and elastomer tags) and naturally produced fish (no clips or elastomer tags) at broodstock collection and sampling sites.

Derived Variables:

- Estimate total escapement
- Estimate the total number of redds within each subbasin of the SEWMU.
- Use ratios of naturally produced fish to hatchery fish sampled at adult collection and sampling facilities to estimate the proportion of naturally produced fish spawning in the SEWMU.
- Estimate the number of naturally produced fish spawning by using proportions of naturally produced fish to hatchery fish, total number of redds, and sex ratios.
- Calculate 10 GM for abundance of naturally produced fish.

Analysis:

- Estimate the standard error (SE) and 95% confidence interval (CI) for the abundance estimate (ICTRT 2007).
- Combine the abundance estimate with the productivity estimate (from Objective 2) and plot it with SE and 95% CI on the viability curve (ICTRT 2007).

- If less than 5% extinction risk on the viability curve, calculate the probability that the population is really greater than 5% extinction risk on the viability curve (ICTRT 2007).
- Compare the 10-yr GM (with estimates of uncertainty) to the abundance criterion.
- Track the trend in 10-yr GM abundance estimates.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal dollars would be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a highest priority objective, especially for Tucannon, Asotin, Touchet and Walla Walla populations. It is a lower priority for the lower Grande Ronde only because of logistical issues there.

Objective 2: ***Determine if the productivity of naturally produced steelhead spawners and juveniles within the SEWMU meet recovery and restoration criteria.***

Monitoring Questions:

Is the 20-year GM of productivity (spawner/spawner; with uncertainty expressed as 1 SE and 95% CI)[48] of naturally produced steelhead greater than or equal to the recovery and restoration criteria:

Population	Recovery (natural-origin)	Restoration (natural- and hatchery origin)
Walla Walla	1.35	> 1.0
Touchet	1.35	> 1.0
Tucannon	1.20	> 1.0
Asotin	1.20	> 1.0
Joseph Creek	1.27	> 1.0
Lower Grande Ronde	1.14	> 1.0

- Has the number of emigrants increased?
- Has the number of emigrants per redd increased?

[48] Follows the dual comparison approach developed by the ICTRT (2007).

Sampling Design:

- From Objective 1 for adults.
- Census (based on mark-recapture to calibrate trapping efficiency) of smolts and emigrants through trapping for juvenile migrants.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.
- Ratios (Sex and Origin)—Objective 1.
- Annual estimates of the number of juveniles emigrating.

Measured Variables:

- Redds—Number of redds (from Objective 1).
- Origin—Origin of spawners (hatchery or naturally produced fish) (from Objective 1).
- Sex—Sex ratio of broodstock collected randomly over the run (from Objective 1).
- Age—Age composition from broodstock (scale analysis).
- Harvest—Number of naturally and hatchery produced fish harvested (from Objective 1).

Measurement Protocols:

- Redd Surveys—Objective 1.
- Age Structure—Collect and read scales from all fish collected for broodstock.
- Sex Ratio—Objective 1.
- Origin—Objective 1.
- Count smolts and emigrants using smolt traps following methods in Bumgarner et al. (2000), Mayer et al. (2010), and Mahoney et al. (2009).

Derived Variables:

- Calculate the age structure of the spawning population.
- Calculate the number of NORs (number of natural origin recruits by brood year for naturally produced parents).
- Calculate productivity or recruits per spawner as the ratio of NORs to total spawners.
- Calculate 20-yr GM for productivity of naturally produced fish.
- Calculate 20-yr intrinsic population productivity, which limits the return per spawner time series for escapements that exceed the estimated 75% threshold associated with carrying capacity (ICTRT 2007).
- Number of juveniles (smolts and parr) per redd.

Analysis:

- Estimate the standard error (SE) and 95% confidence interval (CI) for the productivity estimate (ICTRT 2007).
- Combine the productivity estimate with the abundance estimate (from Objective 1) and plot it with SE and 95% CI on the viability curve (ICTRT 2007).
- If less than 5% extinction risk on the viability curve, calculate the probability that the population is really greater than 5% extinction risk on the viability curve (ICTRT 2007).
- Compare the 20-yr GM (with estimates of uncertainty) to the productivity criterion.
- Track the trend in 20-yr GM productivity estimates.
- Analyze annually based on brood year.

- Analyze as a time series (initially as a 5-year period).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal dollars may be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a highest priority objective, especially for Asotin Creek, Tucannon River, and Touchet and Walla Walla rivers. This is a lower priority for the Wenaha Basin and lower Grande Ronde population primarily because of logistical concerns.

Objective 3: ***Determine if the number and spatial arrangement of steelhead spawning areas within the SEWMU meets recovery and restoration criteria.***

Monitoring Questions:

- How many major and minor spawning areas are currently used by steelhead in each subbasin of the SEWMU?
- What is the spatial arrangement of the occupied major and minor spawning areas used by SEWMU steelhead?

Sampling Design:

- Randomly selected reaches of major and minor spawning areas will be determined through the Generalized Random Tessellation Stratified (GRTS) design (or other agreed-to protocol).

Spatial/Temporal Scale:

- All major and minor spawning areas will be surveyed annually to the extent possible.
- Sampling is conducted periodically (if weather and stream conditions permit) throughout the spawning season (March-May).

Measured Variables:

- Redds—Number and locations of steelhead redds.
- Areas used - presence/absence.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all major and minor spawning areas within the distribution of the population.
- Map the location and number of steelhead redds within each spawning area.

Derived Variables:

- Number and distribution of redds throughout major and minor spawning areas.

Analysis:

- Analyze as distribution data (linear, dendritic, trellis, etc.).
- Analyze as a time series to determine if major and minor spawning areas meet the occupancy standards.[49]
- **Possible Funding Entities:**
- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal dollars would be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 4: ***Determine if the spatial extent or range of the spawning population meets recovery and restoration criteria.***

Monitoring Questions:

- Are all historical major spawning areas used by SEWMU steelhead meeting occupancy standards?[50]

Sampling Design:

- Redd Surveys—Objective 3.

Spatial/Temporal Scale:

- Redd Surveys—Objective 3.

---

[49] Occupied areas are those in which two or more redds from natural origin spawners have been observed in all years of the most recent brood cycle (one generation) and for at least half of the most recent three brood cycles. For major spawning areas there must be two or more redds in both the upper and lower halves of the weighted intrinsic potential area (ICTRT 2007).

[50] There must be two or more redds in both the upper and lower halves of the weighted intrinsic potential area (ICTRT 2007).

Measured Variables:

- Redds—Number and locations of steelhead redds.

Measurement Protocols:

- Redd Surveys—Objective 3.

Derived Variables:

- Number and distribution of redds throughout the presumed historical range of the species.

Analysis:

- Analyze as distribution data (goodness of fit).
- Analyze data over time to determine if distributions meet the occupancy standards.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal dollars would be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 5: ***Determine if the distance (gaps) between steelhead spawning areas is increasing.***

Monitoring Questions:

- Are 75% or more of the major spawning areas occupied?
- Have unoccupied major spawning areas caused gaps of 10 km or more between spawning areas?
- Has the loss of minor spawning areas at the lower end of the population caused an increase in distance to an adjacent population of more than 25 km?

Sampling Design:

- Redd Surveys—Objective 3.

Spatial/Temporal Scale:

- Redd Surveys—Objective 3.

Measured Variables:

- Redds—Locations of steelhead redds.

Measurement Protocols:

- Redd Surveys—Objective 3.

Derived Variables:

- Percent of major spawning areas occupied.
- Distance (km) between occupied major spawning areas.
- Distance between populations.

Analysis:

- Compare current gap to presumed historical gap.
- Track gaps between major spawning areas and between populations over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds (note - to be able to complete the monitoring need, additional funds will have to be available).
- State and/or federal dollars would be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

Objective 6: ***Determine if the major life history strategies used by steelhead in the SEWMU are similar to those used historically.***

Monitoring Questions:

- Are all the major life-history strategies (anadromy vs resident; adult run timing; and juvenile migration patterns) that occurred historically still expressed within the steelhead populations?

Sampling Design:

- Adult run timing—Continuous sampling at hydroelectric dams (adult fish ladders) and broodstock collection sites, and tributary traps.
- Juvenile migration patterns—Continuous operation of rotary traps.
- Juvenile migration patterns—Mark-recapture studies using PIT tags. Juvenile steelhead will be PIT tagged within each major tributary and their movements detected near the mouths of the major tributaries and at smolt trapping sites within all of the MSAs. These fish can also be detected at Snake and Columbia River hydroelectric projects during their migrations to and from the ocean.

Spatial/Temporal Scale:

- Adult run timing—Annual sampling will occur at mainstem dams and at the broodstock collection sites throughout the migration period.
- Juvenile migration patterns—Annual sampling at rotary traps in streams within each subbasins.
- Juvenile migration patterns—PIT tag sampling will occur annually.

Measured Variables:

- Adults—Number and time of adults passing counting, collection, or detection stations.
- Adults-age composition from scales.
- Juveniles—Number and time of juveniles collected at collection stations or collection sites.
- Juveniles—Age composition from scale analysis.

Measurement Protocols:

- Adults will be counted from collection at sampling sites, and monitoring at remote PIT tag detection sites.
- Juveniles will be counted at rotary traps using methods described in Gallinat et al. (2003), Bumgarner et al. (2000), Mayer et al. (2010), and Mahoney et al. (2009) and at remote PIT tag detection sites.
- Collect and read scales and tags from all fish collected at traps and detections sites.

Derived Variables:

- Adult migration timing—Calculate beginning, peak, and end of run timing.
- Adult age composition-Determine age structure from scale reading.
- Juvenile migration timing—Calculate the beginning, peak, and end of smolt migration.
- Juvenile migration—Calculate the age structure of steelhead smolts.

Analysis:

- Compare adult migration timing to the assumed historical or reference condition.
- Track changes in migration timing of adults and juveniles over time.
- Compare juvenile migration patterns to the assumed historical or reference condition.
- Track changes in the age structure of steelhead smolts and adults.[51]
- Track changes in SAR and smolts per redd over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.

[51] At this time no effect sizes have been identified for these two analyses. That is, it has not been determined how large a difference in migration timing or how much of a difference in age structure of smolts would be considered detrimental. In addition, at this time no reference condition has been established for these analyses.

- Adult monitoring on the mainstem Columbia and Snake rivers is implemented and coordinated by the Corps of Engineers.
- The Snake River Salmon Recovery Board will coordinate activities between the existing programs and comparison of data to recovery metrics.

This is a high priority objective.

Objective 7: ***Determine if morphological/behavioral and life-history traits of steelhead in the SEWMU are changing relative to presumed historical conditions.***

Monitoring Questions:

- Are spawn timing, size at migration and maturity, fecundity, and juvenile migration patterns of naturally produced steelhead changing relative to reference conditions in the SEWMU populations?

Sampling Design:

- Adult spawn timing—Survey of spawning activity on the spawning grounds.
- Size at maturity—Complete census of fish collected for broodstock.
- Size at migration—Collected from juvenile migrants from traps.
- Fecundity—Random sample of females used for broodstock collection.
- Age structure—Complete census of fish collected for broodstock (from Objective 2).
- Juvenile migration patterns—Objective 6.

Spatial/Temporal Scale:

- Adult spawn timing—Annually sample the time of spawning (based on redd surveys; Objective 1).
- Size at Maturity—Annually sample all adults trapped across the spawning distribution.
- Size of juvenile migrants—Annually subsample of emigrants.
- Fecundity—Annually sample the fecundity of fish collected for broodstock.
- Age structure—Annually collect scales from all fish trapped (adults and juveniles from Objective 2).
- Juvenile migration patterns—Objective 6.

Measured Variables:

- Beginning (10^{th} percentile), peak (mode), and end (90^{th} percentile) time (Julian date) of steelhead redd construction.
- Age-specific post-orbital to hypural (POH) and fork length (mm) of any carcasses encountered during spawning ground surveys.
- Age-specific fork length (mm) of fish trapped or collected for broodstock.
- Age-specific fork length (mm) of fish handled at traps or collected for broodstock.
- Fork length (mm) of juvenile fish captured at traps.
- Count of eggs per female spawned by age class.
- Age composition from scale analysis and marks or tags.
- Age composition from scale analysis of juveniles.

- Juvenile migration from Objective 6.

Measurement Protocols:

- Consider randomly selected reaches of major and minor spawning areas will be determined through the Generalized Random Tessellation Stratified (GRTS) design (or other agreed-to protocol); stream surveys conducted by walking and/or floating (see Objective 1).
- Lengths collected from all fish sampled at broodstock collection sites.
- Fecundity estimated by using the weight-per-count method (Murdoch and Peven 2005).
- Age structure from Objective 2.
- Juvenile migration from Objective 6.

Derived Variables:

- Tenth percentile, mode, and 90th percentile Julian date of spawning.
- Average size (POH and fork length) per age class.
- Average number of eggs per female by age class.
- Percentage of smolts that overwinter in spawning tributaries and percentage that overwinter in the mainstem, if appropriate tagging studies are implemented.

Analysis:

- Assess relationship between fecundity and female size (regression analysis).
- Compare fecundity at age to the assumed historical or reference condition. [52]
- Assess relationship between age and size (regression analysis).
- Compare size at age to the assumed historical or reference condition.
- Track changes in fecundity at age and size at age over time.
- Compare juvenile migration patterns to the assumed historical or reference condition.
- Track changes in juvenile migration patterns over time.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

Objective 8: *Determine if the within-population genetic variation of SEWMU steelhead is consistent with low risk for viability.*

[52] At this time no historical or reference conditions have been identified for analyses requiring comparisons of present conditions with historical or reference conditions.

Monitoring Questions:

- What is the genetic variation within SEWMU steelhead populations?

Sampling Design:

- Systematic sampling throughout the spawning run.
- Samples size = 100 naturally produced adult steelhead and 100 hatchery produced adult steelhead (sample sizes may not be achieved during years with low escapements).

Spatial/Temporal Scale:

- Samples collected once every five years at existing trapping locations.

Measured Variables:

- Microsatellite genotypes

Measurement Protocols:

- Tissue samples collected from broodstock collected at adult traps.
- Microsatellite or SNP technology.

Derived Variables:

- Allele frequency

Analysis:

- Within collection genetic diversity (using GENETIX)
- Among collection genetic differentiation (randomized chi-square using FSTAT)
- Individual assignment (partial Bayesian procedure)

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- Additional funding from state and/or federal agencies would be needed to compare results with recovery criteria.

Implementation and Coordination:

- Genetic sampling will be implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 9: ***Determine if the proportion of hatchery and exogenous steelhead spawners in the SEWMU subbasins meet recovery criteria.***

Monitoring Questions:

- What proportion of steelhead spawners in SEWMU populations is derived from hatchery fish produced within the population using best management practices (BMPs)?
- What proportion of the steelhead spawners in SEWMU populations is derived from hatchery fish produced outside the population but within the MPG or DPS (includes within-population programs not using BMPs) and their sources and origin?
- What proportion of the steelhead spawners in SEWMU populations is derived from hatchery fish produced outside the Snake River DPS?

Sampling Design:

- Complete census of all steelhead collected and handled at traps, and their sources and origin.

Spatial/Temporal Scale:

- Annual sampling throughout the run period at adult traps.

Measured Variables:

- Number of hatchery and naturally produced fish and their sources and origin.
- Number of tagged or marked fish.

Measurement Protocols:

- Examination for tags on steelhead collected and handled at broodstock collection sites.
- Examination for tags on steelhead detected at remote PIT tag detection sites.

Derived Variables:

- Origin of tagged or marked fish.
- Proportion of spawning population made up of different origin fish.

Analysis:

- Use current-year data along with previous estimates to calculate the average percentage of total escapement within each of the three categories over an appropriate timeframe. The timeframe may change depending on how and when hatchery practices change, but should include one generation to conclude moderate risk or two to three generations to achieve a low-risk rating (ICTRT 2007).
- Direct comparison with recovery criteria.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal dollars would be needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 10: ***Determine if the distribution of steelhead spawners across the different ecoregions within SEWMU subbasins meet recovery and restoration criteria.***

Monitoring Questions:

- Have there been substantial shifts in steelhead distribution across the basin-specific ecoregions?

Sampling Design:

- Redd Surveys—Objective 1.

Spatial/Temporal Scale:

- Redd Surveys—Objective 1.

Measured Variables:

- Redds—Locations of steelhead redds.

Measurement Protocols:

- Redd Surveys—Objective 1.

Derived Variables:

- Number of redds within each ecoregion.
- Percent of occupied spawning area within each ecoregion.

Analysis:

- Compare current to historic and calculate the percent change in each of the ecoregions to determine if it is "substantial" (defined as at least 67 percentage points) (ICTRT 2007).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a low priority objective.

C.2.10 Prioritization of population status and trend monitoring

Table C-5 provides a summary of the monitoring priority for population status and trend monitoring. This table, based on the priorities identified in Table C-3, should be used (in combination with others below) to assist the SRSRB and other stakeholders in determining which monitoring should occur and at what time frame.

Table C-5. Summary of prioritization of objectives for population status and trend monitoring and recommendations for each SEWMU population.

Objective	Key Variables	Priority	Spring Chinook			Steelhead				
			Tucannon	Asotin	Wenaha	Walla Walla	Touchet	Tucannon	Asotin	Grande Ronde Basin (SEWMU)
1. Determine if the abundance of spawners within the SEWMU Populations meet recovery and restoration criteria.	# Adults/Redds Origin Sex Harvest Hatchery spawners	Highest	Maintain funding, initiate study to determine cause of straying upstream of Tucannon River	Increase monitoring as population builds or is reintroduced	Increase monitoring in WA portion	Maintain or increase funding, improve population-specific information	Maintain or increase funding, improve population-specific information, initiate study to determine cause of straying upstream of Tucannon River for Tucannon population.			Increase monitoring in Wenaha Basin and Lower Grande Ronde tribs.
2. Determine if the productivity of naturally produced spawners and juveniles within SEWMU Populations meet recovery and restoration criteria.	# Adults/Redds Origin Sex Harvest Hatchery spawners # emigrants (juvenile) R/S Juv/redd	Highest	Maintain funding, initiate study to determine cause of straying upstream of Tucannon River	Increase monitoring as population builds or is reintroduced	Increase monitoring in WA portion	Maintain or increase funding, improve population-specific information	Maintain funding, improve population-specific information, initiate study to determine cause of straying upstream of Tucannon River for Tucannon population.			Increase monitoring in Wenaha Basin and Lower Grande Ronde tribs.
3. Determine if the number and spatial arrangement of fish spawning areas within SEWMU subbasins meets recovery and restoration criteria.	# Redds Origin	High	Maintain funding	Maintain	Increase funding for sampling in the WA portion of the basin	Increase monitoring	Maintain	Increase monitoring	Maintain	Increase monitoring
4. Determine if the spatial extent or range of the spawning population meets recovery and restoration criteria.	Can be derived from collecting information from other objectives	High								
5. Determine if the distance (gaps) between spawning areas is increasing		Medium								

6. Determine if the major life history strategies used by fish in SEWMU subbasins are similar to those used historically.	Adult and juvenile migration patterns and age of smoltification.	High	Maintain	Maintain			Maintain	Increase monitoring	Maintain	Increase monitoring
7. Determine if morphological/behavioral and life-history traits of fish in SEWMU subbasins are changing relative to presumed historical conditions.	Spawning time Age-specific length Fecundity Age composition Juvenile migration timing	Medium				maintain	maintain	Increase monitoring	Maintain	
8. Determine if the within-population genetic variation of SEWMU fish is consistent with low risk for viability.	Microsatellite genotypes	High	Maintain	Increase monitoring as population builds				Increase monitoring	Increase monitoring	Increase monitoring
9. Determine if the proportion of hatchery and exogenous fish in SEWMU subbasins meets recovery and restoration criteria.	Origin	High	Maintain	Increase monitoring as population builds	Maintain current efforts, but Increase monitoring, in Butte Creek and other tributaries	Maintain	Maintain	Increase monitoring	Maintain	Increase Monitoring
10. Determine if the distribution of fish spawners across the different ecoregions within SEWMU subbasins meets recovery and restoration criteria.	Can be derived from collecting information from other objectives	Low								

C.3 LIMITING FACTORS STATUS/TREND MONITORING PLAN

This section outlines plans for monitoring the status and trend of factors that limit the viability of populations in southeast Washington State recovery area. Provided below are separate outlines for each of the primary liming factor categories; habitat, hydropower, harvest, hatcheries, disease and predation, regulatory mechanisms, and natural factors. As noted in Section 3, the focus of this monitoring and evaluation plan will be on monitoring changes in habitat and hatcheries. Changes in other limiting factors will be monitored as resources become available or under other venues with differing mandates (e.g., LSRCP, FCRPS BiOp).

C.3.2 Habitat Status and Trend Monitoring

Habitat conditions in tributaries, the mainstem, and the estuary affect the survival of Upper Columbia populations. This sub-section of the plan outlines monitoring within the tributaries and estuary. Mainstem habitat conditions (flow and water quality) are addressed in the Hydro sub-section. Predation and disease are components of the habitat that are addressed in a separate sub-section.

Objective 1: ***Describe the change in tributary habitat conditions in southeast Washington State SEWMU.***

There are several entities that monitor habitat conditions within the southeast Washington State SEWMU. They include the Forest Service, Department of Ecology, WDFW, various conservation districts, the CTUIR, NPT, and others.

This monitoring and evaluation plan relies heavily on ISEMP. This program has developed specific written methods for measuring different habitat variables. These are available on the ISEMP (http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/index.cfm) website.

Monitoring Questions:

- What is the current condition of tributary habitat within the distribution of spring Chinook and steelhead populations (Tucannon, Walla Walla (including Touchet), Asotin, and lower Grande Ronde) in the southeast Washington State recovery area?
- Are habitat conditions within the southeast Washington State recovery area trending toward properly functioning condition (NMFS 1996)?

Sampling Design[53]:

- EMAP rotational split-panel design with six panels; one panel with sites visited every year and five other panels with sites visited on a five-year cycle.
- Sites should be selected from the Washington State "master sample" list (Larson et al. 2007; see http://www.ecy.wa.gov/programs/eap/stsmf/)

[53] It is important to note that information should be collected remotely to the degree that it can be to be consistent with state-wide monitoring protocols and recommendations.

- Each panel will consist of 25 sites.

Spatial/Temporal Scale:

- The spatial scale will include all anadromous streams within the distribution of spring Chinook and steelhead populations in the southeast Washington State recovery area.
- Annual sampling (during low-flow conditions) will occur within the annual panel and one of the five rotating panels.
- Length of sample sites will be 20 times the bankfull width, but not less than 150 m or more than 500 m long.

Measured Variables:

- Habitat variables monitored in ISEMP will be measured in all subbasins. Table 3 identifies variables currently measured in the ISEMP program.

Measurement Protocols:

- As an example, methods used to measure habitat variables in ISEMP are listed in Table C-6 and described in Hillman (2006) and Moberg (2007) and found at http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/index.cfm.

Derived Variables:

- Water quality—Average values, maximum and minimum values, and number of days that a metric exceeds criteria.
- Physical habitat—Average values, variability, percentiles, and density (e.g., number per km) (see Kaufmann et al. 1999).

Analysis:

- Descriptive statistics and variance decomposition.
- Status—Horvitz-Thompson or π-estimator (see Stevens 2002).
- Trend—Multi-phase regression analyses (see Stevens 2002).

Possible Funding Entities:

- BPA, USFWS, WDFW, USFS, and WDOE currently funds habitat RM&E in the SEWMU.

Implementation and Coordination:

- Field work is implemented and coordinated through collaborative efforts between the co-managers, USFS, DOE, and other contractors.
- The Snake River Salmon Recovery Board will coordinate activities between the monitoring programs and recovery actions.

Table C-6. Recommended methods and sampling frequency of physical/environmental indicator variables in ISEMP. Some of the methods recommended in this table have been modified based on protocol comparison tests. Modified methods are noted with an asterisks (*) (see Hillman 2006).

General characteristics	Specific indicators	Recommended method	Sampling frequency
Water Quality	Temperature	Zaroban (2000)	Hourly

	Turbidity	OPSW (1999)	Hourly
	Conductivity	OPSW (1999)	Daily
	pH	OPSW (1999)	Daily
	Dissolved oxygen	OPSW (1999)*	Daily
	Nitrogen	OPSW (1999)	Monthly
	Phosphorus	OPSW (1999)	Monthly
Habitat Access	Road crossings	Parker (2000); WDFW (2000)	Annually
	Diversion dams	WDFW (2000)	Annually
	Fishways	WDFW (2000)	Annually
Habitat Quality	Dominant substrate	Peck et al. (2001)*	Annually
	Embeddedness	Peck et al. (2001)*	Annually
	Depth fines	Schuett-Hames (1999)	Annually
	LWD (pieces/km)	BURPTAC (1999)*	Annually
	Pools per kilometer	Hawkins et al. (1993); Overton et al. (1997)	Annually
	Residual pool depth	Overton et al. (1997)	Annually
	Fish cover	Peck et al. (2001)	Annually
	Off-channels habitats	WFPB (1995)*	Annually
Channel condition	Stream gradient	Peck et al. (2001)*	Annually
	Wetted width	Peck et al. (2001)	Annually
	Bankfull width	Peck et al. (2001)	Annually
	Width/depth ratio	Peck et al. (2001)*	Annually
	Bank stability	Moore et al. (2002)	5 years
Riparian Condition	Structure	Peck et al. (2001)	5 years
	Disturbance	Peck et al. (2001)*	5 years
	Canopy cover	Peck et al. (2001)	5 years
Flows and Hydrology	Streamflow	Peck et al. (2001)	Continuous
Watershed Condition	Watershed road density	WFC (1998); Reeves et al. (2001)	5 years
	Riparian-road index	WFC (1998)	5 years
	Land ownership	n/a	5 years
	Land use	Parmenter et al. (2003)	5 years

This is a high priority objective.

<u>Objective 2:</u> ***Describe the change in habitat conditions in the Columbia River Estuary.***

A monitoring plan for the estuary was developed under the FCRPS BiOp (Johnson et al. 2008). Those factors that most affect SEWMU Chinook and steelhead include toxics and flow (plume)[54] (Appendix I). These factors are addressed in the estuary monitoring plan and are outlined below. Because the Snake River Salmon Recovery Board does not have funds to monitor habitat conditions in the estuary, the Board will rely on other entities to conduct monitoring there.

Monitoring Questions:

- What is the current condition of habitat (toxics and flow) within the Columbia River estuary?
- Are habitat conditions within the estuary trending toward reference or historical conditions?

Sampling Design:

- Rotational split-panel sampling design.

Spatial/Temporal Scale:

- Spatial scale will include the entire estuary (and plume).
- Annual sampling within the annual panel and rotational panels.

Measured Variables:

- Toxics/Contaminants (e.g., PCBs and mercury)
- Water discharge
- Snowpack
- Surface water elevation
- Water velocity

Measurement Protocols:

- Water quality—Core samples and standard EPA analysis methods.
- Flows/elevation—Data loggers and water collectors.
- Velocities—Flow meters and/or timed floats.
- Snowpack—Meteorology snow depth measurements.

Derived Variables:

- Water quality—Concentrations of toxics and contaminants.
- Flows—daily average, maximum and minimum (m^3/s).
- Velocities—daily average, maximum and minimum (m/s).
- Elevation—daily average, maximum and minimum (m).
- Snowpack—Average levels in meters.

Analysis:

- Status—Horvitz-Thompson or π-estimator (see Stevens 2002).
- Trend—Multi-phase regression analyses (see Stevens 2002).

[54] Predation in the estuary is also an important limiting factor on SEWMU stocks. This factor is addressed in the Disease and Predation section.

Possible Funding Entities:

- BPA, USACE, and NOAA would be the primary funding entities.

Implementation and Coordination:

- The Lower Columbia River Estuary Partnership would implement and coordinate estuary monitoring activities.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a low priority objective.

C.3.3 Hydropower Status and Trend Monitoring

Monitoring for hydro-related impacts currently occurs through various forums. For the Federal Columbia River Power System (FCRPS), a Hydro-RME module has been developed to assess the status of limiting factors associated with the FCRPS.

Objective 1: ***Ensure survival of juveniles passing the project meets agreed upon standards.***

Monitoring Questions:

- Does the estimated survival of juvenile spring Chinook and steelhead meet BiOp (FCRPS) standards?

Sampling Design:

- Mark-Recapture Studies—Use paired-releases of tagged groups of fish.

Spatial/Temporal Scale:

- Release test and control groups at locations upstream and downstream of the project being measured.
- Frequency and number of studies needed for estimating survival is dependent on requirements of the FCRPS BiOp.
- After standard is met conduct periodic tests to ensure compliance.

Measured Variables:

- Number of live fish detected at downstream locations.
- Tag life (if applicable for active tags)

Measurement Protocols:

- Varies depending on method (tag) used (see Peven et al. 2005).

Derived Variables:

- Detection probabilities.

- Mixing of test and control groups at detection site(s).
- Point estimate of survival and associated precision.

Analysis:

- Analyze using standard methods described in Peven et al. (2005).

Possible Funding Entities:

- Each hydro operator will be responsible for survival estimates at their project(s). The BPA and USACE will fund these studies.

Implementation and Coordination:

- This work is, or will be implemented and coordinated by the FCRPS process.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a low priority objective.

Objective 2: ***Ensure efficient passage of adults passing the project.***

Monitoring Questions:

- Are adults passing the hydrosystem without being delayed to a point that it could affect reproductive success?

Sampling Design:

- Mark-Recapture Studies—Release a group of tagged fish downstream and potentially upstream (depending on the objectives of the individual hydroproject) of the hydroproject(s) being measured.
- Telemetry Study – capture and tag adult Tucannon spring Chinook and steelhead and monitor the upstream and downstream migration at Little Goose and Lower Granite Dams.

Spatial/Temporal Scale:

- Frequency of estimating passage is dependent on requirements of FCRPS BiOp.

Measured Variables:

- Tag detections within fishways and upstream of the project (including spawning tributaries).
- Number of tagged steelhead and spring Chinook adults failing to return to the Tucannon River and their behavior around the mouth of the Tucannon River and the nearby dams.
- Final destination of adults that fail to return to the Tucannon River.

Measurement Protocols:

- Varies depending on method (tag) used and specific objectives of study.

Derived Variables:

- Detection probabilities.
- Passage timing.
- Presence on spawning grounds (dependent on study objectives).

Analysis:

- Analyze as distribution data.
- Use trend analysis if applicable.

Possible Funding Entities:

- Each hydro operator will be responsible for estimates at their project(s). The BPA and USACE will fund these studies.

Implementation and Coordination:

- This work is implemented and coordinated through the FCRPS process.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a medium priority objective.

Objective 3: ***Determine if the hydro-project operations are negatively affecting chemical composition of the river.***

Monitoring Questions:

- Are certain hydro operations creating total dissolved gas (TDG) levels that could harm fish?

Sampling Design:

- Continuous (hourly) readings at hydroprojects or in reservoirs during fish passage season.

Spatial/Temporal Scale:

- Hourly readings in the forebay and downstream of each hydro-project.
- Daily monitoring during the migration period for juveniles and adults.

Measured Variables:

- Forebay TDG.
- TDG downstream of the project.
- Level of spill.

Measurement Protocols:

- Hourly readings measured with electron TDG instruments.
- Yearly calibration of probes

Derived Variables:

- 12- and 24-hour average TDG

Analysis:

- Analyze as a time series (trend analysis).

Possible Funding Entities:

- Each hydro operator will be responsible for survival estimates at their project(s). The BPA and USACE will fund these studies.

Implementation and Coordination:

- This work is implemented and coordinated through regional ad hoc committees that are lead by NMFS and EPA.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a low priority objective.

<u>Objective 4:</u> *Determine if hydropower operations are affecting homing and stray rates.*

Monitoring Questions:

- Do project operations hinder the ability of migrating adult salmonids from returning to their natal stream?

Sampling Design:

- Telemetry study using spring/summer Chinook salmon and steelhead of known origin (from juvenile PIT tagging).

Spatial/Temporal Scale:

- Study should be conducted over a three-year time period.
- Fish should be captured and tagged at McNary or Ice Harbor dams if possible.

Measured Variables:

- Distance traveled and location (e.g. side of the Snake River) when passing the Tucannon River
- Spatial distribution within the mainstem Snake River and tributaries
- Delay near the mouth of the Tucannon River before ascending the Snake or Tucannon rivers
- Tucannon and Snake River discharges and water temperatures

Measurement Protocols:

- Daily tracking results summarized

Derived Variables:

- Migration rates

- Spatial preference
- River temperature and discharge differences between Snake and Tucannon rivers
- Most upstream migration location
- Migrational pathways (up- and downstream movements)
- Final (detection during spawning season) location and fate of fish (e.g. spawned or pre-spawn mortality)

Analysis:

- See Keefer et al. (2008)

Possible Funding Entities:

- Each hydro operator will be responsible for survival estimates at their project(s). The BPA and USACE will fund these studies.

Implementation and Coordination:

- This work should be implemented and coordinated through regional ad hoc committees that are lead by local co-managers.
- Coordination of results from these programs could occur through the SRSRB.

This is a very high priority objective.

