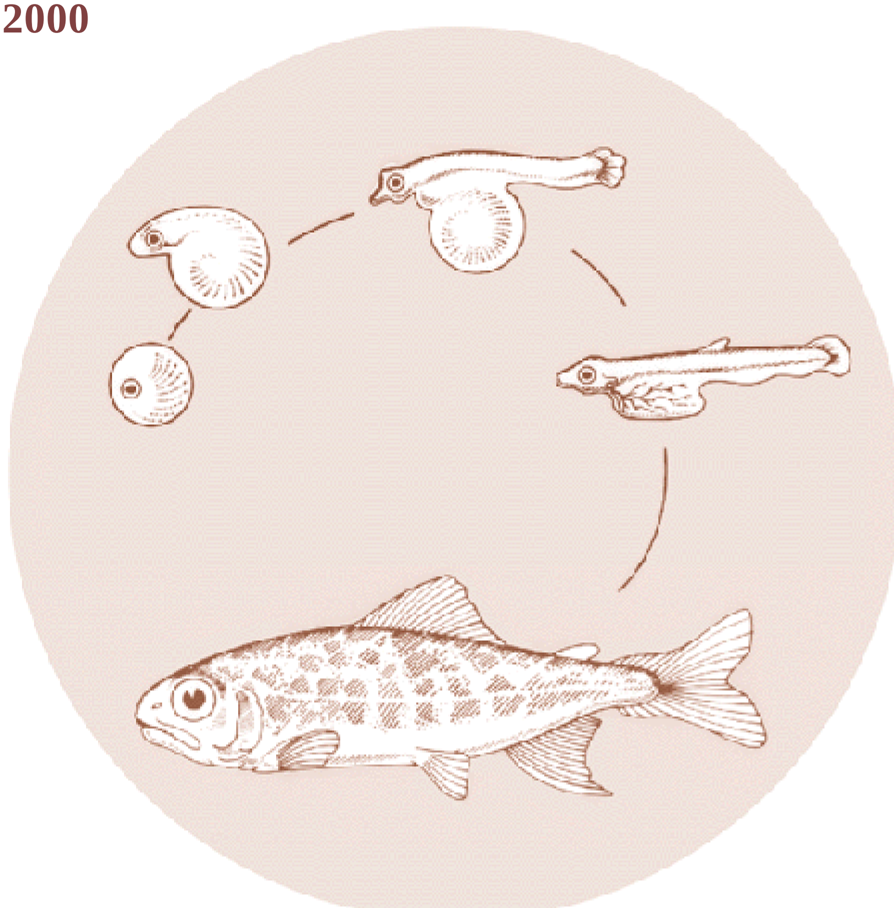
Northeast Oregon Hatchery Project

Spring Chinook Master Plan

Technical Report
2000



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Northeast Oregon Hatchery
Spring Chinook Master Plan

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April 2000

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Executive Summary

Spring chinook salmon populations in the Imnaha and Grande Ronde rivers are listed as threatened under the Endangered Species Act (ESA) and are at high risk of extirpation. The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, and Oregon Department of Fish and Wildlife, are co-managers of conservation/restoration programs for Imnaha and Grande Ronde spring chinook salmon that use hatchery supplementation and conventional and captive broodstock techniques. The immediate goal of these programs is to prevent extirpation and provide the potential for restoration once factors limiting production are addressed. These programs redirect production occurring under the Lower Snake River Compensation Plan (LSRCP) from mitigation to conservation and restoration. Both the Imnaha and Grande Ronde conservation/restoration programs are described in ESA Section 10 permit applications and the co-managers refer to the fish production from these programs as the Currently Permitted Program (CPP).

Recently, co-managers have determined that it is impossible to produce the CPP at Lookingglass Hatchery, the LSRCP facility intended for production, and that without additional facilities, production must be cut from these conservation programs. Development of new facilities for these programs through the Columbia Basin Fish and Wildlife Program is considered a new production initiative by the Northwest Power Planning Council (NPPC) and requires a master plan. The master plan provides the NPPC, program proponents and others with the information they need to make sound decisions about whether the proposed facilities to restore salmon populations should move forward to design. This master plan describes alternatives considered to meet the facility needs of the CPP so the conservation program can be fully implemented.

Co-managers considered three alternatives: modify Lookingglass Hatchery; use existing facilities elsewhere in the Basin; and use new facilities in conjunction with a modified Lookingglass Hatchery. Each alternative was evaluated based on criteria developed for rearing fish for a conservation program. After this review, the Nez Perce Tribe determined the only alternative that meets the needs of the program is the alternative to use new facilities in conjunction with a modified Lookingglass Hatchery. This is the Proposed Alternative.

The Proposed Alternative would require:

- Construction of a new incubation and rearing facility in the Imnaha River and modifications of the existing Gumboot facility to accommodate the Imnaha component of the Lookingglass Hatchery production,
- Construction of a new incubation and rearing facility in the Lostine River to accommodate the Lostine component of the Lookingglass Hatchery production, and
- Modifications at Lookingglass Hatchery to accommodate the Upper Grande Ronde and Catherine Creek components of the Lookingglass Hatchery production.

After an extensive screening process of potential sites, the Nez Perce Tribe proposes the Marks Ranch site on the Imnaha River and the Lundquist site on the Lostine River for new facilities. Conceptual design and cost estimates of the proposed facilities are contained in this master plan. The proposed facilities on the Imnaha and Lostine rivers would be managed in conjunction with the existing adult collection and juvenile acclimation/release facilities.

Because this master plan has evolved into an endeavor undertaken primarily by the Nez Perce Tribe, the focus of the document is on actions within the Imnaha and Lostine watersheds where the Nez Perce Tribe have specific co-management responsibilities. Nevertheless, modifications at Lookingglass Hatchery could make it possible to provide a quality rearing environment for the remainder of the CPP. The Nez Perce Tribe will assist co-managers in further evaluating facility needs and providing other components of the NPPC master planning process to develop a solution for the entire CPP.

Although the fish production for the conservation programs is already authorized and not at issue in this master plan, a detailed description of the fish culture program, historic and current management practices, and life history and biology of Imnaha and Lostine River spring chinook salmon is also provided in this master plan for background and supporting information.

Chapter 1 Introduction

In this chapter:

- The Purpose of the Master Plan
- How to use the Master Plan
- Where to find more information
- Organization of the chapters

1.1 The Purpose of the Master Plan

The Northwest Power Planning Council (NPPC) requires master plans for new programs and facilities proposed to restore salmon populations throughout the Columbia River Basin. The purpose of a master plan is to provide the NPPC, program proponents and others with the information they need to make sound decisions about whether the proposed program or project should move forward to design. The review and approval process for hatchery facilities in the Pacific Northwest is an extensive one. This Master Plan fulfills the first step of the current planning and approval process (see box).