C.3.4 Harvest Status and Trend Monitoring

Harvest impact rates on listed salmonids are set by NOAA Fisheries in Harvest Biological Opinions. The fisheries are currently implemented with monitoring and evaluation programs that are intended to measure compliance with the allowed impact rates. This level of monitoring should continue, as directed under *U.S. v Oregon* and its Technical Advisory Committee.

Because the Snake River Salmon Recovery Board does not have funds to monitor harvest impacts, the Board will rely on other entities to conduct this monitoring. The following outline provides some additional monitoring that could be done to decrease error and uncertainty in the measurement of harvest rates and would allow the measurement of harvest rates at a finer resolution.[55]

Objective 1: ***Improve Understanding of Stock Composition in Fisheries.***

Monitoring Questions:

[55] NOAA will develop a harvest RME module that will further address harvest impact rates on listed species. This module should provide the information needed to evaluate the status of out-of-basin harvest as a limiting factor on SEWMU stocks.

- Can in-season monitoring apportion catch, encounters, and escapement?

Sampling Design:

- Development and standardization of a regional PIT tagging program for all species, including:
- Representative marking of hatchery stocks and wild populations.
- Deployment of PIT tag detectors for fisheries sampling.
- Expanded deployment of PIT tag detectors in terminal areas.
- Development of a regional Genetic Stock Identification (GSI) program with an emphasis on species for which broad-scale PIT tagging is not a viable option, including:
- Systematic establishment and maintenance of a regional DNA micro-satellite or SNP baseline.
- Systematic non-lethal tissue sampling of catch and encountered fish in the fisheries.

Spatial/Temporal Scale:

- Annual sampling.
- Monitoring will occur at already established check points in the lower Columbia River and in terminal areas.

Measured Variables:

- Number of fish harvested.
- Total amount of fishing effort.
- Stock identification of fish in catch.
- Number of non-target fish released.
- Stock identification of fish released.

Measurement Protocols:

- Use PIT tag detectors at check points to determine composition of stock.
- Collect samples for GSI analysis.

Derived Variables:

- Catch per effort.
- Harvest rate.
- Stock composition of catch.
- Non-target fish release rate.
- Percent of run harvested.

Analysis:

- Compare to agreed-upon incidental take rates.
- Trend analysis

Possible Funding Entities:

- WDFW, ODFW, NOAA Fisheries, Tribes, and BPA.

Implementation and Coordination:

- This work is, or will be, implemented and coordinated primarily through the *US v OR* and FCRPS BiOp processes.

- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a medium priority objective.

Objective 2: ***Improve Modeling Interface between Columbia River and Ocean Fisheries.***

Monitoring Questions:

- To what degree are SEWMU Chinook and steelhead being harvested in the ocean and lower Columbia River fisheries?

Sampling Design:

- In-season monitoring and reporting of catch.
- Post-season run reconstruction.

Spatial/Temporal Scale:

- Annual sampling.
- Monitoring will occur at already established check points in the lower Columbia River and all terminal fisheries if they are prosecuted.

Measured Variables:

- Number of fish harvested in the ocean and lower river fisheries.
- Total amount of fishing effort.
- Stock identification of fish in catch.

Measurement Protocols:

- Record tags detected in fisheries.

Derived Variables:

- Stock-specific catch rates.
- Stock-specific catchability, vulnerability, and maturity.
- Estimates of variance around fishery parameters.

Analysis:

- Use trend analysis if applicable.

Possible Funding Entities:

- State, federal, and tribal agencies.

Implementation and Coordination:

- This work is, or will be, implemented and coordinated primarily through the *US v OR* and FCRPS BiOp processes.

- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a medium priority objective.

Objective 3: ***Determine if the total harvest of Snake River Chinook and steelhead in ocean and river fisheries is affecting the ability to meet abundance and productivity goals of the recovery plan.***

Monitoring Questions:

- Are incidental harvest rates of ocean and terminal fisheries reducing the likelihood of meeting recovery criteria?

Sampling Design:

- Post-season run reconstruction.

Spatial/Temporal Scale:

- Annual sampling.

Measured Variables:

- Total harvest.
- Fish ladder counts.
- Redd counts.
- Stock identification.

Measurement Protocols:

- Current methods for estimating catch rates.
- Standard methods for fish ladder and redd counts.
- Establish protocols for stock ID.

Derived Variables:

- Percentage of run harvested.
- Escapement.
- Calculate abundance and productivity with and without harvest.

Analysis:

- Estimate the standard error (SE) and 95% confidence interval (CI) for the abundance and productivity estimates with and without harvest (ICTRT 2007).
- Combine the abundance and productivity estimates and plot them with their associated SE and 95% CI on the viability curve (ICTRT 2007).
- Determine if the selective pressure is large enough to cause a moderate or high risk rating in spatial structure and diversity (ICTRT 2007).

Possible Funding Entities:

- State, federal, International (Pacific Salmon Committee), and tribal agencies.

Implementation and Coordination:

- This work is, or will be, implemented and coordinated primarily through the *US v OR* and FCRPS BiOp processes.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a medium priority objective.

Objective 4: *Determine encounter rates and release mortality rates of SEWMU Chinook and Steelhead in all fisheries.*

Monitoring Questions:

- What affect does encounter and release mortality have on run reconstruction?

Sampling Design:

- Survey monitoring of encounter rates in fisheries that release by-catch.
- Additional research into gear-specific release mortality rates, including variation in mortality rates and delayed mortality rates (if measurable).

Spatial/Temporal Scale:

- Annual sampling for encounter rates.
- Study-specific for gear-specific mortality rates.

Measured Variables:

- Number of fish encountered in fisheries that are released.
- Type of gear and harvest method used.
- Number of fish that die after release.

Measurement Protocols:

- Record numbers of fish released.
- Tag captured fish that will be released.

Derived Variables:

- Percent of fish that die after release.
- Number of fish that die per capture method or gear.
- Delayed or latent mortality of released fish, as reasonably (and statistically reliably) measurable.

Analysis:

- Not applicable.

Possible Funding Entities:

- State, federal, and tribal agencies.

Implementation and Coordination:

- This work is, or will be, implemented and coordinated primarily through the *US v OR* and FCRPS BiOp processes.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a medium priority objective.

C.3.5 Prioritization of Habitat, Hydro, and Harvest status and trend monitoring

Table C-7 provides a summary of the monitoring priority for habitat, hydro, and harvest status and trend monitoring. Most of the objectives will be planned and implemented through other venues. This table, based on the priorities identified in Table C-3, should be used (in combination with others below) to assist the SRSRB and other stakeholders in determining which monitoring should occur and at what time frame.

Table C-7. Summary of prioritization of objectives for limiting factor status and trend monitoring and recommendations for each SEWMU population.

Objective	Key Variables	Priority	Spring Chinook			Steelhead				
			Tucannon	Asotin	Wenaha	Walla Walla	Touchet	Tucannon	Asotin	Grande Ronde Basin (SEWMU)
Habitat										
1. Describe the change in tributary habitat conditions in southeast Washington State SEWMU.	See Table C-6	High								
2. Describe the change in habitat conditions in the Columbia River Estuary.	Toxics/Contaminants (e.g., PCBs and mercury) Water discharge Snowpack Surface water elevation Water velocity	Low	Handled through other venue							
Hydropower										
1. Ensure survival of juveniles passing the project meets agreed upon standards.	Number of live fish detected at downstream locations	Low	Handled through other venue							
2. Ensure efficient passage of adults passing the project.	Tag detections within fishways and upstream of the project (including spawning tributaries).	Medium								
3. Determine if the hydro-project operations are negatively affecting chemical composition of the river.	Forebay TDG. TDG downstream of the project. Level of spill.	Low								
4. Determine if hydropower operations	Distance traveled.	Very High	Ensure project	NA		NA		Ensure project	NA	

Objective	Key Variables	Priority	Spring Chinook			Steelhead				
			Tucannon	**Asotin**	**Wenaha**	**Walla Walla**	**Touchet**	**Tucannon**	**Asotin**	**Grande Ronde Basin (SEWMU)**
are affecting homing and stray rates.	Spatial distribution within the mainstem Snake River and tributaries. Delay near mouth of Tucannon River. Final location and fate of fish.		funding and implementation					funding and implementation		
Harvest										
1. Improve Understanding of Stock Composition in Fisheries.	Number of fish harvested. Total amount of fishing effort. Stock identification of fish in catch. Number of non-target fish released. Stock identification of fish released.	Medium	Handled through other venue							
2. Improve Modeling Interface between Columbia River and Ocean Fisheries.	Number of fish harvested in the ocean and lower river fisheries. Total amount of fishing effort. Stock identification of fish in catch.	Medium	Handled through other venue							
3. Determine if the total harvest of Snake River Chinook and steelhead in ocean and river fisheries is affecting the ability to meet abundance and productivity goals of the recovery plan.	Total harvest. Fish ladder counts. Redd counts. Stock identification.	Medium	Handled through other venue							

			Spring Chinook			Steelhead				
Objective	**Key Variables**	**Priority**	**Tucannon**	**Asotin**	**Wenaha**	**Walla Walla**	**Touchet**	**Tucannon**	**Asotin**	**Grande Ronde Basin (SEWMU)**
4. Determine encounter rates and release mortality rates of SEWMU Chinook and Steelhead in all fisheries.	Number of fish encountered in fisheries that are released. Type of gear and harvest method used. Number of fish that die after release.	Medium	Handled through other venue							

C.3.6 Hatchery Status and Trend Monitoring

The WDFW, CTUIR, NPT, and the ODFW have developed monitoring programs for their respective hatchery programs in the SEWMU. The monitoring of hatchery programs provides most of the information needed to assess the status and trends of populations of spring Chinook and steelhead in the SEWMU.[56]

Below subbasins are grouped together because the monitoring and evaluation objectives and questions for supplementation programs in different subbasins are similar. Most of the information collected as part of the supplementation monitoring programs will also help evaluate non-supplementation hatchery programs.

Types of hatchery programs

The purpose of hatchery programs has historically been to mitigate for lost habitat and habitat function from various perturbations and to increase harvest opportunities. In recent years, the focus of hatchery programs has been shifting more to conservation based principles. However, many programs remain that focus on increasing harvest opportunity for tribal and non-tribal stakeholders.

This Plan defines hatchery programs as either *conservation* or *harvest augmentation* based. In addition, following HSRG (2004), programs can be *integrated* with a natural spawning population, or *segregated* from one (Table C-8).

Table C-8. Different types of hatchery programs.

Purpose	Natural population influence	
	Integrated	Segregated
Conservation	√	
Harvest augmentation	√	√

<u>Objective 1:</u> *Determine if the mitigation goals have been met*

Most hatchery programs within the SEWMU were developed to mitigate for the construction and operation of the mainstem Snake River dams, and the focus has historically been for harvest mitigation. While recent changes are geared towards conservation, the primary goal of many of the programs is still mitigation. Therefore it is important to understand what monitoring and evaluation is needed to understand whether the mitigation goals are being met.

---

[56] A plan to assess the effects of competition and density-dependent factors on listed species in the estuary and mainstem Columbia River will be developed in the Estuary RME Module.

Monitoring Questions:

- Did the hatchery program return enough adults to meet the mitigation goal?
- Did the hatchery program achieve the smolt-to-adult return rate goal?

Sampling Design:

- Census (based on mark-recapture to calibrate trapping efficiency) of smolts and other emigrants through trapping.
- Census of adults returning.
- Creel surveys.

Spatial/Temporal Scale:

- Sample anglers within open fishing areas throughout the angling period.
- Annual estimates of juveniles released for each population.
- Annual counts or estimates of hatchery adult returns and origins of hatchery fish in each population area

Measured Variables:

- Numbers of hatchery fish taken in harvest.
- Number of hatchery and naturally produced fish on spawning grounds.
- Number of hatchery fish removed at capture sites

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Detection of CWT or PIT tagged returning adults
- Creel surveys.

Derived Variables:

- Total harvest by fishery estimated from expansion analysis.
- Smolt-to-adult return rate
- Origins of hatchery fish returning to, or contributing to each population

Analysis:

- A one-sample t-test can be used to compare harvest rates with the level needed for program goals.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and/or other BPA funds.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a highest priority objective.

Objective 2: ***Determine the relative reproductive success of hatchery-origin spawners in the natural environment.***

Perhaps the largest uncertainty in the use of conservation hatcheries to either preserve or rebuild naturally reproducing populations is how effective hatchery-origin spawners are in the natural environment when they spawn amongst themselves, and in particular interbreed with natural-origin spawners.

Of primary concern is the effect interbreeding may have on the fitness of the naturally reproducing population. One way to quantify this is to measure the relative reproductive success (RRS) of hatchery-origin fish on the spawning grounds, which enables managers to quantify short-term impacts of supplementation on productivity.

Monitoring Questions:

- What is the relative reproductive success of hatchery-origin fish in the natural environment compared to natural-origin fish in the same environment?

Sampling Design:

- Parentage analyses using multilocus genotypes.
- Full parental based tagging (PBT) for hatchery programs.

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution and juvenile migration periods for at least two generations.

Measured Variables:

- For pedigree:
- Number of redds.
- Number of hatchery– and natural-origin fish on spawning grounds.
- DNA
- For mechanisms associated with RRS:
- Sex
- River entry and spawn timing of individual spawners
- Body size and morphology
- Freshwater and saltwater age
- Egg retention (Chinook only)
- Fecundity (by origin)
- Spawning behavior (e.g., male dominance hierarchies)
- Spawning location in relationship to smolt release location
- Redd characteristics for individual spawners (location, morphology, depth, velocity, temperature)

Measurement Protocols:

- Collect DNA samples from as close to 100% of adult spawners captured at collection and trapping sites.
- Count the number of hatchery and naturally produced fish collected for broodstock.
- Identify the origin and count the number of steelhead ascending spawning streams using remote PIT tag detectors.[57]
- Collect DNA samples from as many juveniles as possible from screw traps, or other sampling methods.[58]
- Collect additional information if mechanisms for differences of RRS are desired.

Derived Variables:

- Estimate adult parentage for sampled juveniles.
- Estimate the number of juveniles produced per parent.
- Estimate the influence of mechanisms for differences in RRS.

Analysis:

- Compare number of juveniles produced per parent between hatchery- and natural-origin parents.
- Analyze annually based on return year.
- Analysis over time (trend) may include correlating (regressions analysis)

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and/or other BPA funds.

Implementation and Coordination:

- This work needs to be coordinated with a regional effort that will begin in the beginning of 2011, which will be coordinating Columbia basin-wide hatchery RM&E.
- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

[57] For this study to be robust, access to wild fish will need to be sufficient enough to allow precision targets to be met.

[58] For steelhead RRS, it may be challenging to get a large enough sample size and to be able to separate out potential spawning from resident rainbow trout.

Objective 3: ***Determine if conservation programs increase the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream)[59] and if the return per spawner (R/S) of the supplemented population is similar to that of the non-supplemented population.***

At the core of conservation programs[60] is the objective of increasing the number of spawning adults (i.e., the combined number of naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the recruit per spawner (R/S) or the ratio of NORs to the parent spawning population. It is also important to consider that most artificial propagation programs in the SEWMU are conservation based, but with a main goal of providing harvest opportunity.

Differences in carrying capacities of supplemented and non-supplemented streams can confound the effects of a conservation program on total number of spawners returning to the streams. To avoid concluding that the conservation program has no effect or perhaps a negative effect on total spawners, the capacity of the habitats must be estimated and considered in the analyses.

Adult Return Rates of Hatchery Fish

Monitoring Questions:

- Is the annual number of hatchery fish that spawn naturally greater than the number of naturally and hatchery produced fish taken for broodstock (i.e., what is PNI or is population "mining" occurring)?

Sampling Design:

- Complete census of redds, carcasses, and/or broodstock.

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution (where possible).

Measured Variables:

- Number of redds or adults returning.
- Number of hatchery produced fish on spawning grounds.
- Number of naturally and hatchery produced fish removed for broodstock.
- Number of hatchery produced fish harvested.

---

[59] Finding appropriate reference streams that lack hatchery influence is difficult. Columbia basin-wide coordination may be needed so managers can utilize streams for references for multiple treatment populations.

[60] Conservation programs are also called "supplementation" programs in many instances. This Plan describes the program as conservation-based, and using the strategy of supplementation as the primary tool to implement the conservation program.

- Number of males and females sampled at broodstock collection sites.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Count the number of hatchery and naturally produced carcasses and fish collected for broodstock.
- Identify the origin and count the number of steelhead ascending spawning streams using remote PIT tag detectors or at weirs or counting stations.
- Identification of sex of fish collected for broodstock (using morphological characteristics, dissection, and/or possibly ultrasound).

Derived Variables:

- Estimate spawners per redd.
- Estimate total number of hatchery produced spawners.
- SAR

Analysis:

- Analyze annually based on return year.
- On a five-year period analyze return years for patterns that correlate with extraneous factors such as ocean conditions.
- Analysis over time (trend) may include correlating (regressions analysis) escapements with other extraneous variables (e.g., ocean conditions, climatic effects, etc.).
- Analysis should include the use of reference populations.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Hatchery Contribution to Recruitment of Naturally Produced Fish

Monitoring Questions:

- Is the annual change in the number of natural origin recruits (NORs) produced from the supplemented population greater than or equal to the annual change in NORs in a non-supplemented population?

Sampling Design:

- Complete census of adults, redds, carcasses, and/or broodstock.

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution.

Measured Variables:

- Number of redds and or adults.
- Origin of carcasses and/or brood stock (hatchery or naturally produced fish).
- Sex ratio of broodstock collected randomly over the run.
- Age composition from both broodstock and carcasses (from scale analysis)[61].
- Number of naturally produced fish harvested

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Count the number of hatchery and naturally produced carcasses and fish trapped.
- Identify the origin and count the number of steelhead ascending spawning streams using remote PIT tag detectors or other methods.
- Identification of sex of fish collected for broodstock (using morphological characteristics, dissection, and/or possibly ultrasound).
- Collect and read scales and tags from fish sampled at stock assessment sites and from all carcasses and/or broodstock.

Derived Variables:

- Age structure of the spawning population.
- Number of naturally produced recruits by brood year for both naturally produced parents and hatchery parents (≥ age-3).
- May include ratio or difference scores of NORs (requires reference area).
- Spawner-recruit ratios.

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (trend; initially as a 5-year period; i.e., 5-year mean of annual change).
- Two-sample t-test (other tests may include RIA, ARIMA, or other tests) to evaluate difference scores or ratios over time (initial 5-year period).
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.
- Analysis should include the use of reference populations.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.

---

[61] For steelhead, evaluation of others structures (such as otoliths) may be necessary for estimating freshwater age, because scales may not represent the total age accurately (see Peven 1990; Mullan et al. 1992).

- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Natural Replacement Rates of Supplemented Populations

Monitoring Questions:

- Is the change in recruits per spawner (R/S) within the supplemented population greater than or equal to the change in natural replacement rates in a non-supplemented population?

Sampling Design:

- Complete census of adults, redds, carcasses, and/or broodstock.

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution.

Measured Variables:

- Number of redds.
- Origin of carcasses and/or brood stock (hatchery or naturally produced fish).
- Sex ratio of broodstock collected randomly over the run.
- Age composition from both broodstock and carcasses (from scale analysis).
- Number of hatchery and naturally produced fish at traps.
- Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the mouth of the Columbia River).

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Count the number of hatchery and naturally produced carcasses and fish collected for broodstock.
- Identify the origin and count the number of steelhead ascending spawning streams using remote PIT tag detectors or other methods.
- Identification of sex of fish collected for broodstock (using morphological characteristics, dissection, and/or possibly ultrasound).
- Collect and read scales from all carcasses and/or broodstock.

Derived Variables:

- NORs (number of naturally produced recruits (total recruits) by brood year for both naturally produced parents and hatchery parents (≥ age-3)).
- NRRs (calculated as NORs/spawner).
- May include ratio or difference scores of NRRs (requires reference population).

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (trend; initially as a 5-year period; i.e., 5-year mean of annual change).

- Two-sample t-test (other tests may include RIA, ARIMA, or other tests) to evaluate difference scores or ratios over time (initial 5-year period).
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.
- The testing is appropriate if populations are below carrying capacity and density-dependent factors are not regulating the populations at high spawner abundances.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers .
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 4: ***Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.***

Inherent in the supplementation strategy is that hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the hatchery environment (i.e., domestication). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of the conservation program may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may be subject to differential survival rates or spawning success. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock).

Migration Timing

Monitoring Questions:

- Is the migration timing of hatchery and naturally produced fish from the same age class similar?

Sampling Design:

- Continuous sampling at dams (adult fish ladders), weirs, and broodstock collections sites.
- Continuous annual PIT tagging of representative of hatchery and natural emigrants from the same brood year.

Spatial/Temporal Scale:

- Annual sampling throughout the migration period.

Measured Variables:

- Ages of hatchery and naturally produced fish sampled at broodstock collection sites, during carcasses surveys, and/or at stock assessment sites.
- Time (Julian date) of arrival at Bonneville, McNary, Ice Harbor, Lower Granite dams, and within tributaries of PIT tagged hatchery and natural fish.

Measurement Protocols:

- Adults will be counted using video technology at mainstem dams and collection at sampling sites.
- Collect and read scales and tags from sampled fish at stock assessment sites, carcasses, and/or broodstock.

Derived Variables:

- Mean Julian date for a given age class.

Analysis:

- Analyze annually based on return year and age class.
- Analyze as a time series (trend; initially as a 5-year period and to the extent possible use pre-2006 data).
- ANOVA by age and origin

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Timing of Spawning

Monitoring Questions:

- Is the timing of spawning (measured as the time female salmon carcasses are observed) similar for hatchery and naturally produced fish? (Timing of spawning of hatchery and naturally produced steelhead may be evaluated if marking or tagging efforts provide reasonable results.)

Sampling Design:

- Complete census of all redds and visual identification of origin of spawners and Chinook carcasses observed.
- Trapping of steelhead

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution.

Measured Variables:

- Time (Julian date) of hatchery and naturally produced salmon carcasses observed on spawning grounds within defined reaches.
- Time (Julian date) of ripeness of steelhead captured for broodstock.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Identify hatchery and naturally produced female carcasses.

Derived Variables:

- Mean Julian date.
- Elevations (covariate)

Analysis:

- Analyzed annually based on return year.
- Analyze as a time series (initially as a 5-year period).
- ANOVA by sex and location

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Distribution of Redds

Monitoring Questions:

- Is the distribution of redds (based on carcasses) similar for hatchery and naturally produced fish?

Sampling Design:

- Complete census of all available redds, and if possible, visual identification of spawning fish and carcasses.

Spatial/Temporal Scale:

- Annual sampling of entire distribution of carcasses.

Measured Variables:

- Location of female Chinook salmon carcasses observed on spawning grounds. (The distribution of hatchery and naturally produced steelhead redds may be evaluated if marking or tagging efforts provide reasonable results).

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Identify the location (GPS) of hatchery and naturally produced carcasses.

Derived Variables:

- Location of female salmon carcass in RKm (0.01).
- Calculate percent overlap in distribution across available spawning habitat.

Analysis:

- Analyze annually based on return year (ANOVA).
- Analyze as a time series (trend; initially as a 5-year period).
- ANOVA by origin and sex

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 5: ***Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of hatchery programs. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.***

This objective addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components.[62] Maintaining the long-term fitness of

[62] These metrics are difficult to measure, and phenotypic expression of these traits may be all we can measure and evaluate.

supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location, and stray rates) is addressed under other objectives.

Assessing the genetic component of hatchery programs does not require annual sampling. Meeting stray-rate targets (hypotheses tested under Objective 7) should prevent significant changes in population genetics. Therefore, testing statistical hypotheses associated with genetic components should be conducted every three to five years, depending on the type of hatchery program. More frequent genetic sampling may be necessary if actual stray rates exceed targets.

Allele Frequency

Monitoring Questions:

- Is the allele frequency of hatchery fish similar to the allele frequency of naturally produced and donor fish over time?

Sampling Design:

- Stratified proportional sampling across the spawning distribution and systematic sampling throughout the spawning period (sites selected from the Washington State "master sample" list).
- Sample size of 100 naturally produced fish and 100 hatchery produced fish (sample sizes may not be achieved during years with low escapements).

Spatial/Temporal Scale:

- Samples collected across the spawning distribution once every five years.

Measured Variables:

- Allele frequency

Measurement Protocols:

- Tissue samples (operculum punches) collected from carcasses sampled during spawning ground surveys.
- Microsatellite or SNP genotypes.

Derived Variables:

- Allele frequency

Analysis:

- Analyze as a time series (trend).
- Compare samples within drainages.
- Population differentiation tests, analysis of molecular variance (AMOVA), and relative genetic distances.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.

- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

Genetic Distances

Monitoring Questions:

- Does the genetic distance among subpopulations (e.g., MaSA) within a supplemented population remain the same over time compared to non-supplemented population?

Sampling Design:

- Stratified proportional sampling across the spawning distribution and systematic sampling throughout the spawning period (sites selected from the Washington State "master sample" list).
- Sample size of 144 naturally produced fish and 144 hatchery produced fish (sample sizes may not be achieved during years with low escapements).

Spatial/Temporal Scale:

- Samples collected across the spawning distribution once every five years.

Measured Variables:

- Microsatellite genotypes

Measurement Protocols:

- Tissue samples (operculum punches) collected from carcasses sampled during spawning ground surveys.
- Microsatellite or SNP.

Derived Variables:

- Allele frequencies

Analysis:

- Analyze as a time series (trend).
- Compare samples among drainages.
- Population differentiation tests, AMOVA, and relative genetic distances.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.

- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

Effective Spawning Population

Monitoring Questions:

- Is the ratio of effective population size (N_e) to spawning population size (N) constant over time?

Sampling Design:

- Stratified proportional sampling across the spawning distribution and systematic sampling throughout the spawning period (sites selected from the Washington State "master sample" list).
- Sample size of 144 naturally produced fish and 144 hatchery produced fish (sample sizes may not be achieved during years with low escapements).

Spatial/Temporal Scale:

- Samples collected across the spawning distribution once every five years.

Measured Variables:

- Microsatellite genotypes

Measurement Protocols:

- Tissue samples collected from carcasses sampled during spawning ground surveys.
- Microsatellite or SNP.

Derived Variables:

- Allele frequencies

Analysis:

- Analyze as a time series (trend).
- Population differentiation tests, relative genetic distances, statistics to calculate effective population size (e.g., harmonic means).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

Age at Maturity

Monitoring Questions:

- Is the age at maturity of hatchery and naturally produced fish similar over time?

Sampling Design:

- Complete census of fish sampled as carcasses on spawning grounds and/or fish trapped for broodstock or stock assessments.

Spatial/Temporal Scale:

- Annual sample of all fish collected for broodstock and stock assessments, and all available carcasses across the entire spawning distribution.

Measured Variables:

- Age of hatchery and naturally produced salmon carcasses collected on spawning grounds.
- Age of broodstock.
- Age of adults at trap locations.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Collect and read scales from sampled fish collected at traps, from carcasses, and/or from broodstock.

Derived Variables:

- Saltwater ages

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (initially as a 5-year period).
- Chi-square or ANOVA by origin and gender.
- Whenever possible age at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Size at Maturity

Monitoring Questions:

- Is the size (length) at maturity of a given age and sex of hatchery fish similar to the size at maturity of a given age and sex of naturally produced fish?

Sampling Design:

- Complete census of fish sampled as carcasses on spawning grounds and/or fish collected for broodstock or stock assessments.

Spatial/Temporal Scale:

- Annual sample of all fish collected for broodstock and stock assessments, and all available carcasses across the entire spawning distribution.

Measured Variables:

- Size (length), age, and gender of hatchery and naturally produced salmon carcasses collected on spawning grounds.
- Size (length), age, and gender of broodstock.
- Size (length), age, and gender of fish at stock assessment locations.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Identification of sex of carcasses, fish collected for broodstock, and fish sampled at stock assessment sites (using morphological characteristics, dissection, and/or possibly ultrasound).
- Post-orbital to hypural (POH) and fork length (mm) of carcasses, fish collected for broodstock, and fish sampled at stock assessment sites.
- Collect and read scales from sampled fish collected at stock assessment sites, from carcasses, and/or from broodstock.

Derived Variables:

- Calculate total age and saltwater age.

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).
- ANOVA by origin, gender, and age

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 6: ***Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR expected value.***

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish, the program should be modified or discontinued.

Hatchery Replacement Rates (HRRs)

Monitoring Questions:

- Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the adult-to-adult survival rate (R/S) of naturally produced fish?
- Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the expected value (includes sum of adults harvested, taken for broodstock, and adults on spawning grounds)?

Sampling Design:

- Complete census of adults, redds, available carcasses, and/or broodstock.

Spatial/Temporal Scale:

- Annual sampling across the entire spatial and temporal spawning distribution.

Measured Variables:

- Number of redds or adults.
- Origin of carcasses and/or trapped adults (hatchery or naturally produced fish).
- Sex ratio of broodstock collected randomly over the run.
- Age composition from both adults and carcasses (from scale and tag analysis).
- Number of hatchery and naturally produced fish harvested

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all streams within the distribution of the spawning populations.
- Number of smolts produced annually
- Count the number of hatchery and naturally produced carcasses and fish collected for broodstock.

- Identification of sex of fish collected for broodstock (using morphological characteristics, dissection, and/or possibly ultrasound).
- Collect and read scales and tags from sampled fish collected at stock assessment sites, from carcasses, and/or from broodstock.
- Number of hatchery and naturally produced fish harvested
- Number of broodstock used by brood year (hatchery and naturally produced fish).

Derived Variables:

- Age structure of the spawning population.
- SAR
- Number of hatchery and naturally produced adults by brood year ($\geq$ age-3).
- HRR (number of returning adults per brood year/broodstock)
- NRR (from above)

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (initially as a 5-year period).
- For Q1 a two-sample t-test to compare HRR to NRR
- For Q2 a one-sample t-test to evaluate HRR to expected values.
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 7: *Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.*

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., rearing and acclimation water source, release methodology, and location) are the main variables thought to affect stray rates although hydrosystem effects may contribute to the stray rate by preventing adults from reaching their natal or river of release (if they travel upstream past their natal stream). Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population, the program will not meet the basic condition of a conservation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater than 5% of the spawning aggregate.

Stray Rates among Populations for Brood Return

Monitoring Questions:

- Is the stray rate of hatchery fish less than 5% for the total brood return?

Sampling Design:

- Complete census of all hatchery and natural origin carcasses (spring Chinook) observed during spawning surveys (number of carcasses sampled should be no less than 20% of the estimated spawning escapement), or at traps (steelhead)

Spatial/Temporal Scale:

- Annual sampling throughout the spawning period.
- Steelhead detection near mouths of spawning streams.

Measured Variables:

- Number of hatchery carcasses (or PIT tagged hatchery steelhead, if an adequate number of fish are PIT tagged prior to release) found in non-target and target spawning areas.
- Number of hatchery fish collected for broodstock.
- Number of hatchery fish taken in fishery.
- Age (from scale and tag analysis) of all fish sampled (stock assessment, carcasses, and broodstock).

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all spawning streams or adults at traps.
- Collect and read scales from sampled fish collected at stock assessment sites, from carcasses, and/or from broodstock.
- Collect and read CWTs from hatchery fish.

Derived Variables:

- Hatchery carcasses and take in fishery estimated from expansion analysis.
- Locations of live and dead strays (used to tease out overshoot).

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (trend; initially as a 5-year period).
- A simple statistical approach is to use a one-sample t-test to compare the actual stray rate with the target (5%) stray rate.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

Stray Rates among Populations for Return Year

Monitoring Questions:

- Is the stray rate of hatchery fish less than 5% of the spawning escapement within other independent populations?

Sampling Design:

- Complete census of all hatchery and natural origin carcasses (spring Chinook) observed during spawning surveys (number of carcasses sampled should be no less than 20% of the estimated spawning escapement), or at traps (steelhead).
- Steelhead mark-recapture design.

Spatial/Temporal Scale:

- Annual sampling throughout the spawning period.
- Steelhead detection near the mouths of spawning streams.

Measured Variables:

- Number of hatchery carcasses (or PIT tagged hatchery steelhead) found in non-target and target spawning areas.
- Number of hatchery fish collected for broodstock.
- Number of hatchery fish taken in fishery.
- Number of hatchery fish removed at capture sites.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all spawning streams.
- Identification of PIT-tagged hatchery steelhead at remote PIT tag detectors.

Derived Variables:

- Hatchery salmon carcasses (or PIT tagged hatchery steelhead) estimated from expansion analysis.

Analysis:

- Analyze annually based on return year.
- Analyze as a time series (trend; initially as a 5-year period).
- A simple statistical approach is to use a one-sample t-test to compare the actual proportion of strays with the target of 5% strays

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

Stray Rates within the Population

Monitoring Questions:

- Is the stray rate of hatchery fish less than 10%[63] of the spawning escapement within other spawning aggregations within the target independent population?

Sampling Design:

- Complete census of all hatchery and natural origin carcasses (spring Chinook) observed during spawning surveys (number of carcasses sampled should be no less than 20% of the estimated spawning escapement), or at traps (steelhead).

Spatial/Temporal Scale:

- Annual sampling throughout the spawning period.
- Steelhead detection near the mouths of spawning streams.

Measured Variables:

- Number of hatchery carcasses (possibly PIT tagged hatchery steelhead) found in non-target and target spawning aggregates.

Measurement Protocols:

- Stream surveys conducted by walking and/or floating all spawning streams.

Derived Variables:

- Hatchery salmon carcasses (possibly PIT tagged hatchery steelhead) estimated from expansion analysis.

Analysis:

- Analyze annually based on return year.
- Analyze as a time series (trend; initially as a 5-year period).
- A simple statistical approach is to use a one-sample t-test to compare the actual proportion of strays with the target of 10% strays.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

[63] This value should be reviewed annually.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 8: ***Determine if hatchery fish were released at the programmed size number, and time.***

Although many factors can influence both the size and number of fish released, past hatchery experience should assist in meeting program production levels.

Size of Hatchery Fish

Monitoring Questions:

- Is the size of hatchery fish released equal to the program goal?

Sampling Design:

- Random sample of hatchery smolts.

Spatial/Temporal Scale:

- Monthly sample of all stocks.

Measured Variables:

- Length (mm) and weights (g) of random samples of hatchery smolts.
- Dates of release compared to release date goal.

Measurement Protocols:

- Measure and weigh random samples of smolts.

Derived Variables:

- Means and CVs.
- Deviation in days from release date goal.

Analysis:

- Analyze annually.
- Analyze as a time series (initially as a 5-year period).
- A simple statistical approach is to use a one-sample t-test to compare the actual size of hatchery fish at time of release with the program goal.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

Number of Hatchery Fish

Monitoring Questions:

- Is the number of hatchery fish released equal to the program goal?

Sampling Design:

- Census of smolts released from hatcheries.

Spatial/Temporal Scale:

- Annual assessment of all stocks.

Measured Variables:

- Numbers of smolts released from the hatchery.

Measurement Protocols:

- Count of smolts.

Derived Variables:

- NA

Analysis:

- No statistical analysis needed.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

Objective 9: ***Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of juveniles/smolts per redd) of supplemented streams when compared to non-supplemented streams.***

Out-of-basin effects (e.g., smolt passage through the hydro system and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (R/S and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). One of the objectives of long-term smolt monitoring programs is to determine the egg-to-smolt or egg-to-juvenile survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

Differences in carrying capacities of supplemented and non-supplemented streams can confound the effects of conservation programs on numbers of juveniles per redd. For example, if the supplemented population is at or above carrying capacity and the non-supplemented population is not, numbers of juveniles per redd in the non-supplemented population may be significantly greater than the number of juveniles per redd in the supplemented population. To avoid concluding that the supplementation program has no effect or perhaps a negative effect on juveniles per redd, the capacity of the habitats must be included in the analyses and adjusted for density dependence.

Juvenile Productivity

Monitoring Questions:

- Is the change in numbers of juveniles (smolts, parr, or emigrants) per redd in the supplemented population greater than or equal to that in the non-supplemented population?
- Is the total number of emigrants affected by the proportion of hatchery spawners?
- Does the number of juveniles per redd decrease as the proportion of hatchery spawners increase?[64]

Sampling Design:

- Census (based on mark-recapture to calibrate trapping efficiency) of smolts and emigrants through trapping.

Spatial/Temporal Scale:

- Annual estimates of juveniles within each supplemented population.

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Numbers of redds.
- Number of juveniles (smolts, parr [not appropriate for all populations], and emigrants).

[64] Information is needed to estimate the effects of density dependence on these questions.

- Number of hatchery fish removed at capture sites

Measurement Protocols:

- Spawning surveys conducted by walking and/or floating all streams within the distribution of the supplemented population.
- Count smolts and emigrants using smolt traps following methods in Bumgarner et al. (2000), Gallinat et al. (2001), Mayer et al. (2010), and Mahoney et al. (2009).

Derived Variables:

- Number of juveniles (smolts and parr) per redd.
- Total number of emigrants per year per stream/population.

Analysis:

- Analyze annually based on brood year.
- Analyze as a time series (initially as a 5-year period).
- Two-sample t-test to evaluate differences between treatment and reference slopes (initial 5-year period).
- Regression analysis to examine relationships between hatchery adult composition and juveniles/redd.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP (and other BPA)-funded program and comparison of data to recovery metrics.

This is a highest priority objective.

Objective 10: *Determine if harvest opportunities have been provided using hatchery returning adults where they were intended.*

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or brood stock requirements), surplus fish may be available for harvest. Harvest of surplus hatchery fish downstream from the spawning grounds would also assist in reducing potential adverse genetic impacts to naturally produced populations (loss of genetic variation within and between populations).

Harvest Rates

Monitoring Questions:

- Is the harvest on hatchery fish produced in harvest-augmentation programs achieving harvest mitigation goals?
- Is the escapement of fish from conservation programs, after meeting broodstock and natural production[65] needs, high enough to provide opportunities for terminal harvest?
- What is the total harvest of hatchery-origin fish?

Sampling Design:

- Systematic random survey design (sites selected from the Washington State "master sample" list).

Spatial/Temporal Scale:

- Sample anglers within open fishing areas throughout the angling period.

Measured Variables:

- Numbers of hatchery fish taken in harvest.

Measurement Protocols:

- Creel surveys.

Derived Variables:

- Total harvest by fishery estimated from expansion analysis.

Analysis:

- A one-sample t-test can be used to compare harvest rates with the level needed for program goals.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a high priority objective.

<u>Objective 11:</u> *Reduce negative effects caused by ecological interactions between hatchery and naturally produced juveniles and adults.*

[65] At this time, the escapement of adults needed to fully seed habitat in the SEWMU is unknown.

Ecological interactions between hatchery- and natural origin fish in the wild is a critical uncertainty for most hatchery programs. Ecological and genetic interactions are a concern to many fisheries management agencies. There is a paucity of information concerning these interactions, especially in mainstem areas, the estuary and ocean. This plan addresses potential interactions and information needed for monitoring interactions between hatchery and naturally produced fish in tributaries.

Monitoring Questions:

- How long do hatchery juveniles stay in the river?
- Do naturally produced fish follow hatchery fish as they leave the river (exhibiting a "Pied Piper" effect)?
- Do hatchery and naturally produced juveniles/smolts utilize the same habitats in river?
- Do naturally produced juveniles change their habitat use patterns after hatchery fish are released (are they displaced from habitats)?
- Do hatchery juveniles compete with naturally produced juveniles for food?
- Are growth rates of natural fish affected by the presence of hatchery fish?
- Do hatchery and naturally produced adults occupy the same holding habitat?
- Do hatchery and naturally produced adults spawn in the same locations?
- Do hatchery origin spawners have the same temporal distribution as naturally produced spawners?
- Do hatchery and naturally produced adults interbreed?

Sampling Design:

- TBD

Spatial/Temporal Scale:

- TBD

Measured Variables:

- Number of HOF juvenile fish that do not migrate after release
- Number of NOF emigrating from feeding stations after hatchery release
- Size of NOF prior to HOF release and after
- Habitat use by NOF prior to and after HOF release
- Habitat use by HOF
- Size and weight at emigration of NOF.
- Number of hatchery and naturally produced fish on spawning grounds by date
- Number of hatchery and naturally produced fish in holding areas
- Number of carcasses sampled
- Location of spawning fish
- Location of natural origin spawner redds
- Location of hatchery origin spawner redds

Measurement Protocols:

- TBD

Derived Variables:

- Residualism rates

- Competition (space and food)
- Premature emigration rate (displacement rates)
- Growth rate of NOF
- Density of fish in holding areas and on spawning grounds Spatial distribution of spawning fish
- Percent of total spawning population sampled for carcasses (sampling rate)

Analysis:

- Monitor how long hatchery fish reside in release area after release.
- Compare habitat use and migration patterns of natural origin fish prior to and after release of hatchery fish.
- Compare food habits of natural origin fish prior to and after release of hatchery fish.
- Use reference population to calculate an instantaneous growth rate difference.
- Compare pathogen occurrence in natural origin fish prior to and after release of hatchery fish.
- Track sample rate to ensure that goal is being met.
- Calculate overlap of habitat use by hatchery- and natural origin fish.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

C.3.7 Prioritization of Hatchery status and trend monitoring

Table C-9 provides a summary of the monitoring priority for hatchery status and trend monitoring. This table, based on the priorities identified in Table C-3, should be used (in combination with others below) to assist the SRSRB and other stakeholders in determining which monitoring should occur and at what time frame.

Table C-9. Summary of prioritization of objectives for hatchery status and trend monitoring and recommendations for each SEWMU population.

Objective	Key Variables	Priority	Spring Chinook			Steelhead				
			Tucannon	Asotin	Wenaha	Walla Walla	Touchet	Tucannon	Asotin	Grande Ronde Basin (SEWMU)
1. Determine if the mitigation goals have been met.[a]	Numbers of hatchery fish taken in harvest. Number of hatchery and naturally produced fish on spawning grounds. Number of hatchery fish removed at capture sites	Highest	Important in years when fishing is allowed.	Will be important when population rebounds or the Tucannon population is expanded to the Asotin.	The Wenaha population is managed as a wild fish sanctuary, so the hatchery-related goal is to keep hatchery fish to no more than 5% of the spawning population.	Important in years when fishing is allowed.			The Asotin population is managed as wild fish sanctuary. Any fishery is not likely until restoration goals are met.	Important in years when fishing is allowed.
2. Determine the relative reproductive success of hatchery-origin spawners in the natural environment.	See AHSWG (2008)	High	To be determined with regional collaboration							
3. Determine if conservation programs increase the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and if the return per spawner (R/S) of the supplemented population is similar to that of the non-supplemented population.	Number of redds or adults returning. Number of hatchery produced fish on spawning grounds. Number of naturally and hatchery produced fish removed for broodstock. Number of hatchery produced fish harvested. Number of redds and or	High	On-going, continue funding important	Will be important when population rebounds or is reintroduced.		On-going, continue funding important (does not apply to the Walla Walla or lower Grande Ronde and Asotin as there are no conservation hatcheries for those populations)				

			Spring Chinook			Steelhead				
Objective	**Key Variables**	**Priority**	**Tucannon**	**Asotin**	**Wenaha**	**Walla Walla**	**Touchet**	**Tucannon**	**Asotin**	**Grande Ronde Basin (SEWMU)**
	adults. Origin of carcasses and/or brood stock (hatchery or naturally produced fish). Sex ratio of broodstock collected randomly over the run. Age composition from both broodstock and carcasses (from scale analysis).									
4. Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.	Ages of hatchery and naturally produced fish sampled at broodstock collection sites, during carcasses surveys, and/or at stock assessment sites. Time (Julian date) of arrival at Bonneville, McNary, Ice Harbor, Lower Granite dams, and within tributaries.	High	On-going, continue funding important	NA	NA	Spawner origin information collection needs improvement (except Asotin Creek, and upstream from weirs on Tucannon and Touchet). On-going, continue funding important.				
5. Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of hatchery programs. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	Allele frequency Microsatellite genotypes Age of hatchery and naturally produced salmon carcasses collected on spawning grounds. Age of broodstock. Age of adults at trap locations.	High	Ensure information is collected once every five years, or more if additional questions can be answered.							
6. Determine if the hatchery	Number of redds or	High	On going,	Will be	NA	On going, ensure continued funding			NA	NA

			Spring Chinook			Steelhead				
Objective	**Key Variables**	**Priority**	**Tucannon**	**Asotin**	**Wenaha**	**Walla Walla**	**Touchet**	**Tucannon**	**Asotin**	**Grande Ronde Basin (SEWMU)**
adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR expected value.	adults. Origin of carcasses and/or trapped adults (hatchery or naturally produced fish). Sex ratio of broodstock collected randomly over the run. Age composition from both adults and carcasses (from scale and tag analysis). Number of hatchery and naturally produced fish harvested		ensure continued funding.	important if hatchery program is used for reintroduction.		(does not apply to the Walla Walla and LFH releases in the Touchet, but does apply to the endemic program in the Touchet).				
7. Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.	Number of hatchery carcasses (or PIT tagged hatchery steelhead) found in non-target and target spawning areas. Number of hatchery fish collected for broodstock. Number of hatchery fish taken in fishery. Age (from scale and tag analysis) of all fish sampled (stock assessment, carcasses, and broodstock).	High	Need to ensure that every stream is evaluated in some manner for hatchery strays from other hatchery programs. Data collection should be standardized and easily available between agencies.							
8. Determine if hatchery fish were released at the programmed size number, and time.	Length (mm) and weights (g) of random samples of hatchery smolts. Dates of release compared to release date	High	On-going, ensure continued funding.	NA	NA	On-going, ensure continued funding.			NA	On-going, ensure continued funding.

			Spring Chinook			Steelhead				
Objective	**Key Variables**	**Priority**	**Tucannon**	**Asotin**	**Wenaha**	**Walla Walla**	**Touchet**	**Tucannon**	**Asotin**	**Grande Ronde Basin (SEWMU)**
	goal. Numbers of smolts released from the hatchery.									
9. Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of juveniles/smolts per redd) of supplemented streams when compared to non-supplemented streams (only practical in certain streams where fish in/out information is being collected).	Number of hatchery and naturally produced fish on spawning grounds. Numbers of redds. Number of juveniles (smolts, parr [not appropriate for all populations], and emigrants). Number of hatchery fish removed at capture sites	Highest	Most of information being collected, continue funding and ensure objective is answered.	Expand this analysis if a reintroduction plan is implemented over time	NA		Spawner origin information collection needs improvement (except upstream from weirs on Tucannon and Touchet). Most of information being collected, continue funding and ensure objective is answered.		Need to investigate downstream of Asotin and George Cr weirs and potentially Alpowa Creek and other associated tributaries	NA
10. Determine if harvest opportunities have been provided using hatchery returning adults where they were intended.	Numbers of hatchery fish taken in harvest, and locations of harvest	High	See objective 1 above							
11. Reduce negative effects caused by ecological interactions between hatchery and naturally produced juveniles and adults.	See pages 130-131 above	Medium	To be determined with regional collaboration							

[a] It is important to understand that mitigation goals for LSRCP populations include adult returns and SAR targets. This table does not consider those portions of the mitigation goals.

C.3.8 Disease and Predation Status and Trend Monitoring

Monitoring disease and predation impacts occurs through various forums. All current processes call for controlling predator effects on juvenile salmonids. In the early 1990s, predation effects were estimated on the Columbia River system, and since that time, various control programs have been operating (e.g., Northern Pikeminnow Management Program). In the lower Columbia and Snake rivers, control measures are primarily funded through BPA's reward program, where anglers are paid on a per-fish basis. Research is needed on the effects of disease and non-native piscine predators on the recovery of Snake River populations.

The Snake River Salmon Recovery Board does not have resources to monitor disease and predation. If resources become available, the following outline could be implemented to help assess the effects of disease and predation on recovery of Snake River populations.

Objective 1: ***Determine the effects of predation on population viability.***

Monitoring Questions:

- How much mortality of Chinook and steelhead smolts can be attributable to piscine predators?
- How much mortality of Chinook and steelhead smolts can be attributable to avian predators?
- How much mortality of adult Chinook and steelhead can be attributable to marine mammal predators?

Sampling Design:

- Random sample of locations for predator abundance.
- Systematic sample (or complete census) of predators (stomach contents).
- Census (based on mark-recapture) of smolts within each population.

Spatial/Temporal Scale:

- Predator sampling should occur throughout the migration corridor (including the estuary) in index areas and rotating random sites outside index areas.
- Sample predators systematically throughout the migration period.
- Predator sampling should occur every 5-10 years.
- Annual estimate of smolts produced within each population.

Measured Variables:

- Number of Chinook and steelhead smolts from each population.
- Number of Chinook and steelhead smolts consumed by predators.
- Number of predators sampled.
- Catch per unit effort.
- Sampling rate.

Measurement Protocols:

- Collect or sample predators using appropriate passive or active capture methods.
- Enumerate numbers of different predators and sampling effort.
- Identify species consumed by key morphological features of remains (e.g., bones, otoliths, etc.).
- Use genetic analysis to assign consumed fish to specific populations or ESUs/DPSs.
- Count smolts using smolt traps following methods in Gallinet and Ross (2007), Mayer et al. (2010), and Mahoney et al. (2009).

Derived Variables:

- Total Chinook and steelhead consumed by predator species based on bioenergetics modeling (e.g., Hewett and Johnson 1992).
- Numbers of predators by species (based on standardized CPUE for piscine predators and visual monitoring of pinnipeds, Caspian Terns, and double-crested cormorants).
- Mortality rates.
- Proportion of SAR associated with predation.
- Calculate abundance and productivity with and without predation.

Analysis:

- Bioenergetics modeling (e.g., Hewett and Johnson 1992).
- Estimate the standard error (SE) and 95% confidence interval (CI) for the abundance and productivity estimates with and without predation (ICTRT 2007).
- Combine the abundance and productivity estimates and plot them with their associated SE and 95% CI on the viability curve (ICTRT 2007).
- Track predation rates over time.

Possible Funding Entities:

- Each hydro operator will be responsible for sampling at their project(s). BPA and USACE will like fund most of the work.
- USFWS funds through BPA via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

<u>Objective 2:</u> ***Determine the prevalence, transmission, and distribution of diseases within each population.***

Monitoring Questions:

- What is the prevalence and distribution of disease in populations of concern?
- Is disease being transferred between hatchery and naturally-produced fish?

Sampling Design:

- Random selection of sampling sites within natural production areas (sites selected from the Washington State "master sample" list).
- Systematic sample of hatchery and naturally produced fish.

Spatial/Temporal Scale:

- Monitor hatcheries that have a high incidence of disease.
- Sample fish from natural production areas adjacent to the hatcheries and in distant, remote production areas.
- Sample once every five years.

Measured Variables:

- Number of diseased hatchery and naturally produced fish.
- Disease within hatchery influent and effluent water.

Measurement Protocols:

- Push net, lift net, or pop net sampling within hatcheries.
- Passive (smolt traps) and active (seines, hook-and-line, etc.) fish sampling methods in streams.
- Standard disease identification through tissue (e.g., gill tissue) and water samples.

Derived Variables:

- Percentage of hatchery fish diseased.
- Percentage of naturally produced fish diseased.
- Spatial distribution of disease.
- Percent of caged fish diseased.
- Percent of caged fish that died from disease.

Analysis:

- Changes in prevalence of disease within hatcheries over time.
- Changes in prevalence of disease within naturally produced fish over time.
- Changes in the distribution of disease over time.
- Differences in numbers of diseased fish within cages upstream and downstream from hatchery facilities.

Possible Funding Entities:

- BPA funds through USFWS via the LSRCP and other BPA funds.
- State and/or federal funds needed to do the analyses and comparisons with recovery criteria.

Implementation and Coordination:

- Field work is implemented and coordinated by the co-managers.
- The Snake River Salmon Recovery Board will coordinate activities between the LSRCP-funded program and comparison of data to recovery metrics.

This is a medium priority objective.

C.3.9 Regulatory Mechanisms Status and Trend Monitoring

There are several federal, state, tribal, and local regulatory mechanisms that protect listed species and their habitats. The lack of enforcement of existing regulations may limit the viability of Snake River populations. Monitoring the status and trend of enforcement of existing regulations is needed.

The Snake River Salmon Recovery Board does not have resources to monitor regulatory mechanisms. However, individual board member can identify and communicate regulations that are inadequate or that may need to be revised to support salmon recovery objectives to those agencies or entities with regulatory authority. If resources become available, the following outline could be implemented to assess the effects of regulatory mechanisms on recovery of Snake River populations.

Objective 1: ***Identify Federal, state, tribal, and local regulatory mechanisms that benefit and/or protect listed ESUs/ DPSs.***

Monitoring Questions:

- What regulatory mechanisms are in place to maintain or further reduce risk of the primary limiting factors associated with disease and predation, habitat, hydropower, harvest, and hatcheries?

Sampling Design:

- Complete census (listing) of regulations and jurisdiction or intent.

Spatial/Temporal Scale:

- List of federal, state, tribal, and local regulations across all sectors.

Measured Variables:

- Identification of county ordinances, federal and state statutes, and tribal laws.
- Description of the intent of each regulatory mechanism.

Measurement Protocols:

- Review of existing regulatory mechanisms within each sector.
- Legal/literature search and interviews.

Derived Variables:

- Estimated effect of regulatory mechanism on limiting factor(s) within each sector.

Analysis:

- Analysis will focus on whether specific regulatory mechanisms are affecting limiting factors.

Possible Funding Entities:

- Local, state, and federal agencies.

Implementation and Coordination:

- Implementation and coordination through the SRSRB.

This is a Very-high priority objective.

Objective 2: ***Determine the adequacy of regulatory mechanisms.***

Monitoring Questions:

- Are regulatory mechanisms adequate to meet salmon habitat protection and restoration goals?
- Are the regulatory mechanisms identified under Objective 1 being implemented in a manner to meet recovery or restoration goals?
- Are the regulatory mechanisms identified under Objective 1 being enforced?

Sampling Design:

- Complete census of enforcement of regulatory mechanisms.

Spatial/Temporal Scale:

- Assessment of federal, state, tribal, and local regulations and their enforcement across all sectors.

Measured Variables:

- Presence/Absence of enforcement of county ordinances, federal and state statutes, and tribal laws.
- Identification of regulations that are not enforced, or are not enforced consistently throughout the SEWMU.

Measurement Protocols:

- Review of existing enforcement within each sector.
- Legal/literature searches and interviews.

Derived Variables:

- None

Analysis:

- Changes in enforcement of regulations across sectors and throughout the SEWMU over time.

Possible Funding Entities:

- Local, state and federal agencies.

Implementation and Coordination:

- The SRSRB will implement and coordinate monitoring of enforcement of regulatory mechanisms in the SEWMU.

This is a high priority objective.

C.3.10 Natural Factors Status and Trend Monitoring

Natural factors that can limit the viability of Snake River populations include poor ocean conditions, fires, floods, droughts, and landslides. The most important natural factors limiting Snake River populations are poor ocean conditions and drought. Thus, ocean conditions, which are largely beyond the control of management agencies, can have a large effect on the viability of SEWMU populations.

The Snake River Salmon Recovery Board does not have resources to monitor natural factors. If resources become available, the following outline could be implemented to assess the effects of natural factors (ocean and drought conditions) on recovery of Snake River populations.

Objective 1: ***Describe the status and trend of ocean conditions important to Snake River populations.***

The Fish Ecology Division of the Northwest Fisheries Science Center (NFSC) developed a module for monitoring ocean conditions related to salmonid status. A monitoring plan for the estuary was developed under the FCRPS BiOp (Johnson et al. 2008). Outlined below is relevant information from these programs.

Monitoring Questions:

- What is the status and trend of ocean conditions important to Snake River populations?

Sampling Design:

- Use designs identified in NFSC Fish Ecology Division research program (http://www.nwfsc.noaa.gov/research/divisions/fed/climatechange.cfm)

Spatial/Temporal Scale:

- Sample at spatial and temporal scales identified in NFSC Fish Ecology Division research program (http://www.nwfsc.noaa.gov/research/divisions/fed/climatechange.cfm)

Measured Variables:

- Upwelling
- Atmospheric pressure
- Size of warm-water tongue
- Sea-surface temperature
- Cloudiness
- Deep water temperature and salinity
- Copepod species richness
- Northern Copepod biomass anomalies
- Predator fish abundance (e.g., Pacific hake (a.k.a. Pacific whiting) catch)
- Coho catch in September
- Spring Chinook catch in June
- Forage fish abundance

Measurement Protocols:

- Use protocols identified in Johnson et al. (2008).
- Use protocols identified in NFSC Fish Ecology Division research program (http://www.nwfsc.noaa.gov/research/divisions/fed/climatechange.cfm)

Derived Variables:

- Upwelling index based on Ekman mass transport calculation
- Pacific decadal oscillation (PDO) Index
- El Nino Southern Oscillation (ENSO) Index
- Zooplankton Index
- Hake Index (catch per volume from trawl samples)
- See NFSC Fish Ecology Division research program (http://www.nwfsc.noaa.gov/research/divisions/fed/climatechange.cfm)

Analysis:

- Use method identified in the NFSC Fish Ecology Division research program (http://www.nwfsc.noaa.gov/research/divisions/fed/climatechange.cfm)

Possible Funding Entities:

- NOAA and research grants would be the primary funding entities.

Implementation and Coordination:

- NOAA and the Lower Columbia River Estuary Partnership would implement and coordinate monitoring activities.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a low priority objective.

Objective 2: ***Describe the status and trend of climate change in the Snake River Basin.***

The metrics needed to assess drought conditions are currently measured by state and federal agencies throughout the SEWMU. Methods used in the SEWMU need to be consistent with other regional programs. Outlined below is relevant information for assessing drought conditions and other impacts associated with climate change.

Monitoring Questions:

- What is the trend in drought conditions within the Snake River Basin?
- What is the trend in water quality (especially water temperatures) within the Snake River Basin (see Habitat Status and Trend Monitoring section)?

Sampling Design:

- Systematic sampling of stream flows, precipitation, and air and water temperatures

Spatial/Temporal Scale:

- Hourly sampling within each subbasin (Tucannon, Walla Walla (including Touchet), Asotin, and Grande Ronde).

Measured Variables:

- Stream flows (cms or cfs)
- Air and water temperatures (°C)
- Precipitation (mm)

Measurement Protocols:

- Use existing USGS/WDOE gauging stations and weather stations in the southeast Washington State recovery area.
- Measure water temperatures using methods described in Zaroban (2000).

Derived Variables:

- Annual peak and base stream flows.
- Seasonal averages (June-August, September-November, December-February, and March-May) of air temperature and precipitation.
- MWMT, MWAT, daily maximum, daily average, and temperature exceedances.
- Palmer Drought Severity Index (PDSI).

Analysis:

- Changes in drought indices over time.

Possible Funding Entities:

- BPA and NOAA would be the primary funding entities.

Implementation and Coordination:

- The SRSRB will implement and coordinate monitoring of drought conditions in the southeast Washington State recovery area.
- Coordination of results from these programs and recovery metrics should occur through the SRSRB.

This is a low priority objective.

C.3.11 Prioritization of limiting factors status and trend monitoring

Prioritization summaries were not necessary for Disease and Predator, Regulatory Mechanism, and Natural Factors status and trend monitoring because they are all low-medium priority except Regulatory Mechanisms. For Regulatory Mechanisms, the Board suggests monitoring when additional money is available.

For Population (Table C-5), Habitat, Hydro, and Harvest (Table C-7) and hatcheries (Table C-8), specific basin recommendations are suggested above.

C.4 IMPLEMENTATION/COMPLIANCE MONITORING PLAN

This plan requests that all recovery actions include implementation monitoring. Implementation monitoring documents the type of action, its location, and whether the action was implemented properly and completely or complies with established standards. Indicators for implementation monitoring include visual inspections, photographs, and field notes on numbers, location, quality, and area affected by the action. It does not require collection of environmental or biological data. Success is determined by comparing field notes with what was specified in the plans or proposals (detailed descriptions of engineering and design criteria). Thus, design plans and/or proposals serve as the benchmark for implementation monitoring. Any deviations from specified engineering and design criteria should be described in detail.

Implementation monitoring will answer two primary questions: (1) were the actions implemented completely and according to the implementation schedule and (2) were the actions implemented correctly. Because the implementation schedule addresses habitat actions, this section of the monitoring plan focuses on monitoring the implementation of habitat actions. Although recovery actions implemented within other sectors (e.g., harvest, hatcheries, and hydro) are not explicitly addressed here, the following forms can be used with some minor modification to monitor implementation of harvest, hatchery, and hydro actions. The Adaptive Management Plan will be used to determine if implementation targets or goals were achieved.

Below are project tracking forms that should be completed for each habitat project implemented in the southeast Washington State recovery area. Information contained in the forms can be used by the SRSRB to answer the two primary questions above. The following project tracking forms were largely developed by Katz et al. (2006) and represent a regional approach to tracking the implementation of projects.

General Project Information

Project Name/Identification Number	***Name of the project to be implemented/Project identification number***
Project Grantee	*Primary grantee of the project*
Project Subgrantee	*Sub-grantees of the project*
Project Objective	*Objective of the project*
Project Description	*Description of the project*
Expected Project Benefits	*Expected benefits to VSP and habitat conditions*
Project Area Name	*Location of the project (stream name and 5th field HUC)*
Selection Date	*Date that funding was committed to the project*
Start Date	*Start date of the project*
Deliverable Date	*Date that project deliverables are completed*
Scheduled End Date	*Date that the contract is scheduled for completion*
Actual End Date	*Date that the project is actually completed*

Federal Fiscal Fund Year	*The Federal fiscal year in which the funding was awarded*
Proposed Funding	*The amount of money asked for in the proposal*
Funding Received	*The amount of money received to do the work*
Total Funding Spent	*The total amount of money spent to complete the project*
Project Leads	*Names of entities receiving funds to do the project work*
Project Contacts	*Contact person/people for the project*

Worksite Information

Project Name/Identification Number	***Name of project to be implemented/Project identification number***
Work Start Date	*Date that work actually started*
Work End Date	*Date that work ended*
State	*State in which the project is located*
County	*County in which the project is located*
Latitude	*Latitude coordinate value for worksite (0-90 degrees)*
Longitude	*Longitude coordinate value for worksite (0-180 degrees)*
Stream Name	*Name of stream in which the project is located (from StreamNet)*
LLID	*LLID of the stream in which the project is located*
Begin Feet	*Distance (ft) from the stream confluence that the project site begins*
End Feet	*Distance (ft) from the stream confluence that the project ends*
Township	*Township in which the project is located*
Range	*Range in which the project is located*
Section	*Section in which the project is located*
3rd Field HUC	*3rd Field HUC in which the project is located*
4th Field HUC	*4th Field HUC in which the project is located*
5th Field HUC	*5th Field HUC in which the project is located*
Targeted ESU(s)	*ESUs and/or DPSs targeted by the project*
Targeted Population(s)	*Populations targeted by the project*

General Habitat Expense Information

Year	***Year in which projects were implemented***
Habitat Restoration and Protection	*Money spent on habitat restoration and protection*
Instream Funds	*Money spent on instream activities*

Fish Screening	*Money spent on fish screening activities*
Fish Passage Improvement	*Money spent on fish passage improvement projects*
Instream Flow	*Money spent on instream flow activities*
Instream Habitat	*Money spent on instream habitat activities*
Upland Habitat	*Money spent on upland habitat activities*
Water Quality	*Money spent on water quality activities*
Riparian Habitat	*Money spent on riparian habitat activities*
Land Acquisition	*Money spent on land acquisition (lease) activities*
Wetland	*Money spent on wetland activities*
Planning and Assessment	*Money spent on planning and assessment activities*
Research Monitoring	*Money spent on research, monitoring and evaluation*

Project Specific Information

Habitat Action Type	Specific Habitat Actions	Metric
Fish Screening	Fish Screen Installed	*Number of screens installed and flows (cfs) at screened diversion*
	Fish Screen Replacement	*Number of screens installed and flows (cfs) at screened diversion*
Fish Passage	Fish Ladder Improvement	*Number of ladders improved or removed and names of fish that benefit from action*
	Fish Ladder Installation	*Number of ladders installed and names of fish that benefit from action*
	Fishways (ladders, chutes, or pools)	*Number of fishways installed or improved and names of fish that benefit from action*
	Barriers (dams or log jams)	*Number of barriers removed or made passable and names of fish that benefit from action*
	Diversion or Push-Up Dam Removal	*Number of barriers removed and names of fish that benefit from action*
	Road Crossings (not culverts)	*Number of road crossings removed or made passable and names of fish that benefit from action*
	Culvert Improvements or Upgrades	*Number of culverts improved and names of fish that benefit from action*
	Culvert Installation	*Number of culverts installed and names of fish that benefit from action*
	Culvert Removal	*Number of culverts removed and names of fish that benefit from action*
	Weirs (log or rock)	*Number of weirs improved and names of fish that benefit from action*
Instream Flow	Water Leased or Purchased	*Amount of flow (cfs) leased or purchased*

Habitat Action Type	Specific Habitat Actions	Metric
	Irrigation Practice Improvement	*Amount of flow (cfs) returned to the stream*
Instream Structure	Streambank Stabilization	*Length (miles) of stream stabilized (add lengths treated on both sides of the stream)*
	Channel Connectivity	*Length (miles) of stream channel treated*
	Channel Reconfiguration	*Length (miles) of stream channel treated*
	Deflectors or Barbs	*Length (miles) of stream channel treated*
	Log (Control) Weirs	*Length (miles) of stream channel treated*
	Off-Channel Habitat	*Length (miles) of stream channel treated*
	Plant Removal or Control	*Length (miles) of stream channel treated*
	Rock (Control) Weir	*Length (miles) of stream channel treated*
	Spawning Gravel Placement	*Length (miles) of stream channel treated*
	Large Woody Debris	*Length (miles) of stream channel treated*
	Boulders	*Length (miles) of stream channel treated*
	Rootwads	*Length (miles) of stream channel treated*
	Log Structure or Log Jam	*Length (miles) of stream channel treated*
	Beaver Introduction	*Number of beavers introduced*
Off-Channel Wetland	Wetland Creation	*Area (acres) of wetlands created*
	Wetland Improvement or Enhancement	*Area (acres) of wetlands improved or enhanced*
	Wetland Restoration	*Area (acres) of wetlands restored*
	Wetland Vegetation Planting	*Area (acres) of wetlands treated*
	Wetland Invasive Species Removal	*Area (acres) of wetlands treated*
Riparian Habitat	Livestock Water Development	*Number of livestock water developments (may be more than one per project)*
	Water Gap Development	*Number of water gaps developed*
	Fencing	*Length (miles) of riparian habitat fencing*
	Forestry Practices or Stand Management	*Area (acres) of riparian habitat treated*
	Planting	*Area (acres) of riparian habitat planted and species planted*
	Livestock Exclusion	*Area (acres) of riparian habitat protected from livestock*
	Conservation Grazing Management	*Area (acres) of riparian habitat treated*
	Weed Control	*Area (acres) of riparian habitat treated and species controlled*
Sediment Reduction	Road Reconstruction	*Length (miles) of road reconstructed*
	Road Relocation	*Length (miles) of road relocated*
	Road Stream Crossing Improvements	*Length (miles) of road improvements*
	Road Drainage System Improvements	*Length (miles) of road improvements*
	Road Obliteration	*Length (miles) of roads obliterated*

Habitat Action Type	Specific Habitat Actions	Metric
	Erosion Control Structures	*Number of erosion control structures installed*
	Sediment Control	*Number of sediment structures installed*
Upland Agriculture	Livestock Management	*Area (acres) of uplands treated*
	Agriculture Management (BMPs)	*Area (acres) of uplands treated*
	Fencing	*Length (miles) of upland fencing*
	Water Development	*Number and type of water developments*
Upland Vegetation	Planting	*Area (acres) of upland vegetation plantings*
	Invasive Plant Control	*Area (acres) of uplands treated*
	Vegetation or Stand Management	*Area (acres) of uplands treated*
	Slope Stabilization	*Area (acres) of slope stabilization*
Upland Wetlands	Wetland Creation	*Area (acres) of wetlands created*
	Wetland Improvement or Enhancement	*Area (acres) of wetland improved or enhanced*
	Wetland Restoration	*Area (acres) of wetlands restored*
	Wetland Vegetation Planting	*Area (acres) of wetland vegetation planted*
	Wetland Invasive Species Removal	*Area (acres) of wetland invasive sp removed*
Water Quality Improvement	Return Flow Cooling	*Temperature (°C) of return flow*
	Refuse Removal	*Weight (lbs) of refused removed*
	Sewage Clean-Up	*Area (acres) of stream cleaned up*
	Toxic Clean-Up	*Area (acres) of stream cleaned up and name of toxicants*
Land Protection, Acquisition, or Lease	Streambank Protection	*Length (miles) of streambank protected (count both sides of the stream if both sides are protected)*
	Upland Protection	*Area (acres) of uplands protected*
	Wetland Protection	*Area (acres) of wetlands protected*
Nutrient Enrichment	Fertilizer	*Weight (lbs) of fertilizer added and the area (acres) of stream treated*
	Carcass Analog	*Weight (lbs) of analogs added and the area (acres) of stream treated*
	Carcass Placement	*Weight (lbs) of carcasses added and the area (acres) of stream treated*
Project Maintenance	Site Maintenance	*Length (miles) of stream treated*

The information contained in these project tracking forms will be maintained in a database that will be queried annually to determine what actions were implemented, where they were implemented, how big they were, and when they were implemented. This information will then be used to determine if actions were implemented correctly and according to the implementation schedule.