The Program Approval Process

The development of master plans for spring chinook, steelhead and other appropriate stocks in the Imnaha and Grande Ronde River subbasins was authorized by the Northwest Power Planning Council under Section 7.4 (Pursue New Production Initiatives) in the Columbia Basin Fish and Wildlife Program (FWP) (NPPC 1994). Specifically section 7.4L calls for the development of Northeast Oregon Production Facilities to supplement natural production in the Imnaha and Grande Ronde rivers.

The process for approving master plans, preliminary design and construction of new artificial production facilities has changed. In 1997, the NPPC adopted a 3-Step Review Process for “new production initiatives:”

- Step 1 – conceptual planning, represented under the Program primarily by master plan development and approval;
- Step 2 – preliminary design and cost estimation, as well as environmental (National Environmental Policy Act and Endangered Species Act review); and
- Step 3 – final design review prior to construction and operation.

This master plan fulfills the requirements of Step 1 and is being submitted to NPPC.

“New production initiatives” are generally defined as projects that propose to:
(a) construct significant new production facilities,
(b) begin planting fish in waters they have not been planted in before,
(c) increase significantly the number of fish being introduced;
(d) change stocks or the number of stocks; or
(e) change the location of production facilities.
(f) initiation of funding existing facilities with ratepayer funds that were formerly funded otherwise.

Activities proposed in the master plan qualify as a “new production initiative” as they include constructing new production facilities (a) and changing the location of production facilities (e). Fish production in these facilities is already authorized under the LSRCP and this action will not change stocks or fish production.

Master planning for the Northeast Oregon Hatchery began in 1988 when the NPPC authorized the Nez Perce Tribe (NPT), Bonneville Power Administration (BPA) and the Oregon Department of Fish and Wildlife (ODFW) to submit a master plan for review.

This Master Plan details the plans for **conservation** and **integrated recovery**[*] facilities to reduce the risk of **extirpation**, and to restore spring chinook salmon populations in the Imnaha and Grand Ronde rivers of Northeast Oregon (see Map 1). An integrated recovery program, sometimes referred to as **supplementation**, is an **artificial propagation** project *primarily* designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and fish produced are intended to **spawn** in the wild or be genetically integrated with the targeted natural population(s) (National Marine Fisheries Service [NMFS] January 26, 2000).

Specifically, this document contains the master plan for Imnaha River and Lostine River (a tributary of the Grande Ronde River) spring chinook salmon. The planned facilities would work in concert with existing facilities built for the Lower Snake River Compensation Plan (LSRCP) to produce the fish authorized under that program. The LSRCP is a program to **mitigate** for spring, summer, and fall chinook salmon and steelhead losses caused by the four federal dams constructed on the lower Snake River.

Production of spring chinook salmon under the LSRCP mitigation program has been occurring in the Imnaha and Grande Ronde **subbasins** since the early 1980s. Beginning in the early 1990s, the co-managers of this program (ODFW, NPT, and the Confederated Tribes of the Umatilla Indian Reservation [CTUIR]) recognized that these populations were at imminent risk of extirpation and immediate action was necessary. Spring chinook salmon populations in the Imnaha and Grande Ronde rivers are classified by the National Marine Fisheries Service as components of the Snake River spring/summer chinook salmon **Evolutionarily Significant Unit (ESU)** and were listed as **threatened** under the **Endangered Species Act** in May 1992. As a result, the NPT, the CTUIR, and ODFW cooperatively developed conservation/restoration programs for Imnaha and Grande Ronde spring chinook salmon that use hatchery supplementation. These programs redirect existing production occurring under LSRCP from mitigation to conservation and restoration. The Imnaha program uses **conventional broodstock** production, while the Grande Ronde program (also known as the Grande Ronde **Endemic** Spring Chinook Supplementation Program or GRESP) is an integration of conventional and **captive broodstock** production techniques.

Both the Imnaha and Grande Ronde conservation/restoration programs are described in NMFS ESA Section 10 permit applications and the co-managers refer to the fish production from these programs as the Currently Permitted Program (CPP). Detailed description of the CPP can be found in Chapter 4. Funding for the programs occurs through a combination of LSRCP and BPA projects (see Table 1-1). Figure 1-1 shows the interrelationship of these projects and the activities and facilities that they fund. Each project has a relationship to the goals and success of the conservation/restoration program (see Table 1-1 and Figure 1-1).

[*]Words in bold are defined in Chapter 8, Glossary and Acronyms

BASIN LOCATION MAP

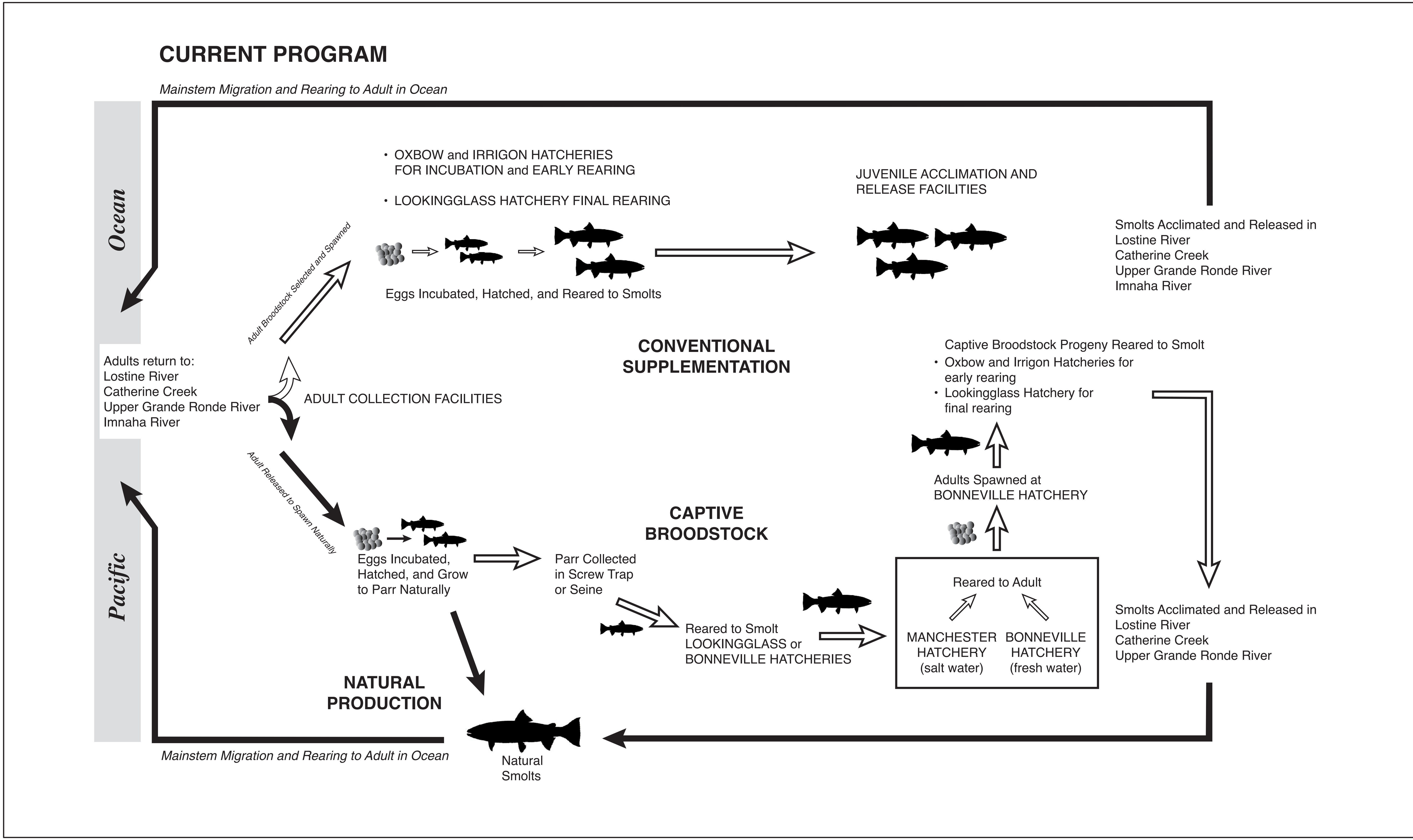


Figure 1-1 Project Relationship

Table 1-1 Related Programs and Projects

Program/Plan and (Number)	Manager	Type	Relationship to Master Plan
Lower Snake River Compensation Plan (LSRCP)	ODFW NPT	O&M and M&E of LSRCP program at Lookingglass Hatchery Co-operation of the Imnaha satellite facility and M&E of the LSRCP program.	The LSRCP program funds operation and maintenance (O&M) of Lookingglass Hatchery and the Imnaha River (Gumboot) satellite facility. Fish production at Lookingglass Hatchery has been refocused from mitigation to conservation and restoration. The new facilities proposed would alleviate the burden at Lookingglass Hatchery and make full production of the conservation programs possible. Monitoring and evaluation (M&E) of the LSRCP for the Imnaha and Grande Ronde is also funded through the LSRCP (see Sections 4.1.13 and 4.2.12 for more detail).
Grande Ronde Basin Captive Broodstock (BPA 9801001)	ODFW	Captive Broodstock O&M and M&E at Lookingglass and Bonneville Hatcheries	BPA project 9801001 funds rearing of captive brood adults in freshwater for the Grande Ronde program. The proposed facilities would provide the additional incubation and rearing space (with sufficient segregation capability for monitoring and evaluation and fish health requirements) needed to rear progeny of the captive broodstock.
Captive Broodstock Artificial Propagation (BPA 9801006)	NPT	M&E of Captive Broodstock	BPA project 9801006 funds monitoring and evaluation activities of captive broodstock production at Bonneville Hatchery. The proposed facilities will provide incubation and rearing space needed to rear progeny of the captive broodstock.
Grande Ronde Supplementation - Lostine River (GRESP) (BPA 9800702)	NPT	O&M/M&E Satellite facilities	BPA project 9800702 funds operation and maintenance and monitoring and evaluation of satellite facilities on the Lostine River for adult collection and juvenile acclimation and release of captive and conventionally produced spring chinook salmon. These facilities will act as satellites to the proposed facilities.
Grande Ronde Supplementation - Upper Grande Ronde and Catherine Creek (GRESP) (BPA 9800703)	CTUIR	O&M/M&E Satellite facilities	BPA project 9800703 funds operation and maintenance and monitoring and evaluation of satellite facilities on the Upper Grande Ronde River and Catherine Creek for adult collection and juvenile acclimation and release of captive and conventionally produced spring chinook salmon. The proposed facilities will alleviate the burden at Lookingglass Hatchery allowing full production of these stocks.
Preserve Listed **Salmonid** Stock Gametes (BPA 9803800)	NPT	Cryopreservation of ESA-listed male chinook gametes	BPA project 9803800 funds the collection, cryopreservation, and storage of male chinook semen collected from Imnaha and Grande Ronde fish both on the spawning grounds and in the hatchery. Project 9803800 would continue to provide these activities for the program at the proposed facilities.

Program/Plan and (Number)	Manager	Type	Relationship to Master Plan
Northeast Oregon Hatchery (NEOH) Master Plan (BPA 8805301)	NPT	Planning Capital Construction	BPA project 8805301 funds planning and activities associated with development of new hatchery facilities in the Imnaha and Grande Ronde subbasins of Northeast Oregon. Development of the master plan document occurred through this project. Project 8805301 will also fund the NEPA process and design of the proposed facilities, as well as capital construction costs.
Northeast Oregon Hatcheries Planning and Implementation (BPA 8805305)	ODFW	Planning O&M/M&E Lookingglass Hatchery	BPA project 8805305 funds ODFW participation in the master planning process. Project 8805305 also funds operation of Lookingglass Hatchery for captive and conventional chinook salmon produced in the Grande Ronde program. The proposed facilities will alleviate the burden at Lookingglass Hatchery and make it possible for production goals to be met.
Manchester Captive Broodstock (BPA 9606700)	NMFS	Captive broodstock O&M at Manchester facility	BPA project 9606700 funds rearing of captive brood adults in saltwater for the Grande Ronde program. The proposed facilities will provide the additional incubation and rearing space (with sufficient segregation capability for monitoring and evaluation and fish health requirements) needed to rear progeny of the captive broodstock.
Fish Passage Center's **Smolt** Monitoring Project (BPA 9403300)	Fish Passage Center	Monitoring of juvenile salmon migration	Juvenile and natural salmon produced at the proposed facilities will provide information on in-river migration timing and survival (see Sections 4.1.13 and 4.2.12).
Early Life History of Spring Chinook (BPA 9202604)	ODFW	M&E of juvenile outmigration in the Grande Ronde	BPA project 9202604 is funded to establish baseline life history information on Grande Ronde River spring chinook salmon. Juvenile trapping data from project 9202604 would be used to evaluate the success of the conservation program and production from the proposed facilities (see Section 4.2.12).
Imnaha River Smolt Monitoring Project (BPA 8712703)	NPT	M&E of juvenile outmigration in the Imnaha	BPA project 8712703 is funded to monitor emigration survival, timing, and life history characteristics, and will intensively monitor emigration of hatchery and natural spring chinook salmon from the Imnaha River system. Project 8712703 would also be used to evaluate the success of the conservation program and production from the proposed facilities (see Section 4.1.13).
Genetic Monitoring and Evaluation of Snake River Salmon and Steelhead (BPA 8909600)	NMFS	Genetic M&E	BPA project 8909600 funds the collection, analysis and establishes a database of genetic data from salmon and steelhead stocks in the Snake River. Juvenile hatchery and natural salmon produced as a result of the proposed facilities would provide information for this database.
Grande Ronde Model Watershed (BPA 9402700)	Grande Ronde Model	Habitat	BPA project 9402700 is responsible for coordinating water quality monitoring and habitat enhancement projects in the Grande Ronde and Imnaha subbasins. These efforts are expected to assist recovery actions described in this master plan. In addition, juveniles produced by proposed