C.5 EFFECTIVENESS MONITORING APPROACH

Effectiveness monitoring is a type of monitoring that tests if recovery actions are working. If they are not, monitoring points the way toward changes in strategies or actions. Thus, effectiveness monitoring is an important part of a recovery plan. As noted earlier, hydro, harvest, and hatchery actions are, or will be, monitored for effectiveness because it is required through regulatory mandates (e.g., *U.S. v OR*, BiOps, Relicensing Agreements, etc.). Habitat actions, on the other hand, should be selected for effectiveness monitoring based on assurance of implementation, the assumed size of the treatment effect (large signal-to-noise ratio), and the presence of adequate controls/references that can be maintained for the life of the monitoring study. Therefore, not all actions can, nor should be, intensively monitored for effectiveness. This section outlines the steps needed to develop valid effectiveness monitoring plans. Monitoring plans will be developed as specific actions meeting the requirements above are funded.

Effectiveness monitoring is more complex, more difficult, and longer term than implementation monitoring. This is in part because effectiveness monitoring can occur across many different spatial scales and may involve the measurement of several different environmental and biological parameters over long periods of time. For example, if the objective is to use nutrient enrichment techniques (carcass analogs) to increase egg-smolt survival of spring Chinook in the Tucannon Basin, then the spatial scale covered by the monitoring study must include the entire area inhabited by the eggs, fry, parr, and smolts. If, on the other hand, the objective is to use sediment reduction techniques to increase egg-fry survival of spring Chinook within a specific reach of stream, then the study area would only encompass the reach of stream used by spawners of that local group. Clearly, the objectives and hence the parameters measured dictate the spatial scale at which effectiveness monitoring is conducted. As a general rule, as the spatial scale for monitoring increases, a more complex program and a longer period of time are needed to detect a treatment effect.

The “amount” or “intensity” of monitoring needed to assess treatment effects also depends on the monitoring question. For example, if one wants to know if the project affected the environmental parameters (physical habitat) that were the target of the action, then less intensive monitoring is needed to answer the question. In contrast, if one wants to know if the project affected the biological parameters (survival or productivity) at a population scale, more intensive monitoring is needed to answer the question. This is because habitat actions rarely affect biological parameters directly. The usual approach is to manipulate the environment (add wood, rock, vegetation, nutrients, passage, etc.) in the hope that the change in the environment will result in a desired change in the population (biological parameters). In the chain-of-causation, the “cause” is the treatment, which directly “affects” the stream environment (first link). The change in the stream environment should then cause a biological response (second link). Because the biological response is more than one link from the treatment, more intensive monitoring is needed to detect biological responses. As a general rule, the more links between the treatment (cause) and the desired effect, the more intensive the monitoring must be in order to detect a treatment effect. This is because several other factors may have a greater effect on the desired outcome than the treatment.

Regardless of the question or scale of the project, all effectiveness monitoring should be implemented according to standard rules of experimental design. There are several logical steps that should be taken when designing any monitoring program. These include establishing project goals and objectives; identifying key questions and specific hypotheses; selecting the appropriate monitoring design; selecting monitoring parameters; identifying appropriate spatial and temporal scales; selecting a sampling scheme for collecting parameters; implementing the monitoring program; and analyzing and communicating results (Figure C-2). Each of these steps is described briefly below.

Effectiveness Monitoring Logic Path

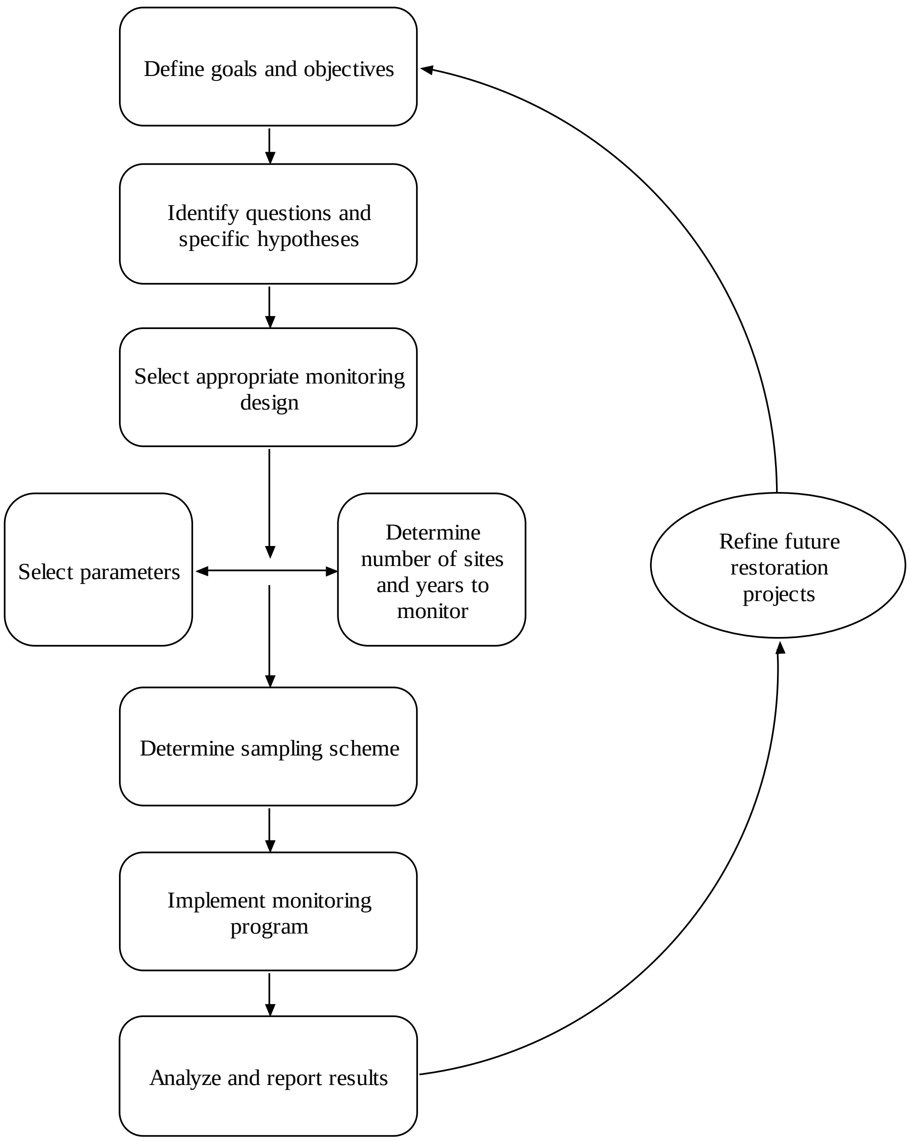


Figure C-2. Basic steps for setting up an effectiveness monitoring program for recovery actions (modified from Roni et al. 2005).

Define Goals and Objectives

Before initiating a study to evaluate a recovery action, the overall goal of the project and the monitoring objectives must be clearly identified. Goals are typically broad and strategic, while objectives are more specific and quantifiable. For example, the goal of a stream restoration project may be to increase habitat diversity and improve overwinter survival of juvenile steelhead. In contrast, the objectives would be to (1) determine if the addition of three rock cross vanes increase pool frequency and quality (depth) and (2) assess if the rock structures increased overwinter survival of juvenile steelhead by 20%. It is critical that the restoration goals and monitoring objectives be identified before implementation of the project. The goals and objectives help to determine the monitoring design, monitoring parameters, and the sampling scheme. Answering the following questions will aid in defining goals and objectives.

1. What is the problem that needs to be corrected by the action?
2. What are the current conditions at the project site?
3. What factors (including their spatial and temporal scales) contributed to the current conditions?
4. What specific actions (treatments) are needed to improve or correct the existing condition?
5. What are the independent variables in the study?

Define Key Questions and Hypotheses

The monitoring objectives need to be refined into key monitoring questions and hypotheses. If the monitoring objectives have been well defined, they can be easily translated into questions and then redefined more specifically into testable hypotheses. Following the example above, the key questions and hypotheses are:

> ***Key Question 1:*** Does the addition of three rock cross vanes increase the number of high-quality (>1 m deep) pools within the stream?
>
> > ***Hypothesis 1***: The addition of three rock cross vanes has no effect on the number of high-quality pools within the stream.[66]
>
> ***Key Question 2:*** Does the presence of high-quality pools (>1 m deep) increase overwinter survival of juvenile steelhead by 20% in the stream?
>
> > ***Hypothesis 2:*** The presence of high-quality pools has no effect on the overwinter survival of juvenile steelhead within the stream.

Key questions and hypotheses will differ among projects and will depend on the overall objectives of the project and monitoring program.

---

[66] The hypothesis to be tested is stated as no difference. This is referred to as the “null” hypothesis.

Select Monitoring Design

There are many potential study designs for monitoring restoration actions. Although none is ideal for all situations, "before-after" study designs can be used for monitoring environmental changes. A before-after study refers to a design where data are collected both before and after treatment. Data collected before treatment serve as pre-treatment or control data (temporal control), while data collected after treatment serve as post-treatment data. If there is a treatment effect, then the post-treatment score should be more desirable than the pre-treatment score (e.g., number of high quality pools within the stream increased from 2 to 5 after the addition of rock cross vanes).

By adding spatial control site(s), the before-after study becomes a "Before-After Control-Impact" (BACI) study, which, if implemented correctly, is a better monitoring design than the before-after study design. Under the BACI study design, a control site[67] is evaluated over the same time period as the treatment (impact) site. The addition of a spatial control site to the before-after study design is meant to account for environmental variability and temporal trends found in both the control and treatment areas and, thus, increase the ability to differential treatment effects from natural variability. Adding more than one control site further increases the probability of detecting a treatment effect. The BACI study design is the preferred design for effectiveness monitoring and to the extent possible sponsors should use this design.

Answers to the following questions will help investigators determine the validity of the monitoring design (see Hillman 2006 for more detail).

1. How will treatments and controls be assigned to sampling units?
2. Will the study include true replicates, sub-samples, or both?
3. Are treatments and controls independent of each other (i.e., are controls completely unaffected by the recovery actions?)?
4. What are the potential threats to the validity (internal and external) of the study?
5. What covariates (if any) will be measured?

Select Monitoring Parameters

Identifying which environmental and/or biological parameters to measure depends on the goals and objectives, key questions and hypotheses, selection of a monitoring design, and the availability of monitoring tools and protocols. Monitoring parameters should be relevant to the questions asked, strongly associated with the restoration action, ecologically significant, socially acceptable, and efficient to measure. Moreover, parameters must change in a measurable way in response to treatment, must be directly related to the resource of concern, and must have limited variability. Hillman (2006) provided a list of habitat indicators that should be measured with each type of habitat action (reproduced here as Table C-10).

[67] Control sites need to be as similar as possible to the treatment sites. The design does not require exact pairing; parameters simply need to "track" each other.

Table C-10. Rankings of the usefulness of physical/environmental indicators to monitoring effects of different tributary habitat actions. Rankings vary from 1 = highly likely to be useful; 2 = moderately likely to be useful; and 3 = unlikely to be useful or little relationship, although the indicator may be useful under certain conditions or may help interpret data from a primary indicator. Table is from Hillman (2006).

General characteristics	Specific indicators	Classes of habitat actions							
		Diversion screens	Barrier removal	Sediment reduction	Water quality improvement	Nutrient enhancement	Instream flows	Riparian habitat	Instream structure
Water quality	Temperature	3	2	3	1	2	1-2	1	3
	Turbidity	3	1-2	1	1	1	1-2	2	3
	Conductivity	3	2	2	1	1	2	2	3
	pH	3	3	3	1	1	3	2-3	3
	Dissolved Oxygen	3	2-3	2-3	1	1	1-2	2-3	3
	Nitrogen	3	3	3	1	1	3	2	3
	Phosphorus	3	3	3	1	1	3	2	3
Habitat access	Road crossings	3	1	3	3	3	3	3	3
	Diversion dams	1-2	1	3	3	3	2	3	3
	Fishways	2-3	1	3	3	3	3	3	3
Habitat quality	Dominant substrate	3	2	1	3	3	1-2	2	1-2
	Embeddedness	3	1-2	1	1-2	3	1-2	2	1-2
	Depth fines	3	1-2	1	1-2	2	2	2	1-2
	LWD	3	3	3	3	3	2	1	1
	Pools	3	1-2	1-2	3	3	1-2	1-2	1
	Residual pool depth	3	1-2	1	3	3	1	1-2	1
	Fish cover	3	2	1	1-2	1-2	1	1-2	1
	Off-channel habitat	3	2	2	3	3	1	1-2	1
Channel condition	Stream gradient	2	2	2	2	2	2	2	2

	Width/depth	3	1-2	1-2	3	3	1-2	1-2	1
	Wetted width	3	1-2	1-2	3	3	1-2	1-2	1
	Bankful width	3	1-2	1-2	3	3	1-2	1-2	1
	Bank stability	3	2	1-2	3	3	2	1	1
Riparian condition	Riparian structure	3	3	2	2-3	3	2	1	1-2
	Riparian disturbance	3	3	2	2-3	3	2	1	1-2
	Canopy cover	3	3	2	2-3	3	2	1	1-2
Flows/hydrology	Streamflows	3	1-2	3	3	3	1	2	1-2
Watershed condition	Road density	3	3	1-2	2	3	2-3	2-3	2
	Riparian-road index	3	3	1-2	2	3	2-3	1	2
	Land ownership	2	2	1	1	2-3	1	1	2
	Land use	1-2	1-2	1	1	2-3	1	1	2

In addition to measuring various environmental and/or biological parameters, all sponsors should establish photo points to document changes within treatment and control sites. Annual photographs taken at the same locations within treatment and control areas both before and after treatment provide an excellent tool for demonstrating environmental effectiveness. Hall (2001) describes methods for documenting environmental change using photo points.

Identify Number of Sites and Years to Monitor

Estimating the number of sites and years to monitor can be a difficult and involved process for most monitoring programs. It usually requires an understanding of spatial and temporal variability of the parameter of interest, statistical decision rules (i.e., Type I and II errors), and effect sizes. Using this information, a "power analysis" can then be conducted to estimate the number of sites and years to monitor. There are a number of tools that can be use to estimate total sample size. Cohen (1988) provides tables and equations for calculating sample sizes. Various computer packages also estimate sample sizes, such as PASS 2000, SYSTAT, and Methodologist's Toolchest.[68] It is recommended that the investigator use the method that meets their particular needs. See Hillman (2006; pages 22-26) for a more detailed discussion on choosing sample sizes for effectiveness monitoring.

Answers to the following questions will help investigators estimate sample sizes.

1. What is the statistical population(s) to be sampled?
2. How will sampling units be identified in the study?
3. How many sampling units make up the sampling frame?
4. What is considered "practical significance" (i.e., what size of change is acceptable or unacceptable?)?
5. How will effect sizes be detected?
6. What is the variability or estimated variability of the statistical population(s)?
7. What Type I and II errors will be used in statistical tests?

Determine Sampling Scheme

Before initiating monitoring, one needs to determine the methods (protocols) and spatial allocation of sampling within a site or study reach. Hillman (2006) identifies methods for measuring environmental and biological parameters. For spatial allocation of sampling, it is recommended that all treatment sites and their corresponding control sites be sampled completely (complete census). However, in some situations, it may not be feasible to sample the entire treatment reach. For example, restoration projects such as nutrient enrichment and large conservation easements may extend for several stream kilometers, making a complete census impossible or expensive. In this case, a sub-sampling strategy (scheme) that reduces effort but provides unbiased estimates of treatment effects is necessary. Although no one sampling design is best for all situations, the preferred approach is a simple random sample or stratified random sample. The optimal sampling design will depend on the spatial arrangement of the parameters of interest and the logistics of moving between locations and collecting samples (see discussion in Hillman 2006; pages 19-22).

[68] The use of trade or firm names in this plan is for reader information only and does not imply endorsement by an agency or the SRSRB of any product or service.

Answers to the following questions will help investigators identify measurement methods.

1. What methods and instruments will be used to measure indicators?
2. What is the precision of each measuring instrument?
3. What effects will the measuring instrument have on the sampling units?
4. How will the study deal with an instrument that affects the sampling unit?
5. What steps will be taken to minimize systematic errors?
6. What will be the sampling frequency for each measurement?

Data Management, Analysis, and Reporting

Data acquisition, management, and analysis are key parts of any effectiveness monitoring program. This includes determining how the data will be entered and stored in a database and making sure the database is consistent with the field forms. Because observer error can be quite large, it is important that field crews understand how data are to be collected. Tools such as data loggers and computer clipboards can simplify entering data into a database but may be expensive and complicate field data collection.

Before collecting data, it is important to consider how the data will be analyzed and what statistical methods should be used. Before-after and BACI designs are well suited to t-tests, analysis of variance, regression, and time series methods. It is also important to use graphical methods to analyze data.

If the Board, managers, and funding entities are to learn from restoration activities, monitoring results should be reported to both the scientific community and the general public. Regardless if a restoration project is a success or failure, it is important to report the findings. Often failures go unreported. To avoid making the same mistakes in the future, it is probably just as important to report failed efforts as successes.

The steps outlined above should be carefully considered when designing a monitoring plan to assess the effectiveness of any recovery action, regardless of how simple the proposed action may be. Even monitoring the effectiveness of irrigation screens requires careful consideration of all steps in the outline. In some cases, the investigator may not be able to address all steps with a high degree of certainty, because adequate information does not exist. For example, one may lack information on population variability, effect size, “practical significance,” or instrument precision. In this case the investigator can address the questions with the best available information, even if it is based on professional opinion, or design a pilot study to answer the questions.

More detailed guidance can be found in Hillman (2005 and 2006). Hillman (2005) provides detailed guidance to investigators interested in determining if a given project has affected the environmental parameters that were the target of the action. That document addresses all sorts of recovery actions, including riparian restoration, floodplain restoration, instream habitat restoration, restoration of connectivity, instream diversion restoration, and acquisitions and conservation easements. Hillman (2006) provides guidance to investigators interested in determining if a given project has affected environmental and biological parameters at different spatial scales. Both guidance documents were written for monitoring projects to be implemented in the Upper Columbia Basin.

C.6 DATA MANAGEMENT

A large volume of data will be generated in the southeast Washington State recovery area as part of the Recovery Plan. Summarizing these data based on how, when, and where they were collected, supporting a range of analytical methods, and adapting to changing requirements in the future is critical. An example of a large-scale data storage process is the Integrated Status and Effectiveness Monitoring Program (ISEMP). Currently ISEMP is creating systems of data processing, storage, analysis, reporting, and distribution to meet the needs of managers and analysts in various subbasins within the Columbia Basin. This plan recommends that either these systems or others like it be used to manage the large volume of data generated as part of the Recovery Plan. In addition, the plan calls for close coordination between these programs and the Northwest Environmental Data-Network (NED; http://www.nwcouncil.org/ned/Default.asp) and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) data management workgroup (http://www.pnamp.org/web/content.cfm?WorkGroupID=5).

The ISEMP data management system is far along in development. The ISEMP system is presently housed and managed by NOAA Fisheries at the Science Center in Seattle. The ISEMP system is currently funded by BPA and NOAA Fisheries. Below is a brief summary of the ISEMP data management system (from Chapter 6 in Terraqua 2006). A detailed description of each system can be found at http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/mngt.cfm.

Data Management Strategy

The ISEMP has standardized data communication and flow through the development of a generic STEM Databank, the Aquatic Resource Schema (ARS) to manage the metadata, and Archive Template Modules (ATMs) that facilitate the field data collection, data uploading, and communication between elements. The data management elements together define a standardized data structure for storing, sharing, and analyzing fish, water quality, stream habitat, and landscape classification data. The several component processes and structures operate as step-wise functions to enter, manage, summarize, and distribute aquatic resource field data and metadata (Table C-11; Figure C-3).

Table C-11. Functions and component processes and structures of the ISEMP data management strategy.

Functions	Component processes and structures
Track and catalog data collection methodologies	Protocol Manager
Standardize field data collection	Standardized protocols and methodologies data dictionary
Organize data at the local (e.g., field collector, agency) level	ATMs – archive template modules
Facilitate efficient transfer of data	Programming code between ATMs and STEM Databank
Archive data in secure, centralized repositories	STEM Databank and Geospatial Databases
Organize data within centralized repositories	ARS – Aquatic Resource Schema; other schemas
Facilitates the interaction between centralized repositories	Programming code between STEM Databank Geospatial Databases
Facilitate data manipulation (e.g., summarization, metric calculation, basic analyses) within the repositories	Programming code within STEM Databank and Geospatial Databases
Facilitate efficient output of data to data analysts and other users	Website and other media (e.g., DVDs)
Train system users in the use of each component of the data management system	Demonstrations, workshops and training sessions

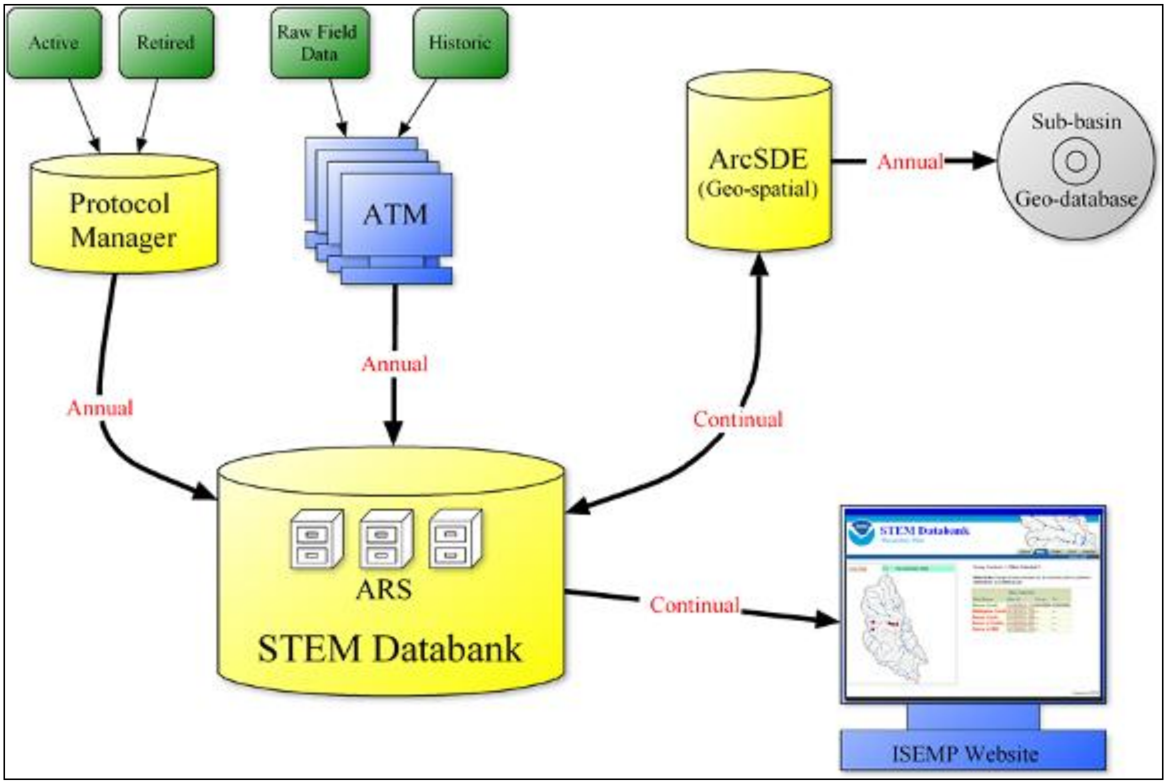


Figure C-3. An illustration of data flow and data structures under the ISEMP data management strategy (from Terraqua 2006).

Protocol Manager

The first step in the data management system is the management of the scientific protocols used in monitoring. Protocols refer to suites of methodologies used by researchers to collect information about an ecosystem. Tracking protocols in a large-scale monitoring program is important because the quality of observational data can vary by protocol and, often, data from one protocol is not compatible with data from alternative protocols. A Protocol Manager (PM), developed by the Bureau of Reclamation and Nation Park Service was adopted to perform the necessary protocol management function. The PM tool is also being adopted by PNAMP in an attempt to prescribe standardized methods for field data collection across a regional scale. PM increases the ease, accuracy, and efficiency of documenting protocols by allowing users to select from existing protocols, modifying existing protocols, or creating new protocol documentation. All data stored within the ATMs and the STEM Databank are associated with a method catalogued in PM, which allows automated access to full metadata descriptions of every value within the databases. The synchronization of PM with the STEM Databank supports efficient protocol comparisons, site comparisons, or analysis of functional relationships.

Archive Template Modules (ATMs)

ATMs are small databases functioning at the agency or desktop scale operated by field data collectors that facilitate data entry and quality control and can perform database functions specific to recovery plan reporting needs. ATMs ensure data integrity by requiring metadata to be documented before observation values can be entered, and by forcing entered values to conform to the specifications of the protocol. Most importantly, ATMs provide a standard procedure to deposit data into the STEM Databank; simple output queries operated within the ATMs produce tables that are directly loaded into the STEM Databank without the need for additional formatting or filtering.

ATMs for water quality, stream habitat, and fish abundance currently exist and consist of a set of data entry forms, data tables, and summary queries built according to the ARS (Figures C-4 and C-5). Additional ATMs will be created to handle other types of data (e.g., macroinvertebrate). The ATMs were developed with Microsoft Access and they expand upon PM by not only tracking protocol and method information, but also managing attribute, domain, and range information for each data element. The ATMs are flexible and popular among data collectors.

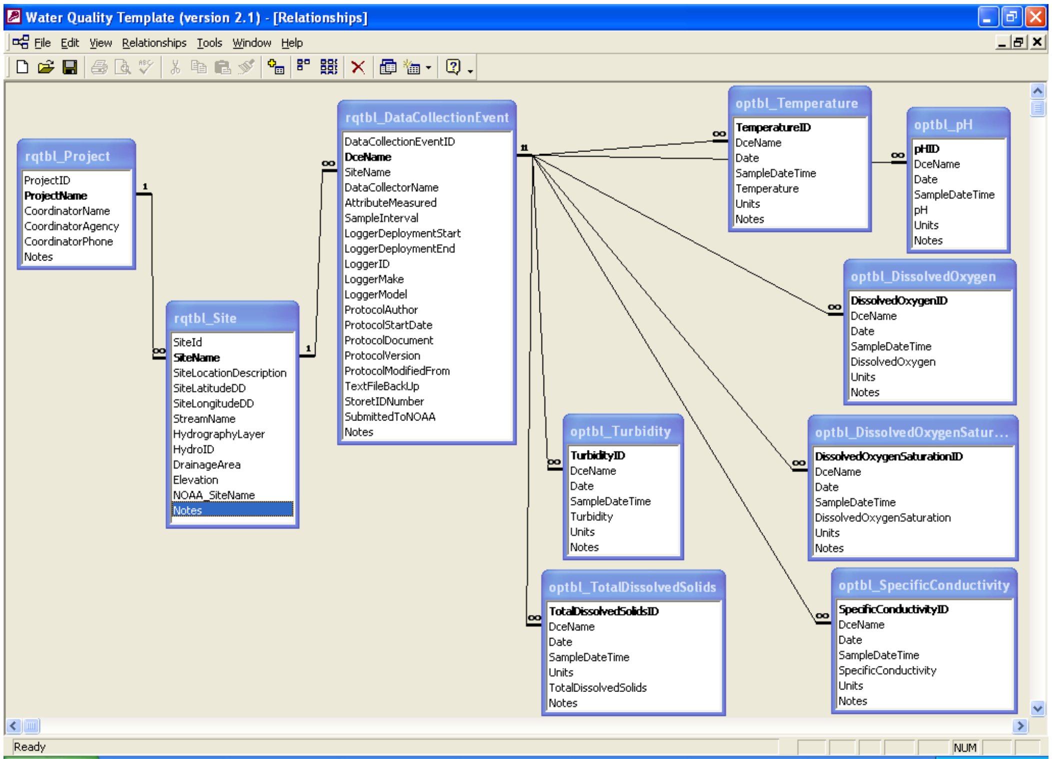


Figure C-4. An example schematic of an ATM (from Terraqua 2006).

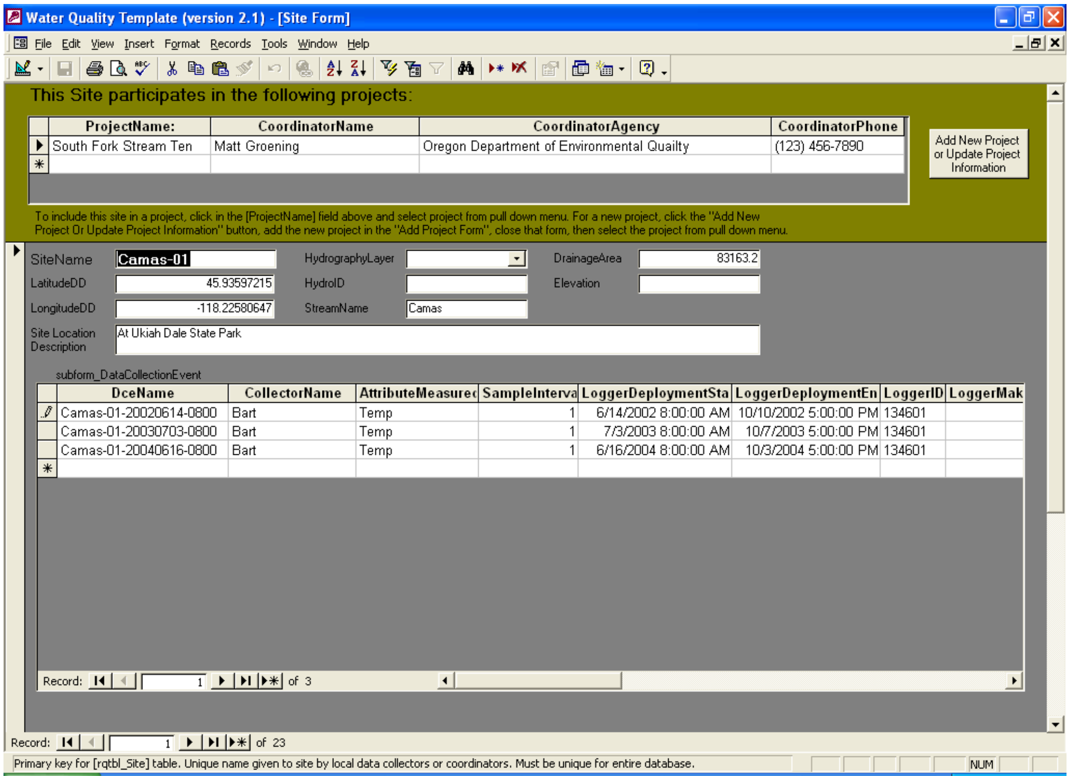


Figure C-5. An example of a data entry form that allows for easy data entry for field staff and provides data validation (from Terraqua 2006).