Program/Plan and (Number)	Manager	Type	Relationship to Master Plan
	Watershed		facilities will provide information on habitat use in treatment areas. (See Section 6.4.2 for more information).
Grande Ronde Habitat Enhancement (BPA 9608300)	CTUIR	Habitat	BPA project 9608300 is funded to improve habitat in the Grande Ronde Subbasin. These efforts are focused in the upper Grande Ronde watersheds of Union County. Improvement in habitat will increase likelihood of program success. (See Section 6.4.2 for more information.)
Wallowa Basin Project Planning (BPA 9403900) and Wallowa/Nez Perce Salmon Habitat (BPA 9702500)	NPT	Habitat	BPA projects 9403900 and 9702500 are funded to improve habitat in the Imnaha and Grande Ronde subbasins. These efforts are focused in Wallowa County. Improvement in habitat will increase likelihood of program success. (See Section 6.4.2 for more information.)
Grande Ronde Habitat Enhancement (BPA 8402500)	ODFW	Habitat	BPA project 8402500 is funded to improve habitat in the Grande Ronde Subbasin. These efforts are focused in Union County. Improvement in habitat will increase likelihood of program success. (See Section 6.4.2 for more information.)

Lookingglass Hatchery was originally designed and constructed under the LSRCP mitigation program to produce two **stocks** of fish:

- Imnaha stock for the Imnaha Subbasin (490,000 **smolts**); and
- Lookingglass Creek stock for the Grande Ronde Subbasin (900,000 smolts).

With the implementation of the CPP, Lookingglass Hatchery was programmed to function as the primary facility for essentially four different program components with eight separate groups of fish (see Table 1-2). Because the new programs did not increase numbers of fish to be produced at Lookingglass Hatchery, an assumption was made that the existing facility, with minor modifications, would be sufficient to meet the CPP needs (ODFW 1998b).

Table 1-2 Currently Permitted Program (CPP) Stocks, Status, and Smolt Production Goals Authorized at Lookingglass Hatchery

Program Type and Stock	ESA Status	Smolt Production
Conservation production to prevent extinction and restore native populations		
1. Imnaha conventional brood		
• Imnaha stock	Threatened	490,000
2. Grande Ronde (GRESP) conventional brood		
• Upper Grande Ronde	Threatened	250,000[a]
• Catherine Creek	Threatened	250,000 [a]
• Lostine River	Threatened	250,000 [a]
3. Grande Ronde (GRESP) captive brood		
• Upper Grande Ronde	Threatened	
• Catherine Creek	Threatened	
• Lostine River	Threatened	
Experimental supplementation to restore an extirpated population		
4. Lookingglass Creek conventional brood		
• Naturalized Rapid River stock	Not-listed	150,000
TOTAL		1,390,000

[a]Conventional and captive production combined goal.

Each of the programs in Table 1-2 have associated monitoring and evaluation (M&E) studies and treatment groups requiring partitioning of **rearing** areas within the existing raceways. In addition, fish health experts believe three levels of Bacterial Kidney Disease (BKD) segregation for each group of fish should be considered essential for health management of ESA-listed stocks (Groberg et al. 1999, Montgomery Watson 1999a). Unfortunately, the increased space and water required to implement the necessary segregation of additional stocks, fish health and M&E requirements at Lookingglass Hatchery have overloaded the facility.

As part of the master planning process, NPT, CTUIR, and ODFW initiated an independent review of Lookingglass Hatchery to evaluate the ability of Lookingglass Hatchery to meet program requirements and identify necessary modifications. The review found that it is impossible to meet CPP needs at Lookingglass Hatchery (Montgomery Watson 1999a). Some major problems have recently developed at the facility that have confirmed the results of the review. Thus the current and potential operating condition at Lookingglass Hatchery is putting the four groups of ESA-**listed fish** reared there at extreme risk. In 1999, co-managers had to move all fish stocks to other facilities for incubation and early rearing.

Co-managers have determined that without additional facilities, production must be cut from these conservation programs. However, the numbers of fish released from the program are based on returning enough adults to reduce the **demographic risk of extinction**. In addition, Lookingglass Hatchery is an integral part of an existing spring chinook salmon captive broodstock project already funded under the NPPC's Fish and Wildlife Program (see Table 1-1 and Figure 1-1). Without additional facilities and a fully operational Lookingglass Hatchery, there is nowhere to rear the offspring of the captive broodstock.

This master plan identifies alternatives to meet facility needs of the CPP so the conservation program can be fully implemented. It specifically identifies the NPT's Proposed Alternative for the Imnaha and Lostine components of the CPP. The ODFW and CTUIR will determine an appropriate strategy for facility modifications at Lookingglass Hatchery or other locations for the Upper Grande Ronde and Catherine Creek components.

This document also provides information on the life history, biology and status of Imnaha and Lostine rivers (Grande Ronde) spring chinook salmon, describes management goals and objectives, and details the programs co-managers have developed aimed at preventing extinction and restoring these population segments.

1.2 Expected Program Benefits

Spring chinook salmon populations in the Imnaha and Grande Ronde rivers are at high risk of extirpation because of low productivity and a low abundance of spawners. The primary benefit expected from this program is a reduction in the demographic risk of extirpation, which will ensure the persistence of these populations. Although there are inherent risks to wild populations from artificial propagation, the greatest short-term risk to these populations is the risk of extirpation. The conservation programs described in this plan would provide an increase in the number of natural spawners to forestall extirpation while the primary factors affecting the productivity of these populations are corrected.

Spring chinook salmon supplementation in the Imnaha River has demonstrated that the hatchery program has provided a substantial survival advantage above natural rates and has increased the total number of returning chinook salmon adults and number of natural spawners in the basin (Carmichael et al. 1998b).

If this program and others (see Table 1-1) are successful at stabilizing and preserving the genetic resources of the Imnaha and Lostine chinook salmon populations, and other factors are addressed to improve productivity (see Table 1-3 and Chapter 6), the hatchery programs should help accelerate the restoration of these populations.

Other expected outcomes include ecological and social benefits: increased nutrients in the ecosystem from salmon carcasses, increased potential to achieve restoration and delisting under ESA, improved ability to meet LSRCP mitigation goals if productivity improves, and increased potential to reestablish tribal and sport fisheries. The program will also provide a better understanding of the role supplementation can play in the recovery of chinook salmon populations.

1.3 Relationship to Other Plans, Programs and Projects in the Region

The Northeast Oregon Hatchery Master Plan must be consistent and work in concert with many other efforts to restore salmon and steelhead in the Imnaha and Grande Ronde River subbasins and throughout the Columbia River Basin. The relationship of this Master Plan to the many ongoing efforts in the region and how the Master Plan is consistent with those programs is summarized in Table 1-3.

Table 1-3 Consistency with other Programs and Plans

Program or Plan	Requirement or other Connection to Program	NEOH Master Plan
Treaty of 1855	The Nez Perce Tribe reserved "The exclusive right of taking fish in all the streams where running through or bordering said reservation ..and.. taking fish at all usual and accustomed places …" in the Treaty of 1855. No subsequent treaty or agreement between the Nez Perce Tribe and the United States altered or affected this treaty-reserved right.	Restoration of salmon **runs** resulting from fish production in the proposed facilities would assist in meeting obligations to the Nez Perce Tribe made by the United States.
Endangered Species Act of 1973	Snake River spring/summer and fall chinook were listed as threatened in May 1992. On August 18, 1994, they were reclassified as endangered species (Federal Register, August 1994). When the emergency rule expired in 1995, the listed status reverted to threatened. Steelhead in the Imnaha and Grande Ronde rivers were listed as threatened under the Endangered Species Act in 1996 (Federal Register, August 9, 1996). Bull trout in the Imnaha and Grande Ronde rivers were listed as threatened under the Endangered Species Act on June 10, 1998 (Federal Register volume 63 No. 111:31647-31674). Taking of Imnaha and Lostine (Grande Ronde) River chinook, steelhead and bull trout is regulated by the Section 7 (federal) and Section 10 (non-federal) process of the Endangered Species Act (P.L. 93-205).	Activities associated with the Imnaha conservation program have been authorized by ESA Section 10 Permit 847 and 1134. A description of the Imnaha CPP is in the pending Section 10 Permit application (ODFW 1998b – see Appendix A), which was submitted to NMFS January 23, 1998. Activities associated with the GRESP have been authorized by ESA Section 10 Permits 973, 1011, 1134 and Modification 1 to Permit 1011. Permit applications describing the Grande Ronde CPP were submitted by ODFW (1998b) March 31, 1998 and BIA (1998) April 13, 1998 and have permits pending. See Appendix A. Section 7 consultations regarding impacts to bull trout and steelhead from these programs have also been done (NMFS 1998b, NMFS 1999 and USFWS 1998).
Snake River Proposed Recovery Plan (NMFS 1995)	This plan was developed by NMFS in 1995 in response to the 1992 listing of Snake River spring, summer and fall chinook salmon.	Fish production in the proposed facilities is consistent with recommendations in the Recovery Plan.
Lower Snake River Fish and Wildlife Compensation Plan (USACE 1975)	Federal authorized program to mitigate for losses caused by four lower Snake River dams. Mitigation goals for spring chinook salmon are 3,210 adults to the Imnaha River and 5,820 adults to the Grande Ronde River.	Fish production in the proposed facilities would be authorized under the LSRCP program. Proposed facilities could eventually be used to achieve program goals.
U.S. v. Oregon	Treaty fishing rights litigation addressing Columbia Basin salmon and steelhead harvest and enhancement goals.	Proposed facilities would assist in meeting obligations and agreements under the lawsuit.
NMFS Hatchery Genetic Management Plan (NMFS January 26, 2000)	A template developed by NMFS for anadromous salmonid hatchery programs in Washington, Oregon and Idaho. The template will be used to assess **artificial production** impacts on listed anadromous fish and provide a source of comprehensive information for regional production and management planning.	Information required in the HGMP template is incorporated into the master plan in Chapter 4. See Appendix B for further information. Completion of an HGMP will be used under the 4(d) rule to allow direct **take** of an ESA-listed species for hatchery production.

Program or Plan	Requirement or other Connection to Program	NEOH Master Plan
Scientific Review Team Review of Artificial Production (Brannon et al. 1999)	Independent scientific review of the Columbia Basin artificial production program, analysis of effectiveness in meeting mitigation responsibilities and enhancing salmonid production, and evaluation of supplementation of natural runs. Describes guidelines that provide the biological basis for NPPC policy on artificial production.	Proposed facilities are consistent with guidelines and recommendations developed by the SRT for artificial production facilities.
Artificial Production Review (NPPC 1999)	NPPC report to Congress on the use of artificial production in the Columbia Basin that includes recommendations for policy reform and strategies for implementing new policies.	This master plan and the proposed facilities are consistent with APR recommendations and policies. See Appendix C.
Wy-kan-ush-mi wa-kish-wit: *Spirit of the Salmon* Tribal Recovery Plan (NPT et al. 1995).	Plan developed by the four Columbia River Treaty Tribes to restore fish runs using gravel-to-gravel management.	Production in the proposed facilities is recommended by the Tribal Recovery Plan.
Wallowa County-NPT Salmon Recovery Plan (Wallowa County and NPT 1993)	A cooperative plan between Wallowa County and the Nez Perce Tribe to improve watershed and habitat conditions in Wallowa County.	Habitat improvements accomplished through this plan are intended to improve productivity and survival of naturally produced salmon and fish reared in proposed facilities.
Imnaha River Subbasin Plan (NPT et al. 1990)	Plan developed by co-managers to address the NPPC goal of doubling salmon and steelhead runs. Adult return goals for spring chinook were 5,770; 3,820 for natural spawning, 1,240 for hatchery production, and 700 for harvest.	Proposed facilities could eventually be used to achieve plan goals.
Grande Ronde River Subbasin Plan (ODFW et al. 1990)	Plan developed by co-managers to address the NPPC goal of doubling salmon and steelhead runs. Spring chinook salmon adult return goals were 16,400; 10,140 for natural spawning, 2,260 for hatchery production, and 4,000 for harvest.	Proposed facilities could eventually be used to achieve plan goals.
Wild and Scenic Rivers Act	The Imnaha and portions of the Lostine River are protected under the WSRA that requires a river to be free flowing and to possess one or more “outstandingly remarkable values.”	Populations and habitat of threatened and endangered fishes are considered an outstandingly remarkable value. Fish production in proposed facilities is consistent with protection of these resources.
Pacific Salmon Treaty	A treaty between the U.S. and Canada governing the joint management of Pacific salmon including harvest, rehabilitation, and enhancement.	Fish production from the proposed facilities could be harvested in marine waters.
Magnuson-Stevens Fisheries Conservation and Management Act	Congressional act that ensured that state fishing regulations off the coasts of Oregon, Washington and California conformed to the federal Fisheries Management Council regulations, which are constrained by the Pacific Salmon Treaty, ESA, and orders of federal courts, such as *U.S. v. OR*, *U.S. v. WA* and treaty Indian fishing rights.	The Act affects the potential harvest of fish produced from the proposed facilities as bycatch in the ocean harvest.