The STEM Databank

The STEM Databank is the central data repository and provides data validation, long-term storage and back-up, and supports multi-users and a web-based user interface. It was developed to:

- Accommodate large volumes of data from multiple agencies and projects;
- Track protocols and methods for all stored data;
- Support a range of analytical methods;
- Develop a web-based data query and retrieval system;
- Adapt to changing requirements.

The architecture of the databank was designed to be very flexible, allowing the addition or removal of attributes without modifying the underlying structure of the repository. The Databank flexibility also allows the integration of data from external electronic sources that are needed for recovery needs (e.g., National Resource Information System, Streamnet, or EPA’s Water Quality Data Exchange). These features have been accomplished by normalizing the STEM Databank architecture and the use of the ARS. A normalized relational database architecture means that data are organized and stored with the minimal redundancy of attributes possible that retains all metadata associated with a unique value. Note that it is possible for the STEM Databank to store data according to other schemas, as long as they are consistent with the ISEMP ARS.

The STEM Databank has several key characteristics, including:

- Data summary in a variety of formats to meet most reporting and analytical requirements;
- Built-in functions calculate standard metrics and generate standard summary statistics;
- Synchronized with PM to enhance data analysis by having protocols attached to individual data values;
- Synchronized with the ATMs for automated upload of field data;
- Synchronized with the geospatial databases in the ArcSDE software environment.

ARS and Other Schemas

The ARS is a database structure that was developed to organize the ISEMP data within the STEM Databank and to serve as a template to support non-ISEMP agencies within the Columbia River Basin in managing, documenting, and analyzing aquatic resource data. The ARS resulted from a design process that focused on development of small-scale, data type specific prototypes, employing ecologist to test the prototypes, gathering input from other database designers, and then integrating the lessons learned. The ARS improves upon previous efforts by imposing a structure on the data that is robust against protocol variation, by supporting the development of cross-walks between protocols (cross-walks define the process for transforming an attribute measured under one methodology to a roughly equivalent value if the attribute had been measured under an alternate methodology), and by defining relationships inherent to the data. The primary characteristics of the ARS include:

- It is a data model that is robust against variations in data collection protocols. The ARS assumes that data collection protocols will vary depending on the resource management questions being addressed and that protocols will continue to evolve over time as both scientific understand and measurement methodologies evolve;
- It supports procedures for ensuring increased data integrity at the time of data entry;
- It supports proper analysis and summarization of aquatic resources data.

The ARS includes tables for documenting projects, sites, statistical designs, data collection events, sampling units, observations, and measurement methodology. The database schema requires that appropriate metadata about field observations be recorded before entering field data into the database. The schema requires that a statistical design, a site, and a protocol exist before data collection events can be created, and that a data collection event exists before observations of water quality, fish abundance, or stream habitat can be created. This referential integrity helps to ensure data integrity at the time of data entry. Additionally, metadata about the data collection protocol and measurement methodologies are used to place restrictions on data entry forms, thereby providing data validation at the time of data entry and ensuring consistency between a protocol and data entered under that protocol.

Geospatial Databases

Geodatabases are databases designed to store geospatial data (i.e., “GIS data layers”) in a standardized format. This format maintains the integrity of metadata and the geographic projections that define the spatial coordinate system. The unique ability of geodatabases to define spatially explicit relationships between data elements allows geodatabases to support advanced spatial analyses.

The ISEMP uses two types of geodatabases: an enterprise geodatabase and personal geodatabases. The enterprise geodatabase is an Oracle database managed through the ESRI ArcSDE software that is maintained on a central server at NOAA Fisheries. The enterprise geodatabase acts as the primary archive of geospatial data, stores geospatial data for regional scale analyses, and provides the spatial context for data stored in the STEM Databank. The STEM Databank maintains links to the enterprise geodatabase through the use of unique identifiers, which allow monitoring data in the STEM Databank to be represented and analyzed in a spatial context.

Personal geodatabases are desktop-scale databases (Microsoft Access database managed through the ESRI ArcCatalog software) designed to facilitate the distribution of geospatial data (the small size of personal geodatabases means they can be distributed via DVDs) and to support subbasin specific analyses. Personal geodatabases are also used to develop and troubleshoot spatial analysis procedures, which can later be implemented on the enterprise geodatabase. For example, the Wenatchee geodatabase was used to define the process of characterizing monitoring sites and upstream catchments. Now that the process has been defined, it can be replicated on the central server using the enterprise geodatabase and performed for other sites throughout the region.

Data Distribution

The current system facilitates data distribution through the ISEMP website, STEM Databank website linkages, geodatabases, the ATMs, and by other media. The ISEMP website (http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/?CFID=31055621&CFTOKEN=73780522&jsessionid=643090c2f7705e3e7334) is accessible by the public and contains documents, such as annual reports and presentations, map products, and data management tools. This website will eventually contain links to the STEM Databank interface when that tool is ready for public use.

C.7 REFERENCES

AHSWG (*Ad Hoc* Supplementation Workgroup). Beasley C. A , B. A. Berejikian, R. W. Carmichael, D. E. Fast, M. J. Ford, P. F. Galbreath,J. A. Hesse, L. L. McDonald, A. R. Murdoch, C. M. Peven, and D. A. Venditti. 2008. Recommendations for Broad Scale Monitoring to Evaluate the Effects of Hatchery Supplementation on the Fitness of Natural Salmon and Steelhead Populations. Final Report. 82 pgs

Bumgarner, J., L. Ross, and M. Varney. 2000. Lower Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1998 and 1999 Annual Reports to U.S. Fish and Wildlife Service, Cooperative Agreements 1448-14110-98-J057 and CA-14110-9-J070. Washington Department of Fish and Wildlife, Olympia, Washington. Report # FPA00-17.

Bumgarner, J and J. Dedloff. 2009. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead and Trout Report 2006 and 2007 run year. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID.

BURPTAC (Beneficial Use Reconnaissance Project Technical Advisory Committee). 1999. 1999 beneficial use reconnaissance project workplan for wadable streams. Idaho Division of Environmental Quality, Boise, ID. Web link:http://www.deq.state.id.us/water/surface_water/99_burp_workplan.pdf

Cohen, J. 1988. Statistical power analysis for the behavioral sciences. Lawrence-Erlbaum, Hillsdale, NJ.

Crawford, B.A., and S. Rumsey. 2009. Guidance For Monitoring Recovery of Pacific Northwest Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). **DRAFT**. NOAA Fisheries, Northwest Region, Portland, OR. 129 pages.

Gallinat, M. P., J. D. Bumgarner, L. Ross, and M. Varney. 2001. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2000 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 1411-09-J070. Washington Department of Fish and Wildlife, Olympia, Washington. Report # FPA01-05.

Gallinat, M. P, and L. A. Ross. 2009. Tucannon River spring Chinook hatchery evaluation program. 2008 Annual Report. WDFW report to the USFWS Lower Snake River Compensation Plan Offices, Boise, ID.

Hall, F. C. 2001. Photo point monitoring handbook: part A—field procedures. USDA, General Technical Report PNW-GTR-526, Portland, OR. http://www.fs.fed.us/pnw/pubs/gtr526/

Hatchery Scientific Review Group (HSRG)–Lars Mobrand (chair), John Barr, Lee Blankenship, Don Campton, Trevor Evelyn, Tom Flagg, Conrad Mahnken, Robert Piper, Paul Seidel, Lisa Seeb and Bill Smoker. 2004. *Hatchery Reform: Principles and Recommendations of the HSRG*. Long Live the Kings, 1305 Fourth Avenue, Suite 810, Seattle, WA 98101 (available from www.hatcheryreform.org).

Hewett, S. W. and B. L. Johnson. 1992. Fish bioenergetics model 2: an upgrade of a generalized bioenergetics model of fish growth for microcomputers. WIS-SG-91-250, University of Wisconsin Sea Grant Institute, Madison, WI.

Hillman, T. W. 2005. Project monitoring: a guide for sponsors in the Upper Columbia Basin. First edition. BioAnalysts, Inc. Prepared for Chelan County Natural Resource Department, Wenatchee, WA.

Hillman, T. W. 2006. Monitoring strategy for the Upper Columbia Basin. Second draft report. BioAnalysts, Inc. Prepared for the Upper Columbia Salmon Recovery Board, Bonneville Power Administration, and the National Marine Fisheries Service.

Holling, C.S. 1978. Adaptive environmental assessment and management. John Wiley and Sons, New York, N.Y.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2005. Interior Columbia Basin TRT: viability criteria for application to interior Columbia Basin salmonid ESUs. NOAA Fisheries Northwest Fisheries Science Center, Seattle, WA.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2007. Viability Criteria for application to interior Columbia Basin salmonid ESUs. Review draft. NOAA Fisheries Northwest Fisheries Science Center, Seattle, WA.

Johnson, G. E., H. L. Diefenderfer, B. D. Ebberts, C. Tortorici, T. Yerxa, J. Leary, and J. R. Skalski. 2008. Research, monitoring, and evaluation for the Federal Columbia River Estuary Program. Pacific Northwest National Laboratory. Prepared for Bonneville Power Administration, Portland, OR.

Jordan, C., and 37 others. 2003. Research, monitoring and evaluation plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion. NOAA Fisheries, Bonneville Power Administration, Army Corps of Engineers, and Bureau of Reclamation, Portland, OR.

Katz, S. L., K. Barnas, and S. Toshach. 2006. Data management needs for regional project tracking to support implementation and effectiveness monitoring. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, WA.

Kaufmann, P. R., P. Levine, E. G. Robinson, C. Seeliger, and D. V. Peck. 1999. Quantifying physical habitat in wadeable streams. EPA/620/R-99/003, U.S. Environmental Protection Agency, Washington, D.C. eb link: http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/phyhab.html

Keefer, M.L, C.C Caudill, C.A Peery, and C.T. Boggs. 2008. Non-direct homing behaviours by adult Chinook salmon in a large, multi-stock river system. Journal of Fish Biology (2008) 72, 27–44

Larson, D. P., A. R. Olsen, and D. L. Stevens, Jr. 2007. The concept of a master sample and its use as a framework for integrating stream monitoring programs. Paper submitted for publication. U.S. Environmental Protection Agency, Corvallis, OR.

Lazorchak, J. M., D. J. Klemm, and D. V. Peck (editors). 1998. Environmental monitoring and assessment program—surface waters: field operations and methods for measuring the ecological condition of wadeable streams. EPA/620/R-94/004F, U.S. Environmental Protection Agency, Washington, D.C. Web link:
http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/ws_abs.html

Lee, K.N. 1993. Compass and gyroscope; integrating science and politics for the environment. Island Press, Washington, D.C.

Mahoney B. D., Glen Mendel, Michael Lambert, Jeremy Trump, Preston Bronson, Michael Gembala and Michael Gallinat. 2009. Walla Walla Subbasin Collaborative Salmonid Monitoring and Evaluation Project: 2007 and 2008 Annual Report. Confederated Tribes of the Umatilla Indian Reservation and Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2000-039-00.

Mayer, K., M. Schuck, and P. Iversen. 2010. Assess salmonids in the Asotin Creek watershed. 2009 Annual report. Washington Department of Fish and Wildlife, Report submitted to Bonneville Power Administration, Project No. 2002-053-00.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmon populations and the recovery of evolutionarily significant units U.S. Department of Commerce, NOAA Technical Memo, NMFS-NWFSC-42, 156.

Moberg, J. 2007. A field manual for the habitat protocols of the Upper Columbia monitoring strategy. Terraqua, Inc. Prepared for the Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program, Portland, OR.

Mobrand, L.E., J. Barr, L. Blankenship, D.E. Campton, T.T.P. Evelyn, T.A. Flagg, C.V.W. Mahnken, L.W. Seeb, P.R. Seidel, and W.W. Smoker. 2005. Hatchery reform in Washington state: principals and emerging issues. Fisheries 30:11-23.

Moore, K., K. Jones, and J. Dambacher. 2002. Methods for stream habitat surveys; aquatic inventory project. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Natural Production Program, Corvallis, OR. Web link:
http://oregonstate.edu/Dept/ODFW/freshwater/inventory/methods.html

Morghan et al. 2006 (need from NMFS)

Murdoch, A. and C. Peven. 2005. Conceptual approach to monitoring and evaluating the Chelan County Public Utility District Hatchery Programs. Prepared for the Chelan PUD Habitat Conservation Plan's Hatchery Committee, Wenatchee, WA.

Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992. Production and habitat of salmonids in Mid-Columbia River tributary streams. U.S. Fish and Wildlife Service Monograph I, Leavenworth, WA.

NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. The National Marine Fisheries Service, Environmental Technical Services Division, Habitat Conservation Branch, Seattle, WA.

NMFS (National Marine Fisheries Service). 2008a. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. ("FCRPS BiOp") NMFS, Portland, Oregon. Available at http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm

NMFS (National Marine Fisheries Service). 2008b. Upper Columbia spring Chinook salmon and steelhead monitoring and evaluation plan. Working Draft. Appendix P to Upper Columbia spring Chinook and steelhead recovery plan.

OPSW (Oregon Plan for Salmon and Watersheds). 1999. Water quality monitoring, technical guide book. Version 2.0. Corvallis, OR. Web link: http://www.oweb.state.or.us/publications/index.shtml

Overton, C. K., S. P. Wollrab, B. C. Roberts, and M. A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) fish and fish habitat standard inventory procedures handbook. USDA Forest Service General Technical Report INT-GTR-346, Ogden, UT.

Parker, M. A. 2000. Fish passage – culvert inspection procedures. Watershed Restoration Technical Circular No. 11. Ministry of Environment, Lands and Parks and Ministry of Forest, British Columbia.

Parmenter, A. W., A. Hansen, R. E. Kennedy, W. Cohen, U. Langener, R. Lawrence, B. Maxwell, A. Gallant, and R. Aspinall. 2003. Land use and land cover in the greater Yellowstone ecosystem: 1975-1995. Ecological Applications 13:687-703.

Peck, D. V., J. M. Lazorchak, and D. J. Klemm. 2001. Environmental monitoring and assessment program—surface waters: western pilot study field operations manual for wadeable streams. Draft Report. EPA/XXX/X-XX/XXX, U.S. Environmental Protection Agency, Washington, D.C. Web link: http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/ewwsm01.html

Peven, C. M. 1990. The life history of naturally produced steelhead trout from the mid-Columbia River Basin. M.S. thesis. University of Washington, Seattle, WA.

Peven, C., A. Giorgi, J. Skalski, M. Langeslay, A. Grassell, S. G. Smith, T. Counihan, R. Perry, and S. Bickford. 2005. Guidelines and recommended protocols for conducting, analyzing, and reporting juvenile salmonid survival studies in the Columbia River Basin. Chelan County Public Utility District, Wenatchee, WA.

Reeves, G. H., and nine others. 2001. Aquatic and riparian effectiveness monitoring plan for the Northwest Forest Plan. USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR.

Roni, P., editor. 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, MD.

Roni, P., M. C. Liermann, C. Jordan, and E. A. Steel. 2005. Steps for designing a monitoring and evaluation program for aquatic restoration. Pages 13-34 *in*: Roni, P., editor. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, MD.

Schuett-Hames, D., R. Conrad, A. Pleus, and M. McHenry. 1999. Method manual for the salmonid spawning gravel composition survey. Timber-Fish-Wildlife TFW-AM9-99-006, Northwest Indian Fisheries Commission, Olympia, WA. Web link: http://www.nwifc.wa.gov/TFW/documents.asp

Stevens, D. L. 2002. Sampling design and statistical analysis methods for the integrated biolgocial and physical monitoring of Oregon streams. Report No. OPSW-ODFW-2002-07, The Oregon Plan for Salmon and Watersheds, Oregon Department of Fish and Wildlife, Corvallis, OR.

Terraqua. 2006. A review of the integrated status and effectiveness monitoring program: 2003-2006. Report to Bonneville Power Administration, Portland, OR. http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/docs_isemp.cfm

Walters, C. 1986. Adaptive management of renewable resources. Macmillan Press, New York, N.Y.

WDFW (Washington Department of Fish and Wildlife). 2000. Fish passage barrier and surface water diversion screening assessment and prioritization manual. Washington Department of Fish and Wildlife Habitat Program, Environmental Restoration Division, Olympia, WA. Web link: http://www.wa.gov/wdfw/hab/engineer/fishbarr.htm

WFC (World Forestry Center). 1998. Pilot study report, Umpqua land exchange project. World Forestry Center, Portland, OR. Web link: http://www.or.blm.gov/umpqua/documents.htm

WFPB (Washington Forest Practices Board). 1995. Washington forest practices board manual: standard methodology for conducting watershed analysis under Chapter 222-22 WAC. Version 3.0. Washington Forest Practices Board, Olympia, WA. Web link: http://www.dnr.wa.gov/forestpractices/watershedanalysis/

WSRFB (Washington Salmon Recovery Funding Board). 2003. Draft 5/16/2003 monitoring and evaluation strategy for habitat restoration and acquisition projects. Washington Salmon Recovery Funding Board, Olympia, WA. Web link: http://www.iac.wa.gov/srfb/docs.htm

Zaroban, D. W. 2000. Protocol for placement and retrieval of temperature data loggers in Idaho streams. Idaho Division of Environmental Quality, Boise, ID. Web link: http://www.deq.state.id.us/water/tlp.htm

APPENDIX D HATCHERY MANAGEMENT SNAKE RIVER SALMON RECOVERY PLAN SOUTHEAST WASHINGTON STATE MANAGEMENT UNIT

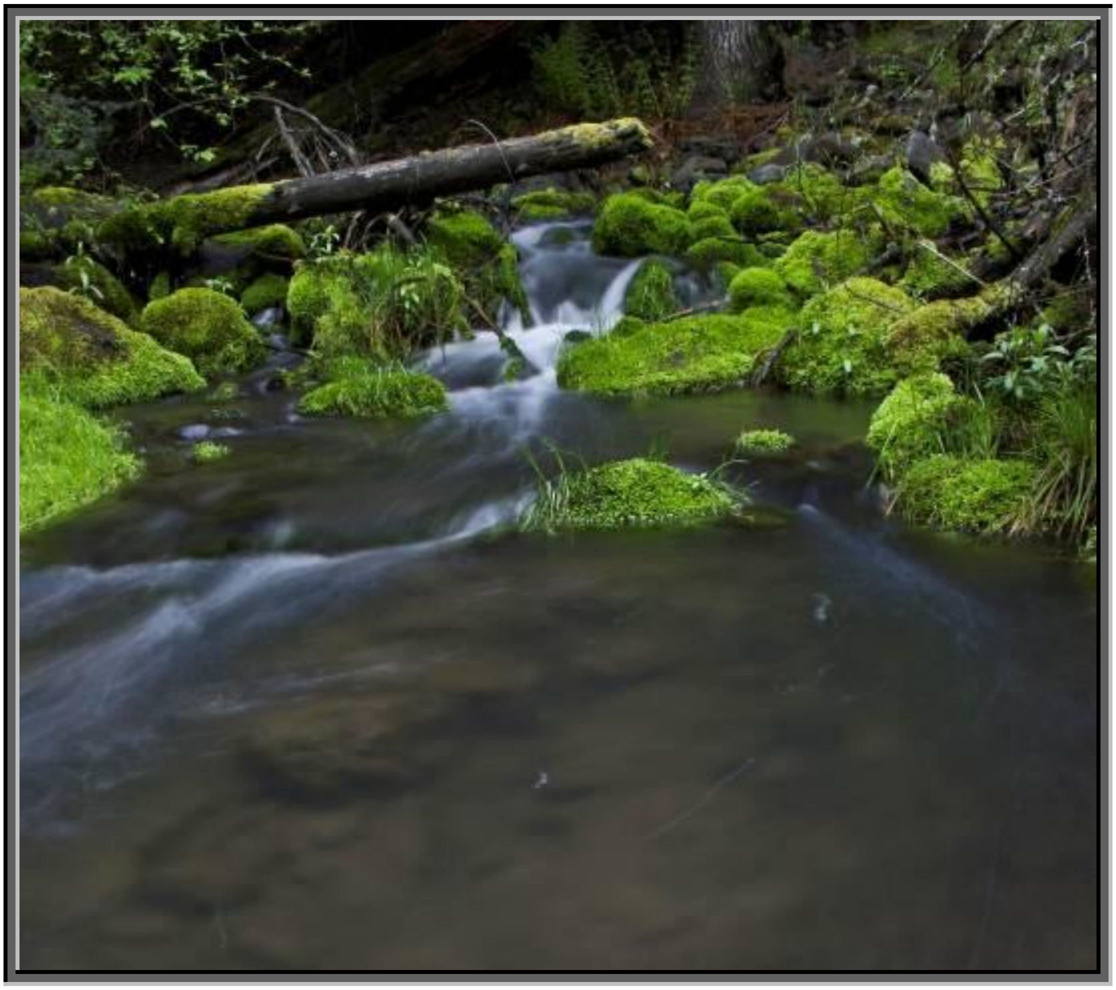


Table of Contents – Appendix D

Hatchery Management SRSR Plan SEWMU

Table of Figures – Appendix D

List of Tables – Appendix D

Appendix D - Hatchery Management Snake River Salmon Recovery Plan Southeast Washington State Management Unit

December 2010

D.1 GLOSSARY AND ACRONYMS

The following are definitions of terms and acronyms used throughout this chapter:

BiOp Biological Opinion

BPA Bonneville Power Administration

Broodstock Adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.

CWT coded-wire tag

Conservation Program

An artificial propagation program that conserves genetic resources. The intent of a conservation program is to increase the number of individuals in an ESU or steelhead DPS and reduce the short term extinction risk (also see "supplementation").

DPS Distinct Population Segment

ESU Evolutionary Significant Unit

FCAP Fall Chinook salmon Acclimation Program

HGMP Hatchery Genetic Management Plan

HOF Hatchery Origin Fish - any fish produced by a hatchery, but typically referring to returning adults

HOS Hatchery Origin Spawners - hatchery-origin fish that spawn in the natural environment

HSRG Hatchery Scientific Review Group

IPC Idaho Power Company

Integrated hatchery program

An artificial propagation program that includes natural-origin fish as broodstock. Typically also has returning HOF spawning in the natural environment.

ICTRT Interior Columbia Technical Recovery Team

LSRCP Lower Snake River Compensation Plan

LFFCP Lyons Ferry Fall Chinook salmon Program

LFH Lyons Ferry Hatchery

LFHC Lyons Ferry Hatchery Complex

LGD Lower Granite Dam

MAT Minimum Abundance Threshold

Mitigation In this sense, a process by which hatchery programs are used to compensate for construction and operation of hydroprojects on the mainstem Snake and Columbia rivers.

MPG Major Population Group

Naturally produced Progeny of fish that spawned in the natural environment, regardless of the origin of the parents.

NOAA National Oceanic & Atmospheric Administration

NOB Natural Origin Broodstock

NOF Natural Origin Fish - fish resulting from spawning in the natural environment, regardless of the origin of the spawners.

NOS Natural Origin Spawners

NMFS National Marine Fisheries Service

pHOS Proportion of Hatchery Origin Spawners

PNI Proportionate Natural Influence - in a population influenced by a hatchery, the expected equilibrium value for a trait relative to the natural optimum as per the model of Ford (2002).

pNOB Proportion of Natural Origin Broodstock

SEWMU In this paper, the SEWMU is defined as Souteast Washignton State, encompassing the Walla Walla, Snake, Tucannon, Asotin, and portion of the Grande Ronde basins within Washington State.

R/S Return per spawner

RRS (Relative reproductive success)

The relative ability of hatchery spawners to produce viable offspring under natural conditions; typically calculated as the number of offspring produced per hatchery spawner divided by the number of offspring produced per wild spawner.

RM&E Research, monitoring, and evaluation.

RPA Reasonable and Prudent Alternative

Segregated hatchery program

	An artificial propagation program in which ideally no NOF are used as broodstock and returning adults are spatially or temporally isolated from the target population(s) so that the proportion of HOF on the spawning grounds is very low
SAR	Smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population or release.
SR	Snake River
SRSRB	Snake River Salmon Recovery Board
Stray rate	The rate at which hatchery produced fish return to areas they were not intended to return to and spawn (also see *wandering*).
Supplementation	A hatchery program strategy where hatchery fish are stocked into locations with the intention they return to these locations as mature adults, spawn naturally, and contribute to natural production.
TSCSP	Tucannon spring Chinook salmon supplementation program
TFH	Tucannon Fish Hatchery
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
VSP	Viable Salmonid Populations
Wandering	The phenomenon by which fish return to areas they were not intended to return to, which may lead to straying (spawning in the area they were not natal to) or continuing their migration to areas where they either spawned or were intended to return to.
Wild	A naturally produced fish, regardless of parentage

D.2 INTRODUCTION

D.2.1 Purpose and Role of this document

The purpose of this document is to provide information on hatchery programs within the Southeast Washington State recovery management unit (SEWMU) and how these hatchery programs support salmon and steelhead recovery within the SEWMU. The SEWMU encompasses the Snake River and its tributaries, including the Tucannon, Asotin, and lower Grande Ronde rivers. In addition, smaller tributaries also have anadromous fish (e.g., Alpowa Creek). The SEWMU also includes the Walla Walla subbasin (Figure 1).[69]

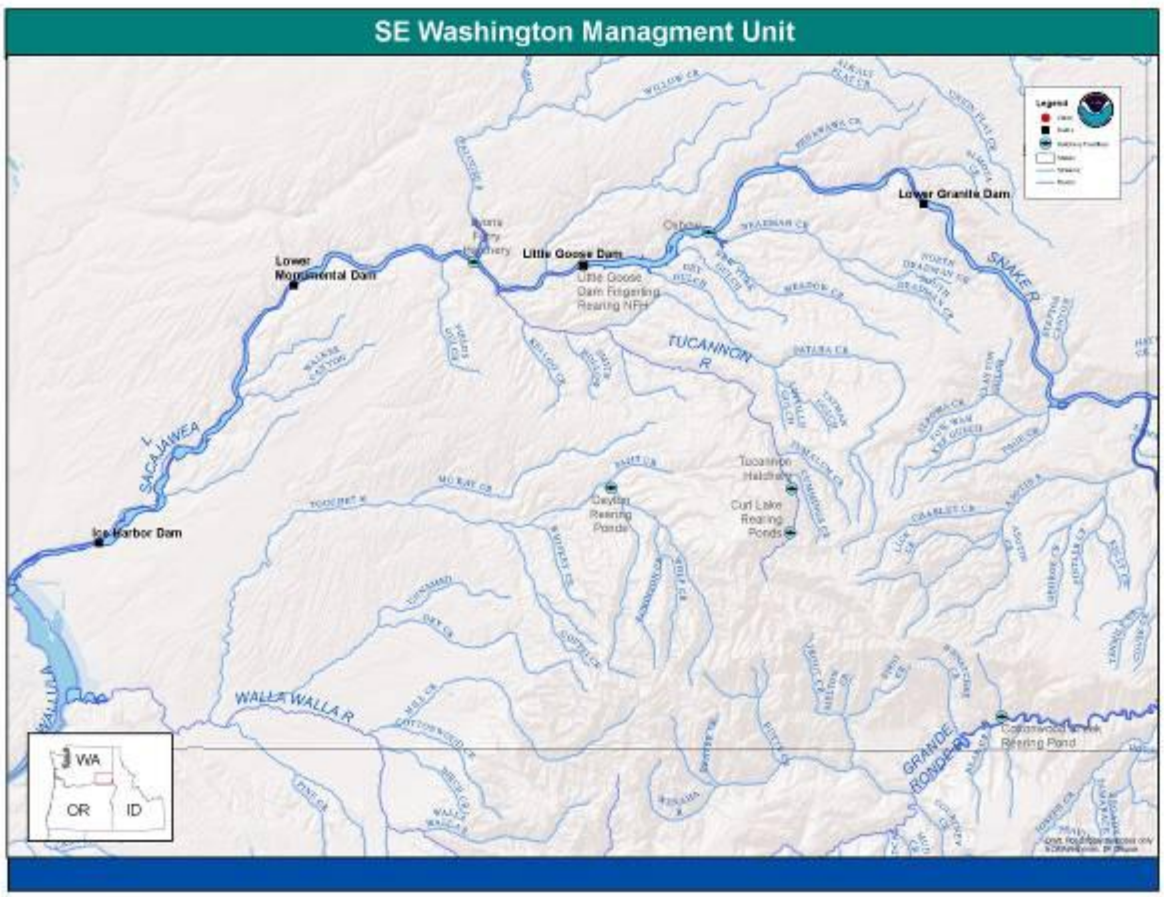


Figure D-1. The southeast Washington State recovery management unit.

[69] It is important to note that the steelhead (and spring Chinook salmon) in the Walla Walla River basin are not considered part of either the Snake River DPS (steelhead) or ESU (spring Chinook salmon). Therefore, any discussion on these programs is provided because of its geographic proximity and jurisdictional inclusion with the other species that make up the SEWMU from the Snake River basin. For further detail on status, scope of limiting factors, etc., please refer to the mid-Columbia steelhead recovery plan (NOAA Fisheries 2009).

D.3 USE OF HATCHERY PROGRAMS AND THE BENEFITS AND RISKS WHEN USED AS A TOOL FOR CONSERVATION AND RECOVERY

In general, the purpose of hatchery programs has historically been to produce fish to mitigate for lost habitat and habitat function from various perturbations and to increase harvest opportunities. In recent years, due to declines in population abundance resulting in ESA listings, the focus of many hatchery programs has shifted more to conservation based principles. However, many programs maintain a focus on increasing harvest opportunity for tribal and non-tribal stakeholders because of legal requirements.

The hatchery programs in Southeast Washington are part of the Lower Snake River Compensation Plan (LSRCP). The purpose of the LSRCP is to replace adult salmon, steelhead and rainbow trout lost by construction and operation of four hydroelectric dams on the Lower Snake River in Washington.

Hatchery programs are generally defined as either *conservation*[70] or *harvest augmentation* based. In many areas, programs have dual roles; when population abundance is low, they serve as conservation, and in higher abundance, as increasing harvest opportunities. In addition, as summarized by the hatchery scientific review group (HSRG) (2004), programs can be *integrated* with a natural spawning population, or *segregated* from one (Table D-1; see glossary for definition of integrated and segregated hatchery programs).

Table D-1. Different strategies of hatchery programs.

Purpose	**Natural population influence**	
	Integrated	Segregated
Conservation	√	
Harvest augmentation	√	√

Benefits (based on NOAA Fisheries 2008a)

Adult fish returning from prior hatchery releases have been helpful in maintaining or restoring historical fisheries, increasing the abundance to historical spawning habitat, and potentially adding spatial structure for the population. Recently, hatchery programs have become a tool to help improve viability as the other factors limiting viability (impacts from hydro, habitat, and harvest) are addressed.

Hatchery programs have also been used as a tool to conserve the genetic resources of depressed natural populations and to reduce short-term extinction risk. Hatchery programs can preserve the raw materials (i.e., genetic resources) that ESU and steelhead DPS conservation depends on. In this role, hatchery programs can reduce the risk of extirpation, and thereby diminish the immediacy of an ESU's extinction risk.

---

[70] Conservation hatcheries include "safety net," supplementation, and reintroduction programs.

Risks

However, it should be cautioned that benefits like those described above should be considered *transitory* or short-term and do not necessarily contribute to abundance and productivity changes needed to meet ICTRT viability criteria (for natural-origin fish). It is important to note that salmon and steelhead populations that rely on hatchery production are not considered viable, based on VSP parameters that are used to assess recovery (McElhany et al. 2000). Hatchery programs are not a proven technology for achieving sustained increases in natural-origin adult production (NRC 1996), and the long-term benefits and risks of hatchery supplementation remain untested (Araki et al. 2007).

Hatchery programs that conserve vital genetic resources are not without risk because the manner in which these programs are implemented can have significant impacts on the genetic structure and evolutionary trajectory of the target population by reducing population or ESU/DPS-level variability and patterns of local adaptation (ICTRT 2007). In fact, when hatchery programs are relied upon to conserve genetic resources and reduce short-term extinction risk, there likely is a trade-off between reducing short-term extinction risk and potentially increasing long-term genetic risk.