Program or Plan	Requirement or other Connection to Program	NEOH Master Plan
Oregon Wild Fish Management Policy of 1987	Developed by ODFW in response to the creation of Oregon's Endangered Species Act in 1987, the primary focus of the WFMP is to preserve the genetic resources of managed fish populations. This policy is currently undergoing revisions and will most likely be called the Native Fish Conservation Policy.	Management of fish production from proposed facilities employs an adult sliding scale developed by NPT, CTUIR, and ODFW as a genetic risk containment tool (see Chapter 4 for more information).
Oregon Legislature House Bill 3609	Passed in 1999, HB 3609 directs the ODFW to work with the Columbia Basin Treaty Tribes to develop natural production plans for the Imnaha and Grande Ronde River subbasins.	Proposed facilities would allow implementation of plans directed by HB 3609.
Return to the River (ISG 1996)	Report to the NPPC in 1994 by the Independent Scientific Group to provide a conceptual and scientific foundation for public policy for decision making bodies.	This report does not recommend policies for recovery and restoration, nor does it recommend specific measures or strategies or deal with institutional structures.
Upstream Report (NRC 1996)	Developed by the National Research Council in 1995 to identify factors that have led to decline and extinction of salmon stocks and recommend strategies for prevention of further decline. The report emphasizes the need to protect **genetic diversity** of salmon and restore spawning and rearing habitat.	The short-term goal of fish production from the proposed facilities is protecting genetic diversity by preventing extinction. For more information on genetic risk containment see Chapter 4. For more information on habitat improvements and protection see Chapter 6.
Pacific Northwest Power Planning and Conservation Act of 1980	This Act established the Northwest Power Planning Council for the purpose of mitigating for the development and operation of hydroelectric projects within the basin. The Council implements the Fish and Wildlife Program to protect, mitigate, and enhance fish and wildlife in the Columbia River basin.	Proposed facilities would be funded through the Fish and Wildlife Program.
Other Supplementation projects including Nez Perce Tribal Hatchery; Johnson Creek Artificial Propagation Enhancement, Yakama Supplementation Program	Supplementation programs funded through the Fish and Wildlife Program.	Proposed facilities are consistent with approach taken elsewhere in the basin to use supplementation to enhance and restore declining salmon runs. Evaluation and research will be coordinated.
Northwest Power Planning Council and Multi-Species Framework Process.	The Framework seeks to link Columbia Basin fish and wildlife restoration policy to a basinwide vision, based on a scientific foundation that recognizes that the river and its species are interrelated parts of a whole. The NPPC will base its Fish and Wildlife program amendments on one of the Framework alternatives.	Fish production from the proposed facilities is intended to prevent extinction of these at-risk populations until limiting factors can be corrected. These facilities can also be used to restore runs once the smolt-to-adult survival rate is improved.

Program or Plan	Requirement or other Connection to Program	NEOH Master Plan
U.S. Army Corps of Engineers' Lower Snake River Feasibility Study.	The Corps has prepared a draft Environmental Impact Statement (EIS) reviews options for improving juvenile salmon migration in the lower Snake River. Breaching the four lower Snake dams is one of the options studied. The EIS provides information for decision-makers who must ultimately decide on what measures are needed to recover Snake River salmon and steelhead runs.	Fish production from the proposed facilities is intended to prevent extinction of these at-risk populations until a decision is made and limiting factors can be corrected. These facilities can also be used to restore runs once the smolt-to-adult survival rate is improved.
Interior Columbia Basin Ecosystem Management Program (ICBEMP).	ICBEMP is a massive federal land-use plan that covers 144 million acres in Oregon, Idaho, Washington, Montana, Nevada, Utah, and Wyoming. Its goal is to restore this area to a condition that will better support fish and wildlife.	Fish production from the proposed facilities is intended to prevent extinction of these at-risk populations until limiting factors can be corrected. These facilities can also be used to restore runs once the smolt-to-adult survival rate is improved.
Columbia River Basin Forum.	Formerly called The Three Sovereigns, the Columbia River Basin Forum is designed to improve the management of fish and wildlife resources in the Columbia River Basin. The process is an effort to create a new forum where the federal government, Northwest states and tribes could better coordinate, discuss and resolve basin-wide fish and wildlife issues under the authority of existing laws.	Fish production from the proposed facilities is intended to prevent extinction of these at-risk populations until a decision is made and limiting factors can be corrected. These facilities can also be used to restore runs once the smolt-to-adult survival rate is improved.
Federal Caucus All-H Paper (Federal Caucus December 1999)	Nine federal agencies formed a *Federal Caucus* to examine opportunities the region has in habitat, harvest, hatcheries and hydropower for recovering listed salmon, steelhead and resident fish. The All-H Paper is a conceptual recovery plan to guide future federal actions.	Fish production from the proposed facilities is intended to prevent extinction of these at-risk populations until a decision is made and limiting factors can be corrected. These facilities can also be used to restore runs once the smolt-to-adult survival rate is improved.

1.4 How to Use the Master Plan

The NPPC has specific requirements for the contents of a Master Plan (see box). The list of requirements is long, but in general the NPPC asks for details about program goals and objectives, expected benefits, expected impacts, alternatives, historical information, consistency with other programs, and other information necessary for the NPPC, program proponents and others to make decisions. This Master Plan contains all the detail required by the NPPC.

The Master Plan contains general and technical information. The main document contains the heart of the information about the proposed program. Some technical information is contained in appendices and referred to in the main document so that technical readers can have the information they require. For example, the Conceptual Monitoring and Evaluation Plan is in Appendix D.

Requirements for this Master Plan

In accordance with Section 7.4B of the Fish and Wildlife Program (NPPC 1994) this master plan addresses:

- project goals; (see Section 3.1)
- measurable and time-limited objectives; (see Section 3.1)
- factors limiting production of the target species; (see Chapter 6)
- expected project benefits (e.g., gene conservation, preservation of biological diversity; fishery enhancement, and/or new information); (see Section 1.2 and Appendix A)
- alternatives for resolving the resource problem; (see Section 3.3)
- rationale for the proposed project; (see Chapters 2 and 3)
- how the proposed production project will maintain or sustain increases in production; (see Sections 4.1.12 and 4.2.11)
- the historical and current status of anadromous and resident fish in the subbasin; (see Section 2.1.1)
- the current (and planned) management of anadromous and resident fish in the subbasin; (see Chapters 4,5 and 6)
- consistency of proposed project with Council policies, National Marine Fisheries Service recovery plans, other fishery management plans, watershed plans and activities; (see Table 1-1, Table 1-3 and Chapter 6)
- potential impact of other recovery activities on project outcome; (see Table 1-3 and Chapter 6)
- production objectives, methods and strategies; (see Chapter 4)
- brood stock selection and acquisition strategies; (see Chapter 4)
- rationale for the number and life-history stage of the fish to be stocked, particularly as they relate to the carrying capacity of the target stream and potential impact on other species; (see Sections 4.1.12 and 4.2.11)
- production profiles and release strategies; (see Chapter 4)
- production policies and procedures; (see Chapter 4)
- production management structure and process; (see Section 3.4.3)
- related harvest plans; (see Sections 4.1.1 and 4.2.1)
- constraints and uncertainties, including genetic and ecological risk assessments and cumulative impacts; (see support documents Neeley et al. 1993 and Neeley et al. 1994, Section 10 Permit applications in Appendix A, LSRCP Biological Assessment (USFWS 1998), NMFS BiOp (NMFS 2000), and conceptual framework for monitoring and evaluation plan in Appendix D).
- monitoring and evaluation plans, including a genetics monitoring program; (see Sections 4.1.13 and 4.2.12 and Appendix D)
- conceptual design of the proposed production and monitoring facilities, including an assessment of the availability and utility of existing facilities; (see Chapter 3)
- cost estimates for various components, such as fish culture, facility design and construction, monitoring and evaluation, and operation and maintenance (see Sections 3.4.1.2 and 3.4.2.2).

In addition to these requirements, this Master Plan also addresses other recent requirements developed through a variety of regional policy and scientific initiatives:

- Requirements for a **Hatchery Genetic Management Plan** developed by NMFS (see Appendix B).
- Requirements of the **Artificial Production Review** (NPPC 1999); (see Appendix C)
- Questions from the Independent Scientific Review Panel; (see Appendix C)

1.5 Where to Find More Information

Many planning documents have been completed for the Northeast Oregon Hatchery program and they provide support for this master plan. They include:

- Northeast Oregon Hatchery Project - Final Siting Report (Montgomery Watson 1995b).
- Northeast Oregon Hatchery Project - Conceptual Design Report (Montgomery Watson 1995a).
- Genetic Risk Assessment of the Imnaha Master Plan (Neeley et al. 1993).
- Genetic Risk Assessment of the Grande Ronde Master Plan (Neeley et al. 1992).
- Imnaha Site Production Wells – Installation and Testing (Montgomery Watson 1998).
- Lostine River Site Production Wells – Installation and Testing – (Montgomery Watson 1999b).
- Final Report for Lookingglass Hatchery Review – (Montgomery Watson 1999a).
- Section 10 permit applications (BIA 1998, ODFW 1998a, ODFW 1998b).
- Grande Ronde Basin Endemic Spring Chinook Salmon Supplementation Program (BPA 1998)

Information from these documents is summarized in this Master Plan.

1.6 Organization of the Chapters

This Master Plan contains the information necessary for the NPPC, program proponents and others to make decisions.

- Chapter 2 describes the need for the program.
- Chapter 3 describes the proposed alternative and alternatives considered.
- Chapter 4 contains a description of the current and planned production procedures and policies for the program.
- Chapter 5 contains life history and other technical information for Imnaha and Grande Ronde chinook salmon.
- Chapter 6 describes the factors limiting natural production of Imnaha and Grande Ronde spring chinook and efforts directed at correcting these factors.
- Chapter 7 contains the references used to prepare this document.
- Chapter 8 has a list of acronyms and a glossary.
- Appendices provide support and other technical information including the Conceptual Framework for the Monitoring and Evaluation Plan, which is in Appendix D.

Chapter 2 Need for the Project

In this chapter:

- The Need for Action
- Status of Spring Chinook salmon
- The Nez Perce Tribe
- The Lower Snake River Compensation Program
- Federal Endangered Species Act

2.1 Need for Action

The need to restore chinook salmon in Northeast Oregon is many faceted, with legal, historic, biological, economic, social and cultural aspects.

2.1.1 Status of Northeast Oregon Spring Chinook Salmon

Chinook salmon are nearly extinct in the Imnaha and Grande Ronde rivers of Northeast Oregon. Snake River spring/summer chinook salmon (including Imnaha and Grande Ronde spring chinook salmon) were listed under the Endangered Species Act as threatened in May 1992. The listing was reclassified as endangered in August 1994 under an emergency rule that expired April 17, 1995, when they reverted back to a threatened status. A proposed rule to reclassify Snake River spring, summer, and fall chinook salmon as endangered was published on December 28, 1994 but has not been acted on (TAC 1997). This emergency situation requires dramatic and unprecedented efforts to prevent extinction and preserve any future options for use of **natural fish** for artificial propagation programs for recovery and mitigation.