Summary from NOAA Fisheries (2008a):

> *Increasing knowledge and experience is another important factor in the application of hatchery supplementation. Hatchery supplementation is an "experimental" technology. It is relatively new and there is little data on long-term benefits and risks – study results for a single generation of Pacific salmon take a minimum of three to five years. The good news is that new information is emerging from ongoing research and important new research will be implemented as a result of NMFSs Biological Opinions. . . . NMFS intends that the information emerging from ongoing and new studies will shape future decisions over hatchery supplementation up and down the west coast.*

D.4 ROLES OF CO-MANAGERS AND SRSRB IN RELATIONSHIP TO HATCHERY PROGRAMS

Hatchery programs within the SEWMU are managed by the Confederated Tribes of Umatilla Indian Reservation (CTUIR), the Nez Perce Tribe (NPT), the Washington Department of Fish and Wildlife (WDFW), and the U.S. Fish and Wildlife Service (USFWS), collectively called the co-managers. Since most of the populations of anadromous fish within the SEWMU are listed under the ESA, NOAA Fisheries is responsible for issuing permits for the hatchery programs and thus has a large influence on how the programs are managed.

These programs are managed through the Lower Snake River Compensation Program (LSRCP) and *US v OR*.[71] Funding is provided through BPA and Idaho Power Company (IPC), and program coordination by the USFWS (for programs under the LSRCP).

[71] For a definition of US v OR, please see the Harvest Module.

The Snake River Salmon Recovery Board (SRSRB) has an interest concerning the hatchery programs within the SEWMU, but no management authority. However, as an interested stakeholder, they may offer suggestions.

D.4.1 Review of hatchery programs

Hatchery Scientific Review Group

In the 2000s, the hatchery scientific review group (HSRG) was first developed to review and make recommendations for hatcheries in the Puget Sound region, and then the Columbia Basin. Their recommendations are not the only alternatives for hatchery programs to meet conservation and harvest goals. From the Policy Statement that accompanied the HSRG report to congress on the Columbia Basin (HSRG 2009):

> *The HSRG recommendations are technical and scientific in nature. They are not intended to be policy decisions, but rather their function is to inform policy decisions. They also are not mandates that carry the force of law or policy, and the intent is not for them to be a litmus test or the exclusive basis for deciding HGMPs or funding decisions. As such, any changes to hatchery programs in response to the recommendations must also be informed by and consistent with existing legal and policy mandates. These mandates include, but are not limited to, the following items:*

- *Legislatively authorized and mandated mitigation obligations of the FCRPS and other dams to provide fish. The mitigation obligations associated with the FCRPS and other dams are substantial and continuing into the future;*
- *Legally mandated harvest agreements in (U.S. v. Oregon, Pacific Salmon Treaty) and tribal treaty trust reserved fishing rights;*
- *Logistical challenges and facility constraints;*
- *Funding needs for new infrastructure and operating budgets (which have been stagnant or decreasing) necessary for implementation and appropriate M&E.*

This list is not complete but it conveys the magnitude of the management issues, goals, and decisions that have been made and are being made by the states, tribes, and federal agencies at the same time that this effort was proceeding.

While the HSRG recommendations are not legally binding, many agencies have adopted some of the recommendations and have begun the process of trying to meet agreed upon targets recommended by the HSRG.

Hatchery Review Team

U.S. Fish and Wildlife Service (USFWS) initiated a series of hatchery reviews in May 2005 to assure that its hatchery programs in the Northwest are part of a scientifically sound and integrated strategy — consistent with State, Tribal, and other Federal strategies — for conserving wild stocks and managing fisheries in watersheds within the Region.

The USFWS's Hatchery Review Team (HRT) completed their reviews of the LSRCP hatchery programs and facilities in Washington, Oregon, and Idaho (USFWS 2010). The HRT applied the HSRG's scientific framework and hatchery review tools to develop reform recommendations for each hatchery program.

D.5 BACKGROUND

Authorizing purpose

The hatchery programs in the SEWMU were authorized to mitigate for the construction of the lower four Snake River dams.[72] This process began with the Fish and Wildlife Coordination Act and culminated with the development of the Lower Snake River Compensation Plan; both of which are described below.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) of 1958 (48 Stat. 401, 16 U.S.C. 661 et seq. as amended) required an analysis of fish and wildlife impacts associated with federal water projects as well as compensation measures to avoid and/or mitigate for loss of or damage to wildlife resources (refer to Section 662 (b) of the Act). The USFWS and NMFS provided the U.S. Army Corps of Engineers (USACE) with a FWCA on the Lower Snake River Project in 1972. Using the FWCA, the USACE wrote a report to Congress in 1975 (USACE 1975) detailing losses of fish and wildlife attributable to the Project. Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (Public Law 94-587).

Lower Snake River Compensation Program

The Lower Snake River Compensation Plan is a congressionally mandated program pursuant to PL 99-662 and PL 103-316. Congress authorized the Lower Snake River Project on March 2, 1945 by Public Law 14, 79th Congress, First Session. The project was authorized under the Rivers and Harbors Act of 1945. It consists of Ice Harbor Dam, completed in 1962; Lower Monumental Dam, 1969; Little Goose Dam, 1970 and Lower Granite Dam, 1975. The project affected over 140 miles of the Snake River and tributaries from Pasco, Washington to upstream of Lewiston, Idaho. The authorized purposes of the project were primarily navigation and hydroelectric power production.

The LSRCP is funded by Bonneville Power Administration with power revenues. Funding is administered to the facility operators through the USFWS LSRCP Office. The WDFW administers and implements Washington's portion of the program. Specific mitigation goals include "in-place" and "in-kind" replacement of adult salmon and steelhead. The LSRCP program for steelhead and trout in

---

[72] In addition, one program (Walla Walla spring Chinook salmon) is authorized by the Mitchell Act (see Section 3.1 for reference to Mitchell Act.

Washington was begun in 1982 and for salmon in 1984. The LSRCP program in Washington has been guided by the following objectives:

1. Establish broodstock(s) capable of meeting egg needs,
2. Maintain and enhance natural populations of native salmonids,
3. Return adults to the LSRCP area which meet designated goals, and
4. Improve or re-establish sport and tribal fisheries.

Specific mitigation goals for the LSRCP were established in a three-step process. First the adult escapement that occurred prior to construction of the four dams was estimated. Second an estimate was made of the reduction in adult escapement (loss) caused by construction and operation of the dams (e.g., direct mortality of smolts, inundation of spawning habitat). Last, the catch to escapement ratio (4:1 for Chinook and 3:1 for steelhead) was used to estimate the future production that was forgone in commercial and recreational fisheries as a result of the reduced spawning escapement and habitat loss. Assuming that the fisheries below the project area would continue to be prosecuted into the future as they had in the past, LSRCP adult return goals were expressed in terms of the adult escapement back to, or above the project area. Other than the recognition that the escapements back to the project area would be used for hatchery broodstock, no other specific priorities or goals regarding how they might contribute to fisheries, be allowed to spawn naturally, or otherwise used was established in the enabling legislation or supporting documents.

Under the mitigation negotiations, local fish and wildlife agencies estimated a 48% cumulative loss rate to juvenile downstream migrants passing through the four lower Snake River dams. Hatchery production was designed to compensate for this 48% loss. It was expected that the remaining 52% of production would be produced through natural production. Unfortunately, natural populations and productivity experienced a significant decline resulting in the hatchery programs being refocused on conservation of the remnant natural production.

D.6 CURRENT HATCHERY PROGRAMS

Within the SEWMU, there are hatchery programs for spring/summer Chinook salmon (Tucannon River basin), fall Chinook salmon (Lyons Ferry Hatchery Complex, and associated acclimation facilities and direct releases upstream of LGR)[73], and steelhead (Walla Walla, Touchet, Tucannon, Grande Ronde basins and Lyons Ferry Hatchery; Figure 1-1). All of the hatchery programs in the SEWMU are authorized and funded through the Lower Snake River Compensation Program (LSRCP). In addition, these production programs are consistent with the 2008-2017 *U.S. vs OR* Management Agreement (Tables B1, B4A and B4B, Table B6).

HGMPs will be developed for each program, and will define to a greater degree the detailed components, facilities, and other important information concerning these hatchery programs. HGMPs are developed by the operating entities to describe the hatchery impact on listed species. NOAA uses the HGMPs as a basis for providing ESA coverage of hatchery operations through Section 7 consultations and Section 10 permits. The following is meant as a broad overview of the existing programs.

[73] This section will not review the Snake River fall Chinook salmon hatchery program. That information will reside in a separate appendix within the comprehensive Snake River Recovery Plan.

Tucannon Spring Chinook Salmon Supplementation Program

Under the mitigation negotiations for the LSRCP, local fish and wildlife agencies determined through a series of conversion rates of McNary Dam counts that 2,400 (2%) spring Chinook annually escaped into the Tucannon River. The agencies also estimated a 48% cumulative loss rate to juvenile downstream migrants passing through the four lower Snake River dams. The Tucannon spring Chinook hatchery program was designed to escape 1,152 adults back to the project area after a harvest of 4,608 (4x escapement goal) downstream. As such, 1,152 fish of Tucannon River origin needed to be compensated for, with the expectation that the other 1,248 (to meet the 2,400) would come from natural production. The agencies also determined through other survival studies at the time that a SAR of 0.87% was a reasonable expectation for spring and summer Chinook salmon. Based on that, it was determined that 132,000 fish should be produced by the LSRCP hatchery program to meet compensation needs. However, after it was apparent that not enough naturally produced fish were returning, the program goals were revised to be more conservation-based.

Goal

> *The immediate short-term (Conservation) goal of the program is to prevent extinction of the population and contribute to the re-building of the population for de-listing. The long-term (Mitigation) goal is to provide a total annual return of between 2,400-3,400 hatchery and natural origin fish back to the Tucannon River which should include at least 750 natural origin fish over an 10-year geometric mean (abundance viability threshold).*

Program history

The current hatchery supplementation program has used Tucannon River endemic stock since the program's inception in 1985. The Tucannon River stock was derived from fish captured at the TFH adult trap. The Biological Opinion issued by NMFS on the Tucannon River spring Chinook salmon program (NMFS 1995) considered the supplementation program to be important in reducing the risk of extinction of natural spring Chinook salmon within the Tucannon River.

It has been observed that about 24% of the adult Tucannon River spring Chinook salmon that had been PIT tagged as juveniles bypassed the Tucannon River when they returned from the ocean and were detected at Lower Granite Dam (Gallinat and Ross 2009). The phenomenon does not appear to be related to origin as both hatchery and natural origin fish bypassed at approximately the same rate.

Spring Chinook salmon from other river systems (strays) are periodically recovered in the Tucannon River and have accounted for over 5% of the total Tucannon River in the past (Gallinat et al. 2001), although in recent years, the rates of straying have been less than 5% (Gallinat and Ross 2009).

Beginning with the 2006 brood year, the annual smolt goal was increased from 132,000 to 225,000 to increase adult returns and ensure at least 132,000 smolts are released. In a further effort to increase adult returns co-managers are also conducting an experiment to examine size at release as a possible means to improve SARs.

In addition, RPA number 39 from the FCRPS BiOp instructs the Action Agencies to continue funding this hatchery and RPA 41 calls for the program to build genetic diversity using local broodstock and a sliding scale for managing the composition (HOF and NOF) of natural spawners.

In the initial years of the spring Chinook salmon supplementation program, between 8 (1985) and 127 (1988) natural origin adults were collected to create the hatchery mitigation broodstock. High pre-spawning mortality forced managers to collect more fish to reach program production goals. Beginning in 1992, broodstock were held at LFH in the cooler, pathogen free well water, which significantly reduced pre-spawning mortality, and the numbers needed for broodstock was reduced. From 1992-2005, WDFW attempted to collect 100 fish annually for the broodstock. From 2006 to the present WDFW has attempted to collect 170 fish for broodstock. The goal of the program since 1992 has been to collect equal numbers of natural- and hatchery-origin fish for broodstock.

In some years, shortage of fish in the run, and shortage of natural fish forced WDFW to collect all fish (natural or hatchery-origin) that returned to the TFH adult trap. For example, in 1995 this amounted to 43 total fish, of which only 10 were natural origin. The co-managers inclusion of the entire run was done with the intent to reduce the demographic risk to the population.

Captive brood program

Fish from the 1997-2002 brood years were raised in the hatchery to adults and spawned. The final captive brood progeny were released into the Tucannon River in 2008 (2006 brood year). Hatchery operations for the captive broodstock program ended with the last release. Monitoring and final evaluation of the captive broodstock program will continue until 2011, when the last adults from the captive brood program are expected to return to the Tucannon River.

Walla Walla River Spring Chinook salmon Program:[74]

Although Walla Walla River spring/summer Chinook salmon have been extirpated and therefore cannot be a part of any ESU, EDT analysis indicate that the subbasin may be capable of supporting self-sustaining populations of spring/summer Chinook salmon in certain watersheds if habitat actions that are proposed are successfully implemented. Therefore, one strategy being implemented by CTUIR is the reintroduction of spring/summer Chinook salmon into the Walla Walla subbasin through the development of an integrated supplementation/re-introduction program.

The program (which is funded under the Mitchell Act) is being implemented in two phases. Phase 1 entails the release of 250,000 spring/summer Chinook salmon smolts (Carson stock) per year in the South Fork of the Walla Walla River, as well as the outplanting of up to 100 Carson stock adults in Mill Creek and possibly the Touchet River. The smolt releases began in spring 2005; while the adult outplants are a continuation of a CTUIR program that began in 2000.

[74] Walla Wall basin spring Chinook salmon are not part of the Snake River ESU and their viability will not be considered when assessing the Snake River or mid-C because they are not listed and never will be ESU.

Under Phase 2, the existing adult holding facility on the South Fork would be expanded to a full hatchery capable of producing 500,000 smolts per year for release into the South Fork. Brood stock would be switched from out-of-basin sources to local returns as soon as possible. Adult outplants would also be continued under the proposed Master Plan. The Walla Walla Hatchery Master Plan is currently in Step 2 (preliminary design) of the NPCC's 3-Step process.

The short-term strategy is continued implementation of Phase 1 of the reintroduction program, transitioning in the long-term to Phase 2 once hatchery improvements to the South Fork facility have been made

Asotin Creek Spring/Summer Chinook salmon Program:

For spring/summer Chinook salmon, the short term hatchery strategy the co-managers propose will be to implement an integrated hatchery program designed to re-establish spring/summer Chinook salmon production in Asotin Creek (currently considered functionally extinct by WDFW and ICTRT). Initial concerns include the identification of an appropriate donor stock and the formulation of procedures to collect broodstock. Recent genetic analysis suggests that the use of Tucannon stock would be consistent within the MPG. No program will be implemented without a management plan agreed to by the co-managers.

This population is considered functionally extinct by ICTRT; reaching viability levels is only needed for the Tucannon population for de-listing. However, expanding spring Chinook salmon into this subbasin may increase the viability of the MPG.

Steelhead Programs (Walla Walla, Touchet, Tucannon, Grande Ronde, and Lyons Ferry)

The LSRCP presently funds production of lower Snake River summer steelhead. The programs were established as compensation for lost fish resources and fisheries resulting from construction and operation of hydroelectric projects in the Snake River.

Goal

> *The short-term goal of the steelhead programs is to mitigate for fish lost through the hydrosystem, and, in some cases (e.g., Tucannon River, initially) to prevent extinction of the populations and contribute to the re-building of the populations for de-listing. The long-term goal is to provide large enough returns of hatchery and natural origin fish back to the rivers that full mitigation is met and enough natural origin fish to meet abundance viability thresholds.*

Steelhead hatchery programs in the SEWMU are:

Walla Walla summer steelhead[75]***:*** The only hatchery program within the Walla Walla population is a segregated harvest program.[76] This program began in 1983, and used Wells, Wallowa, Ringold, and Lyons Ferry brood stock from 1983 - 1990. Since 1991, however, only the Lyons Ferry Hatchery stock has been used.

The segregated program releases age-1 smolts at ~4.5 fpp from a point below the Mill Creek confluence (~RM 35) in mid April (April 15 – 25). The fish are not acclimated before release because earlier studies indicated hatchery return rates were higher for direct releases than acclimated releases, presumably because of very poor water quality in the lower river. Acclimation studies were conducted in the Walla Walla, and confirmed in the Tucannon River. Hatchery releases were reduced to 100,000 beginning with the 2003 brood year. In recent years, releases have been reduced to 85,000.

Touchet River summer steelhead (see footnote 4): Two hatchery programs occur within the Touchet River drainage, a segregated harvest program utilizing out-of-population stock, and an integrated program using NORs captured at the adult trap at Dayton. The segregated program began in 1983, and between 1983 and 1990 used a variety of stocks --Wells, Wallowa, Ringold, and Lyons Ferry. Since 1991 only the Lyons Ferry Hatchery stock has been used.

The segregated program releases age-1 smolts at ~4.5 fpp from an acclimation pond in Dayton, WA (RM 54 Touchet River near Patit Creek confluence). Historically, the mean number of fish released per year has been 116,000 (CBFWA Program Amendment Process 2007). Beginning with the 2003 broodyear, the releases have been approximately 85,000 per year. Releases are volitional between early March and late April, and forced thereafter. All smolts are adipose-clipped and a minimum of 20,000 are CWT as well. In recent years a proportion has also been PIT-tagged. The segregated program releases Lyons Ferry stock smolts from the acclimation pond, below the weir at Dayton, Washington, and the integrated program releases endemic stock smolts upstream of the weir (about 0.5 miles). WDFW estimates that about 20% of the returning hatchery adults from the Lyons Ferry program are recovered either at Lyons Ferry Hatchery or in traps in the Walla Walla and Touchet rivers. The remaining fish are either harvested or spawn naturally. Lyons Ferry adults captured at the Dayton trap have been recycled ~10 miles downstream (to Waitsburg, WA) to augment harvest and limit introgression with the endemic stock, however, they are currently being removed. In 2010, 601 natural origin steelhead were counted passing

---

[75] Walla Wall basin steelhead are not part of the Snake River DPS and their viability will not be considered when assessing the Snake River DPS. They are part of the middle Columbia DPS and are considered part of the SE WA SEWMU.

[76] (From footnote # 7 of Table B6 of US v OR (2008)):*The US v OR Parties agree on current production levels to achieve mitigation objectives for the Walla Walla, Touchet, Tucannon, and lower Grande Ronde (Cottonwood) programs but not necessarily the stock used (non-local) or the release location. These steelhead programs may change during the period covered by this Agreement. To guide this change, the Parties commit to developing steelhead management plans for broodyear 2010, designed to transition to endemic stocks or segregated programs. The management plans will incorporate the hatchery mitigation requirement, timing of the transition, fishery objectives, marking, supplementation component linked to passage improvements on Mill Creek (Walla Walla basin), release locations, criteria to be met for collecting natural-origin adults from the upper Walla Walla basin, marking, etc.*

the Touchet River weir. The total number of steelhead counted at the weir was 814, with 149 hatchery fish from the endemic program and 64 from the LFH (that were removed).

The endemic program collects ~36 unmarked NORs for broodstock. Between 2000, when the program began, and 2004, an average of 52,982 yearling smolts (range 31,440 – 58,733) have been released *above* the Dayton trap/weir (RM 57.2) without acclimation. Release dates have varied from early April to early May based on stream flow conditions and expected size of fish at release. None of the endemic stock smolts are ad-clipped, to reduce harvest losses and facilitate monitoring and evaluating this stock. However, all fish are coded wire tagged in the snout and a VI tag is placed in the adipose eye tissue for external identification. If the endemic program proves successful, Lyons Ferry releases may be halted and the endemic program expanded. Another potential option could be that if the endemic program is successful and the LFH release is terminated, that there will be a proportion of endemic smolts ad-clipped for harvest purposes. Most of the hatchery origin spawners in the natural escapement in the upper Touchet (above the trap RM 54) are fish released from the endemic, integrated program. Differentially marked returns from the endemic program are passed upstream at the Dayton trap/weir, while LFH adults are removed to reduce the number of hatchery-origin spawners.

***Tucannon River summer steelhead*: ** Two summer steelhead stocks have historically been released into the Tucannon River[77]. Lyons Ferry Hatchery (LFH) stock steelhead (non-native stock) reared at LFH are released directly into the lower Tucannon River for harvest mitigation. Tucannon River endemic stock steelhead, are also reared at LFH and Tucannon Hatcheries and released into the upper Tucannon River to supplement the natural population.

WDFW (Bumgarner and Dedloff 2009) has observed a high percentage (65% in 2006-2007) of the natural-origin and hatchery-origin steelhead tagged and/or released in the Tucannon River bypassing the river and passing over Lower Granite Dam. While some of the fish (approximately 15-20% of those that pass Lower Granite) eventually find their way back to the Tucannon River to presumably spawn, many fish are still detected upstream of Lower Granite that do not make their way back to the Tucannon River (Bumgarner and Dedloff 2009). Further research has been proposed to determine the mechanisms that may be causing this phenomenon.

Unmarked steelhead adults were collected in the lower Tucannon River (temporary trap) to create the endemic broodstock. This trap could have low efficiency and may have trapped fish disproportionate to the run timing of the overall population (M. Schuck, WDFW, personal communication). Currently, the goal is to collect 17-18 females and 20 males for broodstock by trapping at the Tucannon Fish Hatchery intake dam fish ladder that will produce approximately 50,000 smolts for release. The hatchery production goals were changed in 2010 to transfer the Lyons Ferry Hatchery stock out of the Tucannon River and ramp up production using the endemic Tucannon stock to eventually trap 40-90 broodstock and release 150,000 endemic stock smolts (100,000 adipose clipped) designed to escape 875 steelhead back to the project area after a downriver harvest of 1,750.

As adult return numbers increase, a proportion of smolts will be ad-clipped for harvest purposes; the goal is 100,000 ad-clipped smolts and 50,000 CWT only.

---

[77] The co-managers have recently decided to terminate the release of Lyons Ferry stock fish into the Tucannon basin (G. Mendel, pers. comm.), however this description is left in here for informational purposes.

Lower Snake River Mainstem and Tributaries (Lower Snake River MPG)**:** Summer steelhead released into the lower Snake River are from a segregated hatchery program operated at Lyons Ferry Hatchery. The program goal is to provide fish for harvest and hatchery broodstock.

LFH stock steelhead are currently trapped, reared, and released on-station at LFH. LFH production consisted of 60,000 smolts (100% adipose clipped) released to provide 630 hatchery adults (assuming a 1.05% SAR) for mitigation harvest and as hatchery broodstock for LFH stock releases in the Snake River (at LFH) and in the Walla Walla Basin (Mid-Columbia River Basin). In 2010, the LFH releases previously programmed for the Tucannon River (100,000) were temporarily added to on-station releases at LFH while the Tucannon hatchery program transitioned to a full endemic steelhead stock program. This additional release from LFH is expected to return 1,050 adults to the Snake River for fishery mitigation. No hatchery programs are proposed for the lower Snake River small tributaries (Almota, Deadman, and others).

Asotin Creek: No hatchery programs for steelhead are proposed within the Asotin subbasin. WDFW released hatchery steelhead into Asotin Creek for a few years in the 1980s and Asotin endemic stock hatchery fish were released into Asotin Creek in the 1960s. The co-managers have agreed to manage Asotin Creek for natural production only, and therefore no hatchery fish are released, or allowed to pass upstream of the weir. However, a high percentage (39-63% over 3 years) of hatchery steelhead return and spawn in Alpowa Creek, which is included as part of the Asotin steelhead population.

Grande Ronde River summer steelhead: Wallowa stock steelhead are currently trapped on Cottonwood Creek in the lower Grande Ronde River basin. Gametes collected are returned to LFH where the fish are reared to pre-smolt size. Smolts are then returned to the Grande Ronde River for acclimation at the Cottonwood Creek Acclimation Pond. Current smolt production is set at 200,000 smolts (within *US v OR* process (2010), Table B6) (100% adipose clipped) to return 1,500 hatchery adult steelhead back to the Snake River basin for harvest. ODFW also releases Wallowa stock steelhead in the upper Grande Ronde Basin that provide for fishing opportunities in the Snake and lower Grande Ronde rivers.

D.7 LIMITING FACTORS AND THREATS

D.7.1 Limiting factors

In Table D-2 below, the limiting factors concerning hatchery programs are listed for SE Washington anadromous salmonid populations. Currently, hatchery programs within the SEWMU are not considered to be the primary limiting factor associated with the viability of any of the populations shown in Table D-2.

Table D-2. Anadromous salmonid populations and major limiting factors concerning hatchery programs affecting SE Washington salmonids (based on SRSRB 2006 and NOAA Fisheries 2008b).

Population	Hatchery Program Major Factor(s) Currently Limiting Population Recovery	Other[a] Major Factor(s) Currently Limiting Population Recovery
Walla Walla River steelhead	Ecological interactions, including competition for limited space and	Hydroelectric projects and associated affects on water quality and flow.
Touchet R. steelhead		

Population	Hatchery Program Major Factor(s) Currently Limiting Population Recovery	Other[a] Major Factor(s) Currently Limiting Population Recovery
Tucannon R. steelhead	resources in streams and estuary.	
Asotin Creek steelhead		Loss of spawning and rearing habitat and reduction in quality.
Lower Grand Ronde R. steelhead	Predation of wild fish by hatchery fish or an increase in predation as a result of predators being attracted to hatchery release points, areas downstream (avian predation at the mouth).	
Joseph Cr steelhead[b]		Possibly transportation.
Tucannon spring Chinook salmon		
Wenaha spring Chinook salmon[b]		
Asotin spring Chinook salmon	Genetic effects resulting from hybridization of domesticated hatchery fish and wild fish leading to the reduced productivity or survival	

[a] Other factors than fisheries management (see separate chapter on fisheries management)

[b] Joseph Creek steelhead and Wenaha spring Chinook salmon are included because of their geographic inclusions (or parts of their watersheds) in the SEWMU.

D.7.2 Current Threats

In this section current threats related to hatchery management that continue to affect the existence of the focal species are summarized. The threats listed below are generalized and can be applied to all hatchery programs. These threats are organized according to three of the five categories below as set forth in Section 4(a)(1) of the ESA that apply to this recovery plan:

1. The present or threatened destruction, modification, or curtailment of its habitat or range.
2. Overutilization for commercial, recreational, scientific, or educational purposes.
3. Disease or predation.
4. Inadequacy of existing regulatory mechanisms.
5. Other natural or human-made factors affecting its continued existence.

D.7.3 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The effects of recreational and commercial fishing on naturally produced Chinook salmon and steelhead may be heightened during fisheries for hatchery produced Chinook salmon (all runs) and steelhead.

Incidental (or direct) harvest mortality in mixed-stock fisheries and commercial fisheries contributes to the loss of naturally produced Chinook salmon and steelhead.

Illegal harvest (poaching) continues to threaten Chinook salmon and steelhead.

D.7.4 Disease or Predation

Disease transmission from hatchery fish to wild fish is unknown, but may be detrimental.

Direct predation: large, hatchery-reared smolts can prey directly on wild juveniles.

Supporting predator populations: releases of hatchery fish can help to support an increased predator population, thereby increasing predation rates on wild fish.

D.7.5 Other Natural or Human-Made Factors Affecting its Continued Existence

- The use of non-locally derived broodstock for hatchery programs may negatively affect genetic integrity.
- Use of locally derived broodstock for hatchery programs may not entirely prevent the negative genetic impact of hatchery fish on wild populations.
- The collection of naturally produced Chinook salmon and steelhead for hatchery broodstock may harm small or dwindling natural populations if not done with caution.
- Competition and genetic introgression resulting from hatchery introductions may reduce the productivity and survival of naturally produced Chinook salmon and steelhead.

D.8 STRATEGIES AND ACTIONS TO PROMOTE RECOVERY

D.8.1 Hatchery strategies

The following strategies relate to the hatchery programs within the SEWMU. Specific hatchery program strategies will be identified in the list below if applicable. These strategies are not meant to be an inclusive list, but are intended to be reflective of current plans and legally binding processes, and are ensured to assist in meeting overarching recovery objectives.

Strategies for the Snake River fall Chinook salmon will not be captured in this section of the plan. Those strategies will be coordinated through the larger "roll-up" of the Snake River Basin Recovery Plan.

Short-term Strategies

1. Continue to use artificial production to maintain critically depressed populations in a manner that is consistent with recovery and avoids extinction.
2. Use artificial production to seed unused, accessible habitats.
3. Use artificial production to provide for tribal and non-tribal fishery obligations as consistent with recovery criteria.
4. Use harvest or other methods, e.g., removal at weirs, increased daily and season bag limits, etc to reduce the proportion of hatchery-origin fish in naturally spawning populations.
5. Where appropriate, use local broodstocks in hatchery programs.
6. Reduce the amount of straying from current hatchery programs.

Long-Term Strategies

1. Ensure that ongoing hatchery programs are consistent with recovery.
2. Meet tribal and non-tribal fishery goals.
3. Use harvest or other methods to reduce the proportion of hatchery-origin fish in naturally spawning populations.
4. Manage hatcheries to achieve sufficient natural productivity and diversity to de-list populations and to avert re-listing of populations.

Research and Monitoring Strategies

1. Employ the best available technology to monitor the effects of hatchery releases on natural populations and natural production.
2. Monitor achievement of fishery goals.
3. Develop marking programs to assure that hatchery produced fish are identifiable for harvest management, accounting towards escapement goals, and reproductive success studies.
4. Evaluate existing programs and redesign as necessary so that artificial production does not pose a threat to recovery.
5. Integrate and coordinate monitoring activities between federal, state, and tribal programs.
6. Examine the reproductive success of naturally produced and hatchery produced spring Chinook salmon and steelhead spawning in the wild.
7. Examine the ecological interactions (competition and predation) between hatchery- and natural-origin salmon and steelhead.
8. Examine residualism of hatchery produced steelhead.

This plan recognizes the need to balance recovery strategies with legal obligations and mandates under LSRCP, the Mitchell Act, federal government and tribal agreements, Hatchery and Genetic Management Plans (HGMPs), *U.S. v. Oregon*, and relicensing agreements.

D.8.2 Discussion of strategies

This section summarizes existing and proposed hatchery operations and further defines strategies that could reduce conservation risks identified for each program in Section 2. Each strategy listed above will be followed by appropriate actions.

Short-term

1. Continue to use artificial production to maintain critically depressed populations in a manner that is consistent with recovery and avoids extinction.

Each hatchery program has been reviewed by the HSRG, and most by the HRT. Some of the recommendations by the HSRG and HRT have been implemented on a case-by-case basis through the appropriate legal process (e.g., *US v OR*). Detailed implementation of each program and how the implementation will affect recovery and avoid extinction will be determined through the HGMP process.

2. Use artificial production to seed unused, accessible habitats.

Attempts will be made by the co-managers to balance the need to seed underutilized habitat with potential risk to the long-term fitness of the natural population through interbreeding between hatchery- and natural-origin fish. Detailed implementation and potential use of "sliding scale" to balance risks to fitness and use of habitat will be determined through the HGMP process.

3. Use artificial production to provide for tribal and non-tribal fishery obligations as consistent with recovery criteria.

The numbers of fish released for each program is determined through the original analysis for the LSRCP and is modified through *US v OR*, except those fish released for mitigation for IPC and CTUIR. Those numbers and other details will be presented in the HGMPs.

4. Use harvest or other methods to reduce the proportion of hatchery-origin fish in naturally spawning populations.

The co-managers propose to control the number of hatchery fish allowed to spawn in the wild to the extent possible in all basins, ***once abundance levels begin to rise in response to limiting factors being addressed***.[78] By controlling the percentage of hatchery origin spawners, the co-managers are attempting to reduce potential negative effects of hatchery fish on naturally produced fish populations. A sliding scale needs to be developed by the co-managers and the RTT to determine triggers that will dictate the percentage of the run that can be used for broodstock at various population levels and the level of pHOS in specific streams. The details for each program will be determined through the HGMP process.

5. To the extent possible use local broodstocks in hatchery programs.

Where appropriate, the use of local broodstock has been implemented in many hatchery programs within the SEWMU. Details can be found within the HGMPs.

6. Reduce the amount of straying from current hatchery programs.

Straying has been shown to be a concern, especially fish from the Tucannon River straying elsewhere. However, further information is needed to determine the mechanisms that lead to Tucannon fish straying, since it appears to not be limited to hatchery-origin fish.

Steelhead from SEWMU programs also appear to stray and wander into lower Columbia River streams (like the Deschutes). Further information concerning whether there are hatchery operations that might be causing this behavior should be investigated, and will be determined through the HGMP process. Actions that could be considered to improve homing could be how long fish are acclimated, where fish are released, etc.

Long-term

The long-term strategies are mostly the same as the short term, and any actions identified for the long term strategies will be determined through the HGMP process. One strategy that is long-term and not captured in the short-term strategies is:

Manage hatcheries to achieve sufficient natural productivity and diversity to de-list populations and to avert re-listing of populations.

The actions subscribed to under the other short- (and long-) term strategies should cover this strategy also. The details on how this will be accomplished will be agreed to under the HGMP process.

D.8.3 Research and Monitoring Strategies

[78] The co-managers have instituted hatchery fish removal in some places already, like Asotin Creek and the upper Touchet.