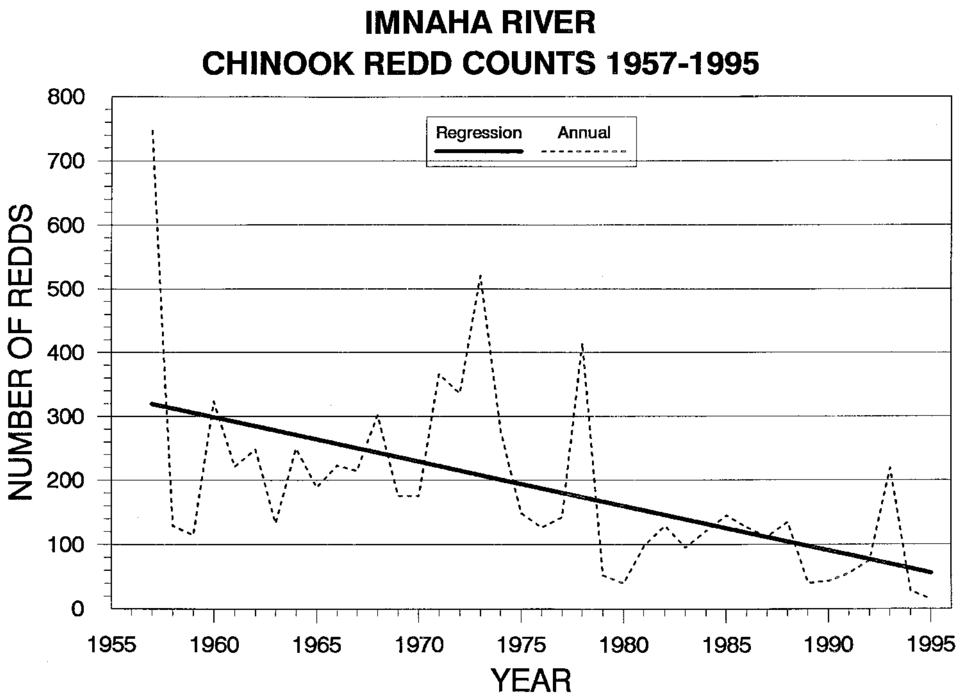
Information about the status of spring chinook salmon in each subbasin is summarized below. Detailed information about the life history and status of the spring chinook salmon is in Chapter 5.

2.1.1.1 Imnaha River

The Imnaha River Subbasin (Map 2) once supported healthy runs of spring chinook salmon, approximately 6,700 adults (USACE 1975). Returns to the Imnaha River subbasin have declined precipitously during the past three decades. Peak **escapement** of spring chinook salmon to the Imnaha River was estimated at 3,459 adults in 1957; recent returns of natural origin fish have declined to levels below 150 individuals (ODFW 1998b).

Progeny-to-parent ratios for the natural spawning population in the Imnaha River have been well below 1.0 (replacement) since 1983 and have been as poor as 0.2 (Carmichael et al. 1998b). A linear trend analysis illustrates the negative trend in **redd** counts and low spawner escapement levels (see Figure 2-1). On average, the spawning stock is expected to decline by 62 percent each generation (every five years), making the naturally-spawning Imnaha River spring chinook salmon population not viable (Mundy and Witty 1998). The best population persistence modeling efforts by ODFW demonstrate that without a supplementation program, the natural population will continue to decline and will become extinct between 2030-2050 (ODFW 1998b).

Figure 2-1 Trend Analyses of Imnaha River Chinook Salmon Redd Counts, 1953-1995

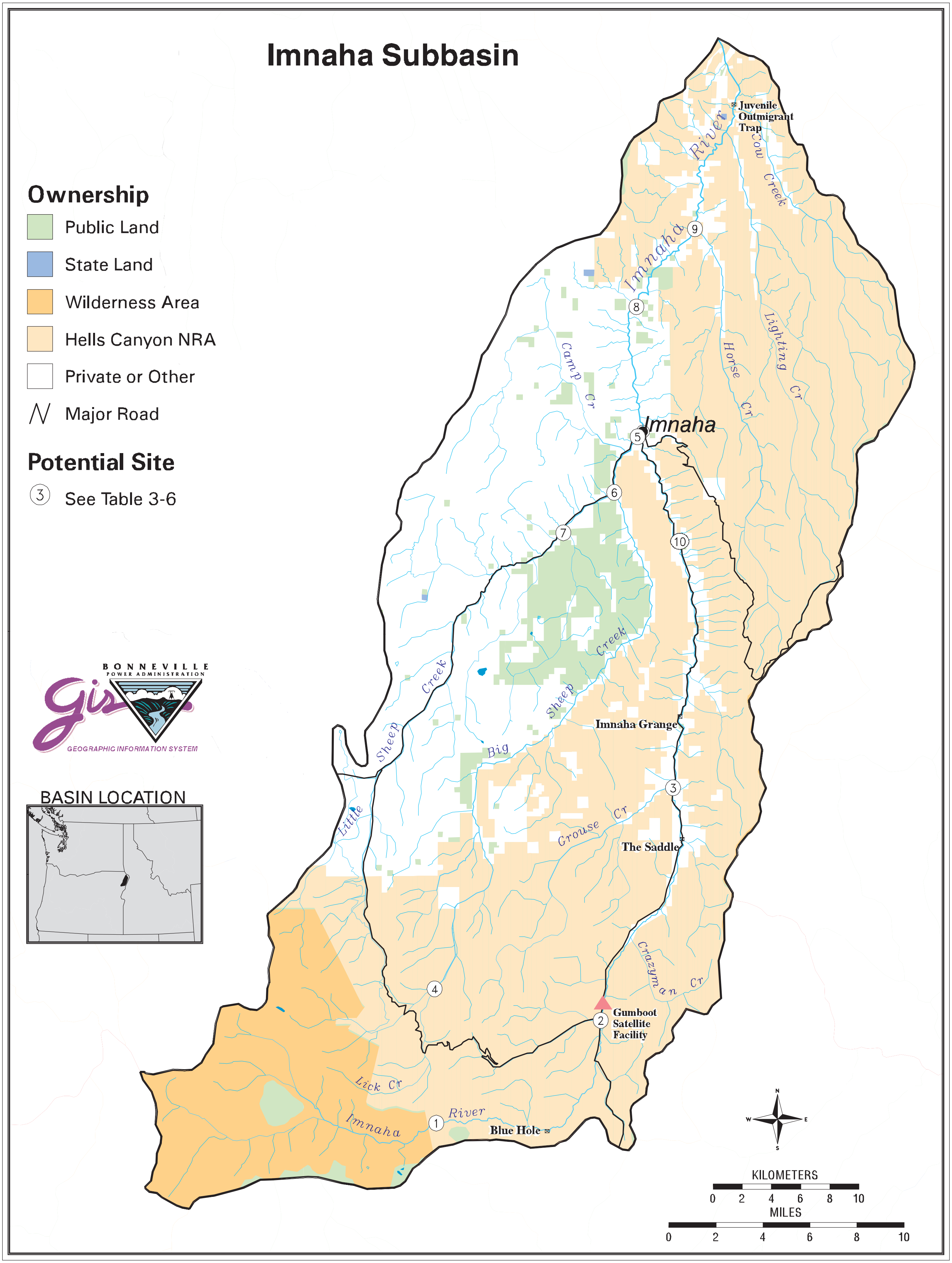