1. Employ the best available technology to monitor the effects of hatchery releases on natural populations and production.

Research, monitoring, and evaluation plans will be determined through the HGMP process. The co-managers are encouraged to participate in basin-wide planning of their monitoring programs so cost-sharing and efficiencies are realized within the SEWMU programs and that the most current technology is being utilized.

2. Develop marking programs to assure that hatchery produced fish are identifiable for harvest management, escapement goals, and reproductive success studies.

Marking fish is an important component of evaluating the hatchery program. The level of marking will be discussed within the HGMPs and determined through processes such as *US v OR*.

3. Evaluate existing programs and redesign as necessary so that artificial production does not pose a threat to recovery.

Reviews of SEWMU programs have been accomplished through reviews from the HSRG and HRT. However, adaptive management of these programs will rely on feedback from the monitoring and evaluation plans that are developed through the HGMP process.

4. Integrate and coordinate monitoring activities between federal, state, and tribal programs.

Stakeholders involved with SEWMU hatchery programs already coordinate monitoring activities with various regional programs. There is currently an effort underway to develop a process where various managers, and other stakeholders from around the entire Columbia basin will be developing recommendations to implement the recommendations of the Ad Hoc Supplementation Workgroup (AHSWG 2008). By participating in this effort, the monitoring activities within the SEWMU will be coordinated with a basin-wide effort.

5. Examine the reproductive success of naturally produced and hatchery produced spring Chinook salmon and steelhead spawning in the wild.

Relative reproductive success (RRS) of hatchery origin fish in the wild can affect the productivity of the natural origin population. If RRS for hatchery origin fish are substantially below that of natural origin spawners, then over time, the productivity of the population will be decreased. As such, it is essential to understand this critical uncertainty within each population that is affected by hatchery fish.

However, it is not reasonable or prudent to believe that all populations that are being supplemented can have RRS measured because of the time and expense involved in doing these studies (usually at least 2-3 generations). Therefore, it is recommended that a review of RRS studies being conducted throughout the Columbia basin be undertaken to determine if results from those studies can inform the management of the conservation hatchery programs within the SEWMU. If it is concluded that other studies cannot be applied to the local hatchery programs, then a RRS study should be developed and implemented following the guidelines suggested by the AHSWG (AHSWG 2008).

6. Examine the ecological interactions (competition and predation) between hatchery- and natural-origin salmon and steelhead.

Ecological interactions between hatchery- and natural-origin fish is a critical uncertainty. Ecological interactions can be characterized by the following (from RIST 2009)

- Direct predation. Large, hatchery-reared smolts can prey directly on wild juveniles.
- Supporting predator populations. Releases of hatchery fish can help to support an increased predator population (including human predators), thereby increasing predation rates on wild fish.
- Competition among juveniles. Releases of hatchery fish may also increase competition among juveniles for food, territories, and cover from predators, decreasing growth, increasing mortality, and potentially affecting population dynamics by inhibiting density-dependent compensation.
- Competition among adults. When hatchery-origin adults are allowed to spawn in the wild, they can compete with wild adults, occupying spawning and rearing resources that could be used by the wild population. This situation can be worsened when hatchery fish are selected to breed early (taking up space) or late (superimposing redds on wild redds) in comparison with wild fish.
- Vectors of disease. Hatchery fish can have higher rates of disease, and be selected for disease resistance, and can pass on disease pathogens to the natural environment.

While there have been many studies documenting effects of ecological interactions between hatchery- and natural-origin fish (summarized in Kostow (2008) and Pearsons (2008)), most of these have occurred within the natal stream where hatchery fish are released, not in the migration corridor, estuary or ocean.

Fish are released from hatcheries in most cases at sizes and assumed readiness to migrate to the ocean, thus not competing with natural juveniles in the rearing environment. However, unless there have been specific studies to observe interactions between hatchery- and natural-origin fish in the wild (both juveniles and adults), the assumption will not be verified. In addition, recent research (e.g., Larsen et al. 2004, 2010) suggests that a substantial portion of the male hatchery fish released may not migrate due to early maturation. Thus, ecological impacts of fish that are assumed to migrate to the ocean may be greater than believed. Determining what studies may occur in the SEWMU will most likely take place through regional processes.

For some hatcheries, steelhead that are either below or above the targeted size of release may not migrate after release.

D.8.4 Summary of strategies for all programs

The following table summarizes the current status, proposed hatchery strategies and actions and future expectations from the actions.

Table D-3. Summary of current status and proposed strategies and actions by MPG within the SEWMU. Actions to be considered have not been agreed to by all stakeholders, and will be finalized through the HGMP and permitting processes.

MPG	Population	Current Status and (ICTRT recovery criteria to achieve < 5% risk of ext. in 100 yrs)	Proposed Hatchery Strategies	Actions to be Considered and/or Implemented	Expectation from the Actions
Lower Snake River spring/summer Chinook salmon	Asotin Creek Spring/Summer Chinook salmon	***Functionally extirpated*** (10-yr geomean of minimum of 500 naturally produced spawners and 20-yr R/S of 1.90)	Integrated (reintroduction and donor stock selection process)	Increase abundance by seeding the area with juvenile fish or ripe spawners.	Reintroduced population that assists MPG in meeting viability criteria, when fish are available, and to a lesser extent, after habitat restoration projects are implemented.
	Tucannon Spring/Summer Chinook salmon	***High risk*** (10-yr geomean of minimum of 750 naturally produced spawners and 20-yr R/S of 2.10)	Integrated (U.S. v Oregon agreement to increase to 225,000 smolts)	Hold adults at hatchery and release in upper basin when ripe to improve distribution. Implement a relative reproductive success study. Explore installation of a weir lower in the basin (to collect broodstock or to remove strays). Determine what factors influence the migration of adults past Lower Granite Dam. Determine why natural spawning produces less than one adult per spawner and implement actions. Determine how to improve SARs	Increase of abundance with increased survival and numbers of fish released. Increase in productivity by reducing pHOS and strays. Increase in spatial structure. Achieve LRSCP mitigation/restoration goals
Walla Walla-Umatilla spring/summer Chinook salmon	Walla Walla Spring/Summer Chinook salmon	***Extirpated*** (no viability criteria for extinct population)	CTUIR proposed - Integrated re-introduction supplementation program currently at 250K smolts	Reintroduce spring/summer Chinook salmon into the Walla Walla (and Touchet) River with	Reintroduced naturally perpetuating population that contributes to harvest and maintains locally

MPG	Population	Current Status and (ICTRT recovery criteria to achieve < 5% risk of ext. in 100 yrs)	Proposed Hatchery Strategies	Actions to be Considered and/or Implemented	Expectation from the Actions
			increasing to 500K under Walla Walla Hatchery Master Plan. Continued outplanting of ~250 Carson stock adults.	appropriate local stock. Adequately monitor to ensure straying to neighboring populations is within acceptable limits (< 5%).	adapted broodstock needs.
Grande Ronde/Imnaha spring/summer Chinook salmon	Grande Ronde Spring/Summer Chinook salmon		No hatchery programs are proposed in the Washington portion of the basin.	None	
	Wenaha[a] Spring/Summer Chinook salmon		None – reserved for wild production	Monitor for hatchery strays Maintain monitoring adult abundance	Wild fish sanctuary that maintains self-sustaining natural populations
Lower Snake River steelhead	Tucannon Summer Steelhead	***High risk*** (10-yr geomean of minimum of 1,000 naturally produced spawners and 20-yr R/S of ≥ 1.2)	Integrated use of endemic broodstock in hatchery releases up to 150,000 fish.	Increase monitoring to understand pHOS and improve ability to estimate total returning adults for the entire basin. Develop and potentially implement study to improve homing and reduce crossing LWG Increase productivity by reducing pHOS and strays. Investigate the use of a weir lower in the basin (to collect broodstock or to remove strays). Develop and implement a RRS study to assist in long term management of the population.	Increase of abundance with increased survival and numbers of fish released. Increase in productivity by reducing pHOS and strays. Achieve LRSCP mitigation/restoration goals

MPG	Population	Current Status and (ICTRT recovery criteria to achieve < 5% risk of ext. in 100 yrs)	Proposed Hatchery Strategies	Actions to be Considered and/or Implemented	Expectation from the Actions
				Manage to increase PNI.	
	Asotin Creek Summer Steelhead	***High risk*** (10-yr geomean of minimum of 500 naturally produced spawners and 20-yr R/S of ≥ 1.2)	None – reserved for wild production	Ensure that hatchery origin fish are excluded from the basin on an on-going basis. Ensure robust monitoring continues to assess adult origin, abundance, and juvenile productivity in all tributaries that are part of this population. Continue monitoring hatchery strays in Alpowa Cr and potentially take corrective actions if agreed to by stakeholders.	Wild fish sanctuary that maintains self-sustaining natural populations, and potentially used as a reference stream for hatchery evaluations.
Snake River mainstem steelhead	Lower Snake River steelhead (not a recognized population)	(because of lack of basin-specific information, no criteria have been set by the ICTRT)	Maintain the existing segregated hatchery program to provide fisheries mitigation.	Increase monitoring in tributaries and at Lower Granite Dam for hatchery straying	Maintains steelhead fisheries and meets LSRCP mitigation goals
Walla Walla-Umatilla steelhead	Walla Walla Summer Steelhead	***High risk*** (10-yr geomean of minimum of 1,000 naturally produced spawners and 20-yr R/S of ≥ 1.35)	Segregated hatchery program in lower river	Explore ways to robustly estimate the origin and abundance of fish reaching the spawning areas. Actions should be taken to ensure that the upper basin is maintained as a wild fish refuge.	Maintains steelhead fisheries and meets LSRCP mitigation goals. Maintenance of natural populations
	Touchet Summer Steelhead	***High risk*** (10-yr geomean of minimum of 1,000 naturally produced spawners and 20-yr R/S of ≥ 1.35)	Integrated (Experimental, evaluate need to transition to totally integrated) Segregated (intensify monitoring of hatchery fish in	Ensure that monitoring is effective in determining the potential impacts of the segregated program on the natural population.	Segregated hatchery program that contributes to harvest goals. Maintains steelhead fisheries and meets LSRCP mitigation

MPG	Population	Current Status and (ICTRT recovery criteria to achieve < 5% risk of ext. in 100 yrs)	Proposed Hatchery Strategies	Actions to be Considered and/or Implemented	Expectation from the Actions
			natural escapement and removal at Dayton Dam)	Manage to appropriate levels of NOB and pHOS based on sliding scale developed by co-managers. Determine long-term strategy for whether hatchery program is integrated or segregated	goals Maintenance of natural populations
Lower Grande Ronde steelhead	Lower Grande Ronde Summer Steelhead	***Moderate risk of extinction*** [b] (10-yr geomean of minimum of 1,000 naturally produced spawners and 20-yr R/S of ≥ 1.14)	Continue segregated program	Increase monitoring in nearby streams to insure straying is at acceptable levels. Manage to increase PNI.	Increase of abundance with increased survival and numbers of fish released. Increase in productivity by reducing pHOS and strays. Ultimately to achieve LRSCP mitigation/restoration goals
	Joseph Creek		None – reserved for wild production	Monitor for hatchery strays and adult abundance	Wild fish sanctuary that maintains self-sustaining natural populations, and potentially used as a reference stream for hatchery evaluations.

[a] The Minam River (not in SEWMU) is also considered to be a reference stream, and will be managed as a wild fish sanctuary.

[b] The ICTRT (2007) did not have enough information to determine the overall viability rating, but postulated that based on the VSP parameters, this population was at moderate risk for abundance and productivity and low risk for spatial structure and diversity, with an overall extinction risk of "moderate."

D.9 REFERENCES

AHSWG (*Ad Hoc* Supplementation Monitoring and Evaluation Workgroup). Beasley C. A , B. A. Berejikian, R. W. Carmichael, D. E. Fast, M. J. Ford, P. F. Galbreath,J. A. Hesse, L. L. McDonald, A. R. Murdoch, C. M. Peven, and D. A. Venditti. 2008. Recommendations for Broad Scale Monitoring to Evaluate the Effects of Hatchery Supplementation on the Fitness of Natural Salmon and Steelhead Populations. Final Report. 82 pgs

Araki, H., W.R. Arden, E. Olsen, B. Cooper, and M.S. Blouin. 2007. Reproductive success of captive-bred steelhead trout in the wild: evaluation of three hatchery programs in the Hood River. Conservation Biology 21(1):181-190.

Bumgarner, J.D., and J.T. Dedloff. 2009. Lyons Ferry Complex Hatchery Evaluation: summer steelhead annual report 2006 and 2007 run year. Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 1411-06-J013, 1411-07-J011. Washington Department of Fish and Wildlife, Olympia, Washington. 107 p.

Gallinat, M.P., J.D. Bumgarner, L. Ross, and M. Varney. 2001. Tucannon River Spring

Chinook Salmon Hatchery Evaluation Program 2000 Annual Report to U.S. Fish and Wildlife Service, Cooperative Agreement 1411-09-J070. Washington Department of

Fish and Wildlife, Olympia, Washington. Report # FPA01-05. 44 p.

Gallinat, M.P., and L.A. Ross. 2007. Tucannon River Spring Chinook Salmon Hatchery

Evaluation Program 2006 Annual Report to U.S. Fish and Wildlife Service,

Cooperative Agreement 1411-06-J013. Washington Department of Fish and Wildlife,

Olympia, Washington. Report # FPA07-09. 73 p.

Gallinat, M.P., and L.A. Ross. 2009. Tucannon River Spring Chinook Salmon Hatchery

Evaluation Program 2008 Annual Report to U.S. Fish and Wildlife Service,

Cooperative Agreement 1411-08-J011. Washington Department of Fish and Wildlife,

Olympia, Washington. Report # FPA09-08. 75 p.

HSRG (Hatchery Scientific Review Group). 2004. Hatchery Reform: Principles and Recommendations of the Hatchery Scientific Review Group.

HSRG (Hatchery Scientific Review Group). 2009. Columbia River hatchery reform system-wide report.

ICTRT (Interior Columbia Technical Recovery Team). 2007. Considering alternative artificial propagation programs: implications for the viability of listed anadromous salmonids in the interior Columbia River.

Kostow, K. E. 2008. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries.

Larsen, D.A., B.R. Beckman, K.A. Cooper, D. Barrett, M. Johnston, P. Swanson, and W.W. Dickhoff. 2004. Assessment of high rates of precocious male maturation in a spring Chinook salmon salmon supplementation hatchery program. Trans. Am. Fish. Soc. 133: 98-120.

Larsen, D.A., B.R. Beckman, and K.A. Cooper. 2010. Examination of conflict between smolting and precocious male maturation in spring (stream-type) Chinook salmon salmon. Trans. Am. Fish. Soc. 139: 564-578.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42,156 p.

National Marine Fisheries Service. 1995. Biological Opinion for 1995 to 1998 hatchery operations in the Columbia River Basin. NOAA/NMFS, April 5, 1995. 82 pp.

NOAA Fisheries. 2008a. Supplemental Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and other Tributary Actions. Appendix C Artificial Propagation for Pacific Salmon. 1230 pgs

NOAA Fisheries. 2008b. Supplemental Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and other Tributary Actions. Appendix D Hatchery Effects Report. 1230 pgs

NOAA Fisheries. 2009. Middle Columbia River steelhead distinct population segment ESA recovery plan. 260 pgs

NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

Pearsons, T. N. 2008. Misconception, reality, and uncertainty about ecological interactions and risks between hatchery and wild salmonids. Fisheries **33**:278-290.

RIST (Recovery Implementation Science Team) Brown, G.M., C. Busack, R. Carmichael, T. Cooney, K. Currens, M. Ford, G. Helfman, J. Hesse, P. Lawson, M. McClure, P. McElhany, G. Reeves, B. Rieman,

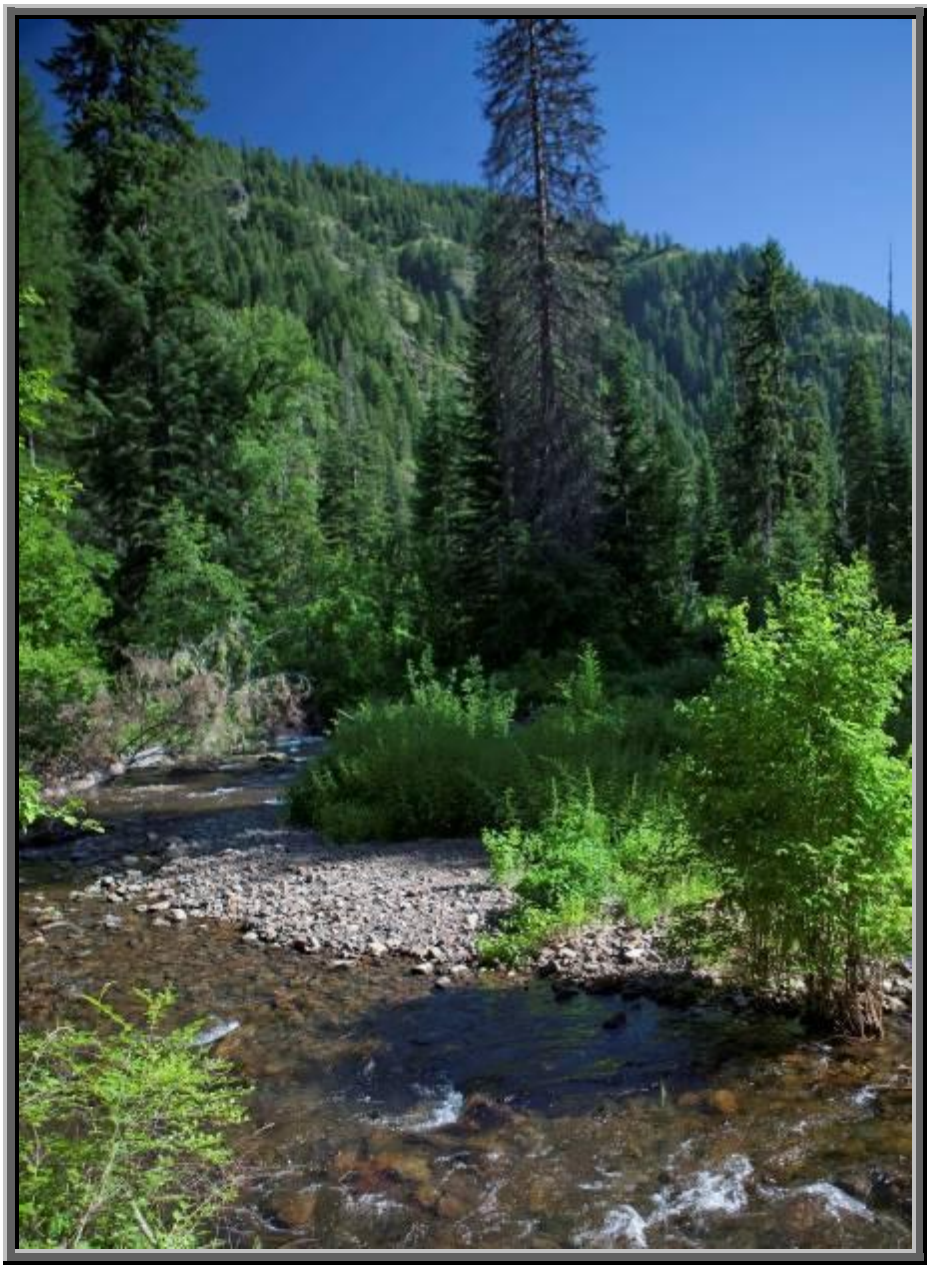
M. Ruckelshaus, B. Thompson. 2009. Hatchery reform science. A review of some application of science to hatchery reform issues. 93 pgs. http://www.nwfsc.noaa.gov/trt/index.cfm

Snake River Salmon Recovery Board (SRSRB). 2006. Technical Document
Snake River Salmon Recovery Plan for SE Washington. Prepared for the Washington Governor's Salmon Recovery Office. Draft report. 583 pages

U.S. Army Corps of Engineers District (USACE), Walla Walla, Washington. 1975. Special Report: Lower Snake River Fish and Wildlife Compensation Plan. 95 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. *Pacific Region Federal Hatchery Review - National Fish Hatchery Recommendations: Draft Summary Report, February 2010*. Hatchery Review Team, Pacific Region. U.S. Fish and Wildlife Service, Portland, Oregon. <http://www.fws.gov/pacific/ fisheries/Hatcheryreview/ team.html>.

APPENDIX E FISHERY MANAGEMENT – SOUTHEAST WASHINGTON MANAGEMENT UNIT



Appendix E. Fishery Management - Southeast Washington Management Unit

Table of Contents – Appendix E

Fishery Management - SEWMU

Table of Figures – Appendix E

List of Tables – Appendix E

E.1 OVERVIEW

This appendix briefly describes fishery management within the Southeast Washington Management Unit (SEWMU) affecting populations inside the SEWMU[79]. It is important to understand that:

> ***fisheries (especially salmon) outside of the SEWMU in the ocean and lower Columbia River strongly affect the opportunity to provide fisheries within the SEWMU.***

For a description of fishery management outside the SEWMU, refer to the harvest module[80].

E.1.1 Geographic scope

The SEWMU encompasses the Snake River and its tributaries, including the Tucannon, Asotin, lower Grande Ronde, Touchet and Walla Walla rivers. In addition, smaller tributaries also have anadromous fish (e.g., Alpowa Creek) (Figure E-1) and trout fisheries that may allow harvest of hatchery steelhead.

---

[79] Snake River fall Chinook salmon will not be covered in this appendix, and will be discussed in detail in the fall Chinook salmon appendix to the comprehensive Snake River Recovery plan.

[80] The Harvest Module was developed by NMFS and can be found within the comprehensive Snake River Salmon Recovery Plan.

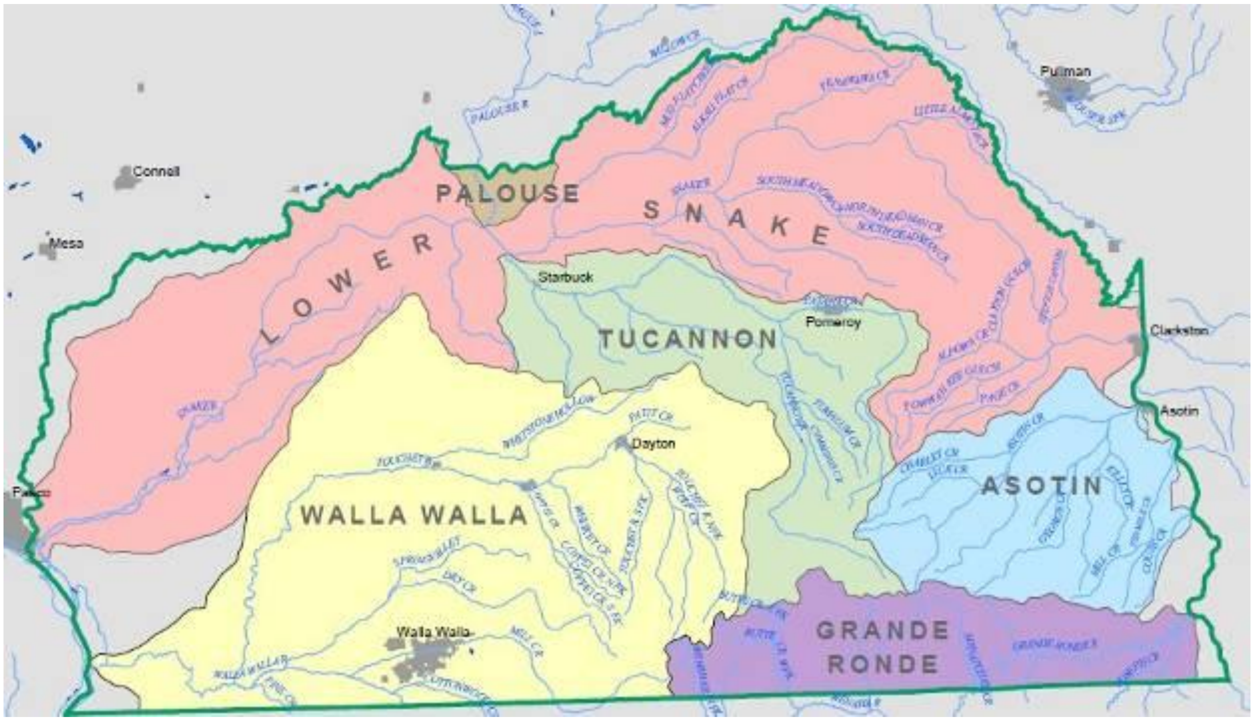


Figure E-1. Southeast Washington Management Unit.

E.2 FISHERIES WITHIN THE SEWMU

All fisheries that affect ESA-listed species within the SEWMU can be authorized under the Endangered Species Act 4(d), Section 7 or Section 10 processes. The mainstem Snake River spring Chinook fisheries up to the Idaho border in Clarkston have been included with the lower Columbia River fisheries in the *U.S. v. Oregon*[81] Management Agreement and associated fisheries BiOP. Up to now, and since Snake River Basin, and mid-Columbia Basin (e.g. Walla Walla Basin) ESUs and DPSs were listed under the ESA, most fisheries in the SEWMU have occurred without ESA authorization.

Recently, a process called the Snake Basin Harvest Management Forum (SBHMF) was created with the purpose of developing coordinated management frameworks for ESA-listed species in the Snake River Basin. The SRMF concept was introduced at the January 2009 *U.S. v. Oregon* Plenary Session and it has convened several times since July 2009. However, the SRMF has yet to result in the development of long-term Fishery Management Plans for the SEWMU and other areas of interest. Participants include representatives from three states (Washington, Oregon and Idaho), and Snake River basin tribes (Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Shoshone-Bannock Tribes) and NMFS.

The Washington Department of Fish and Wildlife (WDFW) submitted a short-term Fishery Management and Evaluation Plan (FMEP) for steelhead and miscellaneous fisheries to NMFS in December 2009 that is

[81] *United States v. Oregon*, originally a combination of two cases, *Sohappy v. Smith* and *U.S. v. Oregon* (302 F. Supp. 899), legally upheld the Columbia River treaty tribes reserved fishing rights. Although the Sohappy case was closed in 1978, *U.S. v. Oregon* remains under the federal court's continuing jurisdiction.

considered an interim plan that is to be replaced by a plan developed in coordination with other SEWMU co-managers through the SBHMF. A main feature of future fishery management plans is the inclusion of abundance-based and population-specific harvest rate schedules that limit the take of ESA-listed species. The main goal of WDFW's current interim steelhead and miscellaneous fisheries FMEP is to provide harvest opportunity for a large subset of recreational fisheries in Washington's portion of the Snake River basin in a manner that promotes recovery of ESA-listed salmonids in the near-term. Fisheries targeting hatchery-origin spring/summer Chinook salmon were not included in WDFW's 2009 FMEP for the SEWMU, and will be included in a future FMEP. Three *U.S. v Oregon* tribes (Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation and The Shoshone-Bannock Tribes) have also indicated plans to submit Tribal Resource Management Plans under the Tribal 4(d) Rule for fisheries targeting Snake River steelhead, Snake River spring/summer and fall Chinook salmon in the SEWMU.

The WDFW's 2009 FMEP, currently under consideration for the SEWMU, includes miscellaneous fisheries and fisheries targeting hatchery-origin steelhead, with associated incidental take of ESA-listed Snake River steelhead and Snake River spring/summer and fall Chinook salmon. The current framework for WDFW's FMEP includes incidental ESA limits that are as low as practicable under the current fishery regimes and population-specific, but are not abundance-based. The current ESA limits for WDFW's FMEP are set and constant irrespective of expected population abundance under most conditions; only when the running three-year average for Snake River steelhead is below some critical threshold, fisheries would not occur.

E.2.1 Spring/summer Chinook

From 1977 to 2000, salmon-directed sport fisheries were not allowed in the SEWMU with the exception of some limited fisheries for jack salmon, because Snake River salmon populations were at such low levels that WDFW was concerned that salmon-directed fisheries would have adverse effects on wild stocks. Beginning in 2001, WDFW(and other co-managers) authorized spring Chinook salmon fisheries in the Snake River Basin targeted at hatchery stocks. The SEWMU fishery was in May, which coincides with peak migration of hatchery fish. Wild fish (not marked with a clipped adipose fin) had to be released. Since 2003, WDFW has opened sport fisheries targeting spring Chinook salmon on the Snake River under emergency in-season procedures. The Snake River fisheries have often been terminated earlier than planned because of lower than expected run size and higher than anticipated ESA impacts in the lower Columbia River.

Limited tribal C&S fisheries targeted at salmon occur within the Snake River Basin, but most of these fisheries are outside the SEWMU in Idaho and Oregon.

E.2.2 Steelhead

The States of Washington, Oregon and Idaho allow in-region recreational fisheries directed at steelhead. In Washington, regulations direct harvest on surplus hatchery fish while protecting wild fish. Wild steelhead release regulations were adopted by WDFW, and adjacent states, beginning in 1984 (based on stubbed dorsal fin regulations). Area closures and fishery timing are used to optimize wild steelhead protection in the recreational fishery. The upper Tucannon River watershed and all tributaries to Tucannon and Grande Ronde rivers are closed to steelhead fishing to protect fish in important natural spawning and rearing areas. Steelhead fishing is closed in Asotin Creek, Joseph Creek, upper Touchet River and upper Mill Creek, to protect wild steelhead. Wild steelhead refuge areas are established in

Asotin Creek and its tributaries, the Joseph Creek Basin, most of the Wenaha Basin (including all of the WA portion), and the upper portions of the Touchet and Mill creek in the Walla Walla Basin.

E.3 HARVEST WITHIN THE SEWMU

As stated above, fisheries for spring/summer Chinook salmon in the Snake River are opened on an "emergency regulation" basis by WDFW in the SEWMU, while steelhead fisheries are planned in and approved in advance. Below is a description of the annual harvest within the SEWMU based on records and reports by WDFW.

E.3.1 Spring/summer Chinook

Spring Chinook salmon fisheries have been held near Little Goose Dam in the Snake River since 2001. Other areas of the Snake River have also been opened periodically when fish numbers have supported it. Between 1977 and 2000, the Snake River had not been opened for Chinook fishing (Trump and Mendel 2010). Table E-1 summarizes the harvest results since 2001 for spring/summer Chinook in the SEWMU.

Table E-1. Summary of spring/summer Chinook salmon fisheries in the SEWMU (data from Trump and Mendel 2010).

Year	Area open	Season (actual)	Harvest (expanded)	Fish released (expanded)
2001	**Little Goose** (Texas Rapids boat launch upstream to the Corps of Engineers boat launch approximately one mile upstream of Little Goose Dam on the south bank of the river)	May 1-May 31	Adults: 1,076 Jacks: 50	Wild adults: 373
	Lower Granite (the mouth of Casey Creek upstream to the fishery restriction boundary 400 feet below Lower Granite Dam)	May 1-May 31	Adults: 147 Jacks: 7	Wild adults: 69
	Cent. Ferry (taken from Table 28 of Trump and Mendel 2010; no description of area)	May 1-May 31	Adults: 216 Jacks: 10	Wild adults: 116
2002	**Little Goose**	April 25-May 26	Adults: 866 Jacks: 0	Wild adults: 351
	Upper Snake River (Heller Bar to Southway Bridge)	April 25-May 26	Adults:105 Jacks: 0	Wild adults: 16 Wild jacks: 0 Hatchery Adults: 63 Hatchery jacks: 0
2003	**Little Goose**	April 26-June 16	Adults:513 Jacks: 282	Wild adults: 405 Wild jacks: 202 Hatchery Adults: 21 Hatchery jacks: 172
2004	**Little Goose**	April 16-May 7	Adults:1,224 Jacks: 21	Wild adults: 337 Wild jacks: 0

Year	Area open	Season (actual)	Harvest (expanded)	Fish released (expanded)
				Hatchery Adults: 10 Hatchery jacks: 0 Unknown jacks: 10
	Above Lower Granite Dam (Redwolf Bridge down to mouth of Wawawai Creek)	April 16-May 7	No estimate because no fish were observed harvested or released	
	Upper Snake River	April 24-May 31	Adults:150 Jacks: 0	Wild adults: 75 Wild jacks: 35 Hatchery Adults: 10 Hatchery jacks: 7
2005	**Little Goose**	June 11-June 30	Adults:77 Jacks: 4	Wild adults: 83 Wild jacks: 2 Hatchery Adults: 0 Hatchery jacks: 2
2006	**Little Goose**	May 17-June 30	Adults:192 Jacks: 21	Wild adults: 100 Wild jacks: 15 Hatchery Adults:30 Hatchery jacks: 12
2007	**Little Goose**	May 9-June 30	Adults: 284 Jacks: 207 Unknown: 13	Wild adults: 67 Wild jacks: 108 Hatchery Adults: 14 Hatchery jacks: 238
2008	**Ice Harbor** (railroad bridge near the mouth of the Snake River upstream to Ice Harbor Dam)	April 22-May 11	Adults: 149 Jacks: 30 Unknown: 26	Wild adults: 40 Wild jacks: 9 Hatchery Adults: 9 Hatchery jacks: 0
	Little Goose	April 24-May 11	Adults: 366 Jacks: 35	Wild adults: 88 Wild jacks: 7 Hatchery Adults: 0 Hatchery jacks: 0
2009	**Little Goose**	April 24-May 17	Adults: 498 Jacks: 183	Wild adults: 100 Wild jacks: 33 Hatchery Adults: 17 Hatchery jacks: 213
2010	**Ice Harbor**	April 20-May 21	Adults: 760 Jacks: 135	Wild adults: 101 Wild jacks: 68
	Little Goose	April 24-May 21	Adults: 832 Jacks: 48	Wild adults: 87 Wild jacks: 19
	Lower Granite	April 24-May 21	Adults: 15 Jacks: 0	Wild adults: 11 Wild jacks: 0
	Clarkston (Blyton Landing	April 24-May-21	Adults: 56	Wild adults: 0

Year	Area open	Season (actual)	Harvest (expanded)	Fish released (expanded)
	Boat Launch (~12 miles above Lower Granite dam) upstream about 19 miles to the boat dock behind the Quality Inn in Clarkston)		Jacks: 0	Wild jacks: 30

E.3.2 Steelhead

Steelhead fishing in the SEWMU has been on-going, and currently targets hatchery-origin fish only. Between 1986 and 2009, the number of hatchery fish harvest has steadily increased in the mainstem Snake River and tributaries (including the Walla Walla) of the SEWMU (Figure E-2).

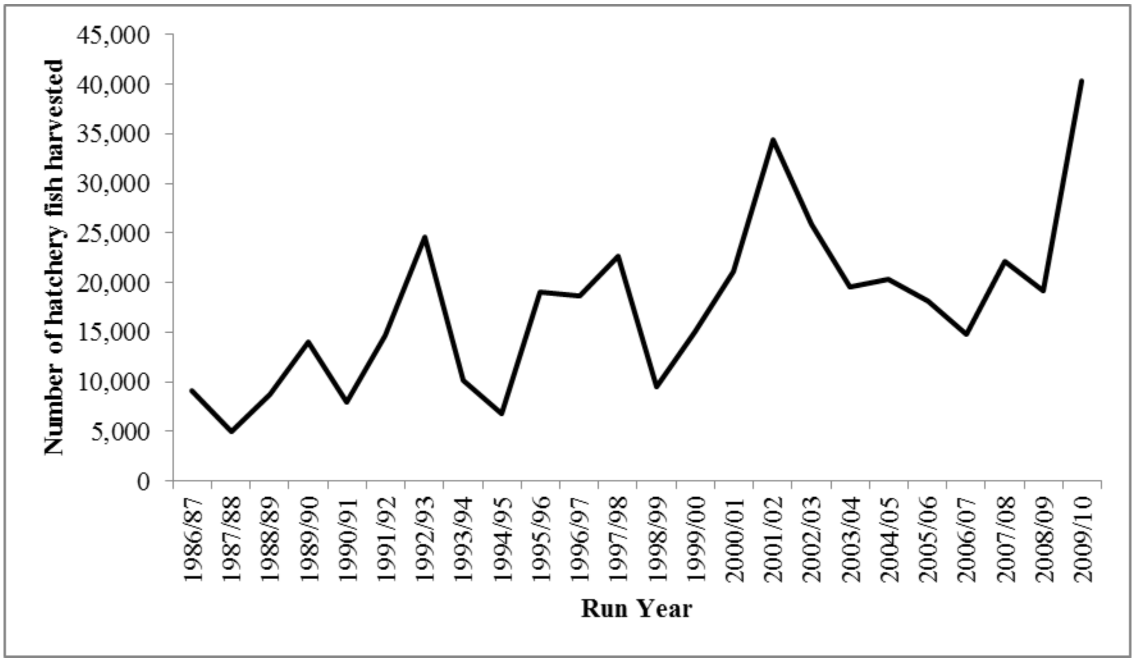


Figure E-2. Total hatchery fish estimated to be harvested within all steelhead fisheries of the SEWMU (data from WDFW catch record cards).

Table E-2 is a more detailed summary of the number of steelhead (both hatchery and naturally produced) caught in SEWMU streams since the 1986-87 run year.

Table E-2. Summary of steelhead harvest in SEWMU streams from 1986-87 run year to 2009-10 run year (data from WDFW catch record cards). Note that the number of wild fish recorded in the table is reliant on catch record cards, and there may be some associated error because of it.

													Snake River																SEWMU	
	Asotin Creek		Grande Ronde		Tucannon		Mill Creek (Walla Walla Co.)		Touchet		Walla Walla		Below Ice Harbor Dam		Ice Harbor to Lwr Monumental		Lower Monumental to Little Goose		Little Goose to Lower Granite		Above Lower Granite (old area)		Lower Granite Dam to Interstate		upstream of the Interstate Bridge		Total Hatchery	Total Wild
Run Year	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild	Hat.	Wild		
1986/87	4	7	156	44	206		40		283	8	1,451	133	171	6	629	24	1,338	16	589	4	4,314	137					9,181	379
1987/88			288	5	180	9	25		207	12	800	14	57		438		691	6	444	4	1,916	31					5,046	81
1988/89			511	4	255		74		231		1,097		121		686		917		739		4,060						8,691	4
1989/90			823		310		60		505		1,691		193		800		1,610		969		7,085						14,046	0
1990/91	2		653		337		34		334		1,474		110		812		1,361		1,068		1,801						7,986	0
1991/92			2,060	10	320	6	18	2	380	6	489	10	720	33	1,650	6	1,880	8	1,076	19	6,041	75					14,634	175
1992/93			1,458	49	354	4	100		212	5	852	32	507	14	1,874	70	2,510	149	9,321	72	4,030	261			3,368	105	24,586	761
1993/94			1,294	57	159		7	1	194	11	1,020	14	308	10	1,300	43	1,715	54	901	27	1,911	89			1,319	86	10,128	392
1994/95			939	28	164		12		299	14	402	26	126		835	19	1,523	45	364	40	921	29			1,270	44	6,855	245
1995/96	18	3	2,824	50	593	10	148	28	559	15	1,382	12	155		1,666	57	5,361	98	1,270	79	2,045	243			3,071	128	19,092	723
1996/97			3,322	33	830	6	101		285	4	1,463	65	85	5	2,030	41	4,908	86	815	16			1,556	192	3,285	74	18,680	522
1997/98	40		4,511	86	748		68		509	4	1,857	25	201	9	2,660	61	4,290	64	1,216	31	36		2,185	104	4,400	68	22,721	452
1998/99	4		1,440	30	246	44	16		51		282		44	4	934	19	2,007	68	519	12			1,358	41	2,614	40	9,515	258
1999/00			2,077	71	1,124	22	13		180	6	521	16	40		1,362	57	3,126	60	1,631	23			2,009	164	2,990	88	15,073	507
2000/01	6		5,755	70	592	18	15		452	18	992	22	114	4	1,769	49	2,721	106	1,156	13			3,294	141	4,254	110	21,120	551
2001/02	6	3	7,981	67	1,731	28	3		805	15	1,961	50	506		2,410	15	6,491	93	1,771	50			4,077	157	6,724	74	34,466	552
2002/03			5,349		1,149		12		180		715		324		2,321		4,578		1,787				5,549		3,960		25,924	0
2003/04			4,710		1,026				223		500		184		1,612		2,445		775				3,441		4,665		19,581	0
2004/05			4,642		1,352		6		268		1,484		141		2,246		3,008		911				3,029		3,299		20,386	0
2005/06			4,512		589		4		156		367		94		2,154		3,692		943				2,705		2,928		18,144	0
2006/07			2,977		527		7		140		460		169		2,516		2,932		810				2,159		2,145		14,842	0
2007/08			4,231		744				63		403		213		3,399		4,112		1,228				3,665		4,117		22,175	0
2008/09			3,220		1,228		4		228		539		296	3	2,483		3,853		1,003				3,398		2,949		19,201	3
2009/10			12,641		1,260		31		459		786		336		4,430		4,519	2	1,880				5,200	2	8,767	5	40,309	9

E.4 THREATS AND LIMITING FACTORS AND CONSERVATION BENEFITS ASSOCIATED WITH CURRENT FISHERY MANAGEMENT

In this section, harvest threats and limiting factors are identified, methods that have been used to assess the threats and limiting factors are discussed, and finally, the results of the analyses are summarized.

E.4.1 Limiting factors

Factors related to fisheries management that could be limiting population recovery are listed below (Table E-3). It is important to note the complexity of harvest management and also the improvements that have been made in recent years.

Table E-3. Anadromous salmonid populations and major limiting factors concerning harvest programs affecting SE Washington salmonids (based on SRSRB 2006).

Population	Fisheries Program Major Factor(s)Currently Limiting Population Recovery	Other Major Factor(s) Currently Limiting Population Recovery[a]
Touchet and Walla Walla steelhead Tucannon River steelhead Asotin Creek steelhead Lower Grande Ronde River and Joseph Creek steelhead Tucannon spring Chinook salmon Lower Grande Ronde River spring Chinook salmon	ESA-listed Salmon and steelhead from the SEWMU are impacted by commercial, sport, and tribal ceremonial and subsistence fisheries, both within and outside the SEWMU (see harvest module). Tributary fisheries in the SEWMU are being developed in such ways that are not considered limiting factors for recovery.	Hydroelectric projects and associated affects on water quality, flows, fish homing (e.g. bypassing the Tucannon River) and predator abundance and distribution. Tributary habitat impairments, barriers, water withdrawals, etc. Loss and/or reduction in the amount and quality of spawning and rearing habitat. Possibly transportation (barges).

[a] Other factors than hatchery management (see separate appendix on hatchery management)

E.4.2 Current Threats

Within Section 4(a)(1) of the ESA, the following categories are listed to determine threats affecting listed species:

- The present or threatened destruction, modification, or curtailment of its habitat or range.
- Overutilization for commercial, recreational, scientific, or educational purposes.
- Disease or predation.

- Inadequacy of existing regulatory mechanisms.
- Other natural or human-made factors affecting its continued existence.

The only one of these threat categories that relates to fisheries management is *Overutilization for commercial, recreational, scientific, or educational purposes*. The factors that could be threatening fish related to this category outside of the SEWMU are dealt with in the harvest module. The factors that could be threatening fish within the recovery area related to this category are:

Incidental or direct fisheries effects on ESA-listed natural-origin Chinook and steelhead.

Illegal, unregulated and unreported harvest could threaten ESA-listed natural-origin Chinook and steelhead.

Current and future management provisions, particularly those being developed through the SBHMF, are attempting to reduce the impacts from these potential threats.

E.5 STRATEGIES AND ACTIONS TO PROMOTE RECOVERY

This section deals with general harvest strategies and actions within the SEWMU to promote recovery of Snake River steelhead and spring/summer Chinook salmon. The specific actions are being developed through the SBHMF. Harvest strategies and actions outside the SEWMU are dealt with in the Harvest Module. General strategies and actions are those that discuss overarching effects, while specific ones will be developed in relationship to specific populations or species.

E.5.1 General Strategies

- Use harvest management to remove hatchery-origin fish and reduce abundance and proportion of hatchery spawners in the wild.
- Use harvest management to limit and reduce impacts on natural-origin fish.
- Leave open the possibility to target natural-origin stocks depending on the health of the populations, particularly for tribal fisheries.
- Closed fisheries to protect wild steelhead and spring Chinook populations in refuge areas (e.g. Asotin, Joseph creeks, and Wenaha Basin within WA), and in upper portions of the Tucannon and Touchet rivers, Mill Creek and most small tributaries within the SEWMU.

E.5.2 General Actions

- Use the Snake Basin Management Forum to develop coordinated fishery plans for fisheries within the SEWRU

E.6 MONITORING AND EVALUATION FOR FISHERY MANAGEMENT WITHIN THE SEWMU.

To determine whether a fishery program within the SEWMU is meeting its goals, robust monitoring and evaluation is needed. Information obtained from monitoring and evaluation can also assist managers in making informed decisions concerning fishery programs, allowing for adaptive management. Table E-4 lists fishery monitoring and evaluation activities that are necessary within SEWMU for adequate fishery management.

Table E-4. A summary of monitoring and evaluation activities that are necessary for fisheries management within the SEWMU.

Monitoring and Evaluation Approach or Focus	Description
Spawner Abundance	Total number of adults that spawn within the population boundary in a single spawning season.
Escapement	Number of adult fish that have "escaped" past fisheries and other sources of mortality to a certain point (e.g., into a tributary or spawning area).
Harvest rates	The proportion of population that is taken by a specific fishery
Exploitation rates	The proportion of the total stock or population harvested in all fisheries
Creel surveys	Statistical significant creel surveys need to be conducted by WDFW (jointly with Oregon Department of Fish and Wildlife, as appropriate) and the tribes to estimate total catch, harvest and incidental "take" of ESA-listed fish. Biological data, including mark information, fish length, and the presence of marks or tags need to be collected.
Catch record cards (CRC)	Non-Indian salmon and steelhead anglers are required to submit CRCs with specific data for all fish retained, including species, date and location of catch, age (adult or jack), and mark status (hatchery or wild).
Coded wire tag (CWT) and PIT information and analysis	Collection and analysis of coded-wire tag and PIT information can provide useful information for fishery management such as: run timing, in-season runsize updates, and well as stock-specific information for hatchery-origin and natural-origin fish captured or retained in the various fisheries.

E.7 MANAGEMENT UNCERTAINTIES

The major fishery-related management uncertainties are:

- Mortality of fish caught and released in mark-selective fisheries
- Mortality of fish caught that escape fishing gear
- Magnitude and distribution of unreported fishing
- Magnitude and distribution of harvest impacts

Table E-5 lists the uncertainties, objectives and strategies related to improving fishery management within the SEWRU.

Table E-5. Management uncertainties and proposed objectives and strategies within the SEWMU.

Uncertainty	Objective to address the uncertainty	Strategies	Comments
Mortality of fish caught and released in mark-selective fisheries	Determine the mortality rates of Snake River steelhead and Snake River spring/summer Chinook salmon that are caught and released in mark-selective fisheries in various environmental conditions.	Develop and implement studies or analyses that can help determine catch-and-release mortality for Snake River steelhead and Snake River spring/summer Chinook salmon in the SEWMU under the expected various environmental conditions, or review and consider applying results from other similar studies.	
Magnitude and distribution of unreported fishing	Determine where, when and how much unreported fishing is occurring for Snake River steelhead and Snake River spring/summer Chinook salmon within the SEWMU	Develop and implement (or expand existing efforts) a monitoring program that is fully funded for five years that can meet this objective.	The SRSRB, utilizing BPA funds, will conduct education and outreach in the summer of 2011 to fishers on the Tucannon River
Magnitude and distribution of harvest impacts	Determine what affect harvest impacts have on the VSP parameters for Snake River steelhead and Snake River spring/summer Chinook salmon populations within the SEWMU.	Develop and implement modeling exercise, in conjunction with co-managers to estimate the impact of various harvest rates on the abundance, productivity and potentially spatial structure and diversity of ESA-listed populations within the SEWMU.	

E.8 REFERENCES

Snake River Salmon Recovery Board (SRSRB). 2006. Technical Document Snake River Salmon Recovery Plan for SE Washington. Prepared for the Washington Governor's Salmon Recovery Office. Draft report. 583 pages

Trump, J. and G. Mendel. 2010. Snake River spring Chinook salmon fishery report, 2010. WDFW, 25 pages.

United States versus Oregon. 2008. 2008-2017 *United State v. Oregon* Management Agreement.

Washington Department of Fish and Wildlife (WDFW). 2009. Fisheries Management and Evaluation Plan for the Incidental Take of Listed Species Submitted Under ESA Section 10/4(d).

WDFW Recreational Fisheries for summer steelhead, warmwater fish, sturgeon, carp and other species. 103 pages.

APPENDIX F ECOSYSTEM DIAGNOSIS AND TREATMENT (EDT)

Table of Contents – Appendix F

Ecosystem Diagnosis and Treatment (EDT)

Table of Figures – Appendix F

Appendix F. Ecosystem Diagnosis and Treatment (EDT)

This Appendix is divided into two parts; Part 1 explains EDT and illustrates the assumptions and attributes that are used within the model, and Part 2 discusses how properly functioning conditions (PFC) are developed into attributes within the EDT model.

F.1 DEFINITION OF ECOSYSTEM DIAGNOSIS AND TREATMENT (EDT)

Ecosystem Diagnosis and Treatment (EDT) is a system for rating the quality, quantity, and diversity of stream habitat relative to the needs of a "focal" salmonid species. The methodology was designed to be a practical, science-based approach for watershed planning. It gives resource managers a scientific tool to link habitat characteristics to salmon performance and provides a basis for prioritizing protection and restoration activities, evaluating progress, and refining restoration strategies.

EDT was developed by Mobrand Biometrics, Inc. (MBI) in the 1990s with input from state, federal, and tribal agency scientists. A partial list of articles and other documents containing more information about EDT appears at the end of Part 1. To date, EDT has been used in most anadromous watersheds in Puget Sound and in the Columbia River Basin. In 2001-2002, MBI worked with the Northwest Power and Conservation Council to bring EDT into the web environment to make the methodology available to the public.

EDT is a methodology that includes a conceptual framework for decision making and modeling tools that organize environmental information in a centralized database. It is a "scientific expert" system that translates watershed and population information into population performance parameters (abundance, productivity, and diversity) for salmonids. In effect, EDT provides a description of the way in which the focal species would rate conditions in a stream, based on scientific understanding of their needs.

This system allows users to predict how stream habitat might change in response to future conditions such as watershed restoration and development. These types of predictions provide a basis for adaptive management of stream restoration.

Application of the EDT methodology results in a scientifically based assessment of environmental conditions, identification of restoration and protection needs, prioritization of restoration actions to maximize potential benefits to salmonids, and formulation of long-term restoration plans for watersheds based on adaptive management principles.

An EDT analysis begins with a description of the stream environment. The stream is divided into segments, or "reaches." Each reach is described quantitatively in terms of the Stream Unit Type, such as riffles, pools, and so on.

F.1.1 The Stream Unit Types used in EDT are:

- Backwater pools
- Beaver ponds
- Large cobble/boulder riffles
- Primary pools
- Pool tailouts
- Glides
- Off-channel areas
- Small cobble riffles

Each reach is then described qualitatively in terms of Environmental Attributes, such as temperature, flows, sediment, and so on.

F.1.2 The Environmental Attributes used in EDT are:

Alkalinity	Harassment	Riparian function
Artificial confinement	Hatchery outplants	Salmon carcasses
Bed scour	Icing	Temperature maximum
Benthos community richness	Metals in soil	Temperature minimum
Diel flow pattern	Metals in water	Temperature spatial variation
Dissolved oxygen	Natural confinement	Turbidity
Embeddedness	Natural flow regime	Water withdrawals
Fine sediment	Nutrient enrichment	Within year high flow
Fish community richness	Obstructions	Within year low flow
Fish pathogens	Pollutants in water	Wood
Fish species introductions	Predation	
Gradient	Regulated flow regime	

The quantitative and qualitative descriptions, combined with some general geographic descriptors, e.g., subbasin, stream, and reach names; channel width and length, form the basic habitat inputs to EDT.

The next step in EDT is to define the species being analyzed, i.e., the "focal" species. Spawning reaches and times and harvest patterns are defined. Life history patterns (profiles) are created for both juveniles and adults within the defined population.

Once the environment has been described and the focal species defined, the next step is to rate the quality and quantity of habitat with respect to the needs of the species. The measure of habitat value is the biological productivity and carrying capacity of the stream for the selected focal species under the habitat conditions described. In EDT, habitat quality is rated using a set of "rules" that relates conditions, such as water temperature, to the survival of a particular life stage of the focal species. The rules are developed by consulting with scientific experts on the habitat needs of the focal species and by examining scientific literature.

F.1.3 The Habitat Attributes used in EDT are:

Channel stability	Obstructions
Chemicals	Oxygen
Competition	Pathogens
Flow	Predation
Food	Salinity
Habitat diversity	Sediment load
Harassment	Temperature
Key habitat	Water withdrawals

Combining the Environmental Quality Attributes into Habitat Attributes allows the quality of the habitat to be related to the survival of one or more life stages of the focal species. For example, the Habitat Attribute "habitat diversity" is formed by combining survival relationships for a particular life stage, such as juvenile rearing over the summer, with Environmental Quality Attributes such as stream gradient, natural and artificial channel confinement, riparian function, and presence of woody debris. The result is that the survival of the juvenile summer rearing life stage can be related to habitat diversity as a function of gradient, channel confinement, riparian function, and woody debris.

The quantity of habitat is rated by summing the amount (total area) of different stream unit types in a stream reach and weighting them according to their potential value for a given life stage. For example, small cobble riffles are more important (weighted heavily) for spawning whereas primary pools are not important for this life stage and receive a weight of zero.

By rating the quantity and quality of habitat as seen "through the eyes" of the focal species reach by reach and performing an EDT analysis based on these inputs, it is possible to identify those areas where conditions are particularly good or bad for the fish. Actions that could be taken in "bad" areas to fix them and in "good" areas to preserve them can also be identified. The EDT output identifies the restoration and protection value for each reach as shown in Figure F-1.

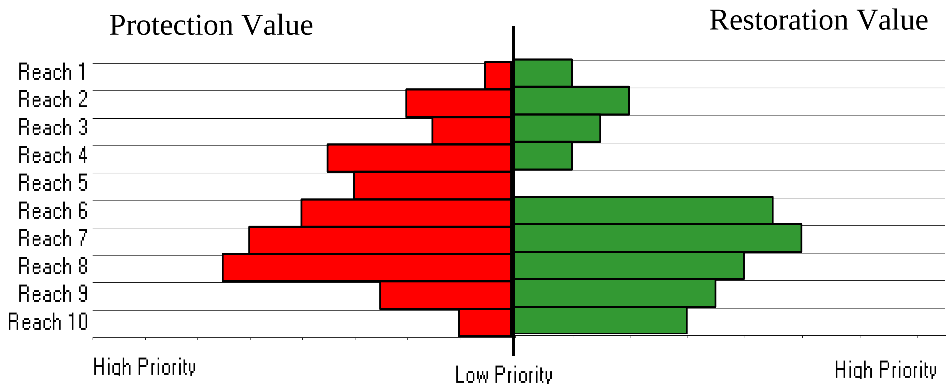


Figure F-1. Example of a plot of restoration and protection priorities along a stream.

Baseline reports from EDT describe population performance potential (under specified habitat conditions) in terms of capacity, productivity, and diversity. Factors limiting each life stage are identified.

Restoration actions based on the population performance potential and limiting factors may then be developed and combined into scenarios. Scenarios demonstrate how a salmonid population's performance can be expected to change as a result of future actions. Different actions or combinations of actions may be compared in terms of their biological effectiveness. Comparison may also be made to the original stream reach data. These comparisons allow planners and managers to choose actions that will yield the greatest benefit for the least cost.

The EDT output report referred to as a "reach analysis" is presented using a "Consumer Reports" format with different sized dots representing different sized impacts (the larger the dot, the more severe the impact) on survival for each focal species at a given life stage.

The EDT Online Web site was developed by MBI in cooperation with government agencies and organizations in the Pacific Northwest. The site is designed to allow planners and technical teams to assess habitat conditions in their areas and to analyze the benefits and risks of recovery actions.

Figure F-2. Draft Stream Reach Analysis Summary for Sandy River Chinook Salmon. (Note: Revisions Expected)

DRAFT - STREAM REACH ANALYSIS SUMMARY FOR SANDY RIVER CHINOOK SALMON (REVISIONS EXPECTED!)

Species/Component:	Spring Chinook
Restoration Potential:	Current conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Stream(s) / Water(s):	Sandy River	**Sub-Watershed:**	
Reach:	Sandy1 extends from confluence with Columbia River upstream 5.4 miles (near Dabney Park)	**Reach Length (mi):**	5.4
		Reach Code:	Sandy1

Restoration Benefit Category:	A	**Life History Diversity Rank:**	4	**Potential % change in diversity:1/**	5.6%
Combined Performance Rank:	2	**Productivity Rank:**	9	**Potential % change in productivity:1/**	7.6%
% of Total Life History Trajectories Affected:	100%	**Average Abundance (Neq) Rank:**	2	**Potential % change in Neq:1/**	28.2%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Habitat diversity	Harvest	Nutrient load	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	% Key habitat (quantity)
Spawning	Sep	2.6%	-89.9%	3							•							⬤		
Egg incubation	Sep-Apr	2.6%	-100.0%	1													⬤	⬤		
Fry colonization	Mar-May	5.3%	-7.3%	10						●										
0-age resident rearing	Mar-Oct	12.9%	-10.7%	5					•	●					●	●		●		
0-age transient rearing	Mar-Aug	14.8%	-2.2%	11						●										
0-age migrant	Oct-Nov	13.8%	-3.2%	9						•					•	●				
0,1-age inactive	Oct-Mar	6.4%	-35.4%	4, 2	●				●	●					•	●	⬤			
1-age migrant	Mar-Jun	68.9%	-0.7%	8						●						●				
1-age resident rearing	Mar-May	6.4%	-3.7%	12						•										
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Apr-Aug	100.0%	-0.9%	6						●	●							●		
Prespawning holding	May-Sep	2.6%	-24.3%	7					•	●	•							●		

1/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

<HP> indicates highest priority given due to fragmentation of habitat by dam or reservoir.

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Table Heading Descriptions

- **Species/Component** – Identifies the species to which the reach analysis applies. In this case, the species being examined is spring Chinook.
- **Restoration Potential** – Identifies the comparison being used to determine the restoration potential of the reach. For the Sandy River, current habitat conditions are being compared to historic (Template) conditions.
- **Restoration Emphasis** – Identifies the emphasis of the restoration approach. Typical restoration approaches could include increasing salmon productivity, re-establishing lost life-history patterns, or improving habitat quality through active restoration.
- **Stream(s) Water(s)** – Used to identify basin, major river, ocean reach, etc.
- **Reach** – Provides a brief description of the reach location.

- **Sub-watershed** – Line provided to allow modelers to break the basin into subbasins for analysis purposes.
- **Reach Length –** The length of the reach in either miles or kilometers.
- **Reach Code** – Identifies the specific reach the data in the table applies to and its EDT modeling designation.
- **Restoration Benefit Category –** The reach category is an arbitrary grouping of reaches based on a visual examination of the change in diversity index, productivity, and abundance for the reach if the reach were fully restored to the historic condition (Template). In this example, Sandy1 was assigned to the “A” category as its restoration has great potential for improving spring Chinook diversity, productivity, and abundance.
- **Life History Diversity, Productivity and Average Abundance (NEQ) Rank** – Shows the ranking of the reach relative to all others for these performance measures. For this example, Sandy1 was the 4th best candidate reach for improving spring Chinook life history diversity, 9th for productivity, and 2nd for increasing abundance.
- **% of Total Life History Trajectories Affected** – Calculates the percent of all modeled fish trajectories that this reach impacts. Sandy1 affects 100% of the trajectories, as it is the first reach in the basin. In general, the further upstream the each, the fewer trajectories the reach affects.
- **Combined Performance Rank** – Combined reach ranking is the average rank among the three performance ranks in comparison to all reaches in the basin. In other words, the three ranks are averaged for each reach, the average scores for the reaches are then sorted lowest to highest, the lowest score is then converted to a 1 (reach with highest restoration potential) other reaches assigned ranks based on ascending order. In this example, Sandy1 was rated “2”; therefore, there is only 1 reach with a higher restoration benefit.
- **Potential % Change in Productivity, Abundance, and Diversity** – These are the basic parameters for comparing the benefit category and reach ranking. They show the potential for improvement in overall population performance if this reach were fully restored to historic conditions. The restoration of Sandy1 would result in a 5.6%, 7.6%, and 28.2% increase in spring Chinook diversity, productivity, and abundance (NEQ), respectively.
- **Life Stage** – This column shows the life stages examined in the model (may vary by species).
- **Relevant Months** – The months, or target month, when the life stage occurs.
- **% of Life History Trajectories Affected By Life Stage** – This column shows how the reach is used by the entire spring Chinook population. Trajectories are computer-generated pathways through the landscape. Trajectories originate with spawning and end with pre-spawning holding, i.e., closed life history. It should be noted that:

1. The percent of the life history trajectories affected for pre-spawning, egg incubation, and spawning are reach specific. For example, note that the % of life history trajectories is the same for all of these life stages (2.6%).

2. Note that the values for other life stages vary considerably as fish from different reaches in the basin use this reach differently. For example, 68.9% of the 1-age migrant trajectories pass through this reach, but only 5.3% of the fry colonization trajectories use the reach. The fry trajectories are made up of fry produced in the reach and those migrating downstream from the next reach or two upstream.

- **Productivity change (%)** – This is the change in life stage specific productivity resulting from the change in the attributes shown across the row (black dots). For Sandy1, the reach analysis shows that spawning productivity has decreased by 89.9% due primarily to a change in temperature in this reach in comparison to Template conditions.
- **Life Stage Rank** – Rank is a combination of productivity loss and relative use of the reach by a particular life stage. A reach that is heavily used for a particular life stage and that has experienced a large loss will rank high. A reach may have experienced a large change in

productivity for a life stage but if the reach is not used heavily by that life stage it will rank lower. In this example, egg incubation (1) was the life stage most heavily affected by the change in the attributes, followed by 1-age inactive (2) and spawning (3).

- **Change in attribute impact on survival** – A Consumer Report style format is used to show the change in each attribute in comparison to the Template condition. Larger black circles indicate greater effect on survival as the result of a decrease in habitat quality. Circles are scaled in comparison to all other circles presented for the reach. Note that a lot of small black circles spread across multiple attributes could equal or exceed the effect of a single large circle. Thus, both the life stage rank and the size of the circles must be examined to discern the conclusions presented in this table. Clear circles show where conditions have improved for a life stage. For example, the addition of a reservoir would increase pool habitat which in turn would result in an increase in key habitat for juvenile rearing.

F.2 DEFINITION OF PROPERLY FUNCTIONING CONDITIONS, AS APPLIED IN EDT ANALYSES

Properly functioning conditions (PFC) is a concept created originally by the Bureau of Land Management (BLM) to assess the natural habitat-forming processes of riparian and wetland areas (Pritchard et al. 1993). When these processes are working properly, it can be assumed that environmental conditions are suitable to support productive populations of native anadromous and resident fish species. The notion of Properly Functioning Conditions for salmonid systems has also been advanced by the NMFS (1996) in connection with recovery of species listed under the Endangered Species Act.

The PFC concept has been translated into a set of EDT Level 2 attribute ratings—ratings that define a PFC environmental condition relevant to anadromous salmonids within Pacific Northwest streams.

PFC does not imply pristine or template conditions. There are many examples of healthy populations occupying degraded habitat. With this in mind, PFC ratings were applied to all reaches regardless of current habitat rating, e.g., if riparian function is 100 percent for the current condition, the PFC condition would still apply the 70 percent functional rating. Also, PFC is not intended to imply a standard against which all streams are compared. PFC cannot be “better” than historic conditions for a stream reach, e.g., if percent fine sediment in historic reconstruction was 15 percent, the PFC rating for sediment must be greater than or equal to 15 percent.

Properly Functioning habitat conditions outlined by the NMFS (1996) were used to help define the EDT PFC Level 2 ratings.

F.3 REFERENCES

American Fisheries Society. 1994. Proceedings of the Northwest Pacific Chinook and Coho Salmon Workshop of the American Fisheries Society, November 1994, Eugene, Oregon.

Lestelle, L.C., L.E. Mobrand, J.A. Lichatowich, and T.S. Vogel. 1996. Applied ecosystem analysis – a primer, EDT: the ecosystem diagnosis and treatment method. Bonneville Power Administration. Project No. 9404600, Portland, Oregon.

Lichatowich, J.A. and L.E. Mobrand. 1996. Chinook salmon (Oncorhynchus tschawytscha) in the Columbia River: the components of decline. Mobrand Biometrics, Inc., compiler. Report 5 of 8 in Applied Ecosystem Analysis – background, EDT: the ecosystem diagnosis and treatment method. Bonneville Power Administration, Portland, Oregon.

Lichatowich, J., L.E. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in freshwater ecosystems. Fisheries 20(1): 10-18.

Mobrand, L.E., L. Lestelle, and L. Gilbertson. 1995. An approach to planning ecosystem restoration with specific reference to the Grande Ronde Watershed, Oregon. In: M.L. Keefe (ed.) Salmon Ecosystem Restoration: Myth and Reality, Proceedings of the 1994

Mobrand, L.E., L.C. Lestelle, J.A. Lichatowich, and T.S. Vogel. 1997. An approach to describing ecosystem performance "through the eyes of salmon". Canadian Journal of Fisheries and Aquatic Sciences 54: 2964-2973.

National Marine Fisheries Service (NMFS). 1996. Making ESA determinations of effect for individual or grouped actions at the watershed scale. Environmental and Technical Services Division, Habitat Conservation Branch, Portland, OR.

Prichard, D., H. Barrett, J. Cagney, R. Clark, J. Fogg, K. Gebhardt, P. Hansen, B. Mitchell, and D. Tippy. 1993. Riparian area management: process for assessing proper functioning condition. TR 1737-9. Bureau of Land Management, BLM/SC/ST-93/003+1737, Service Center, Co.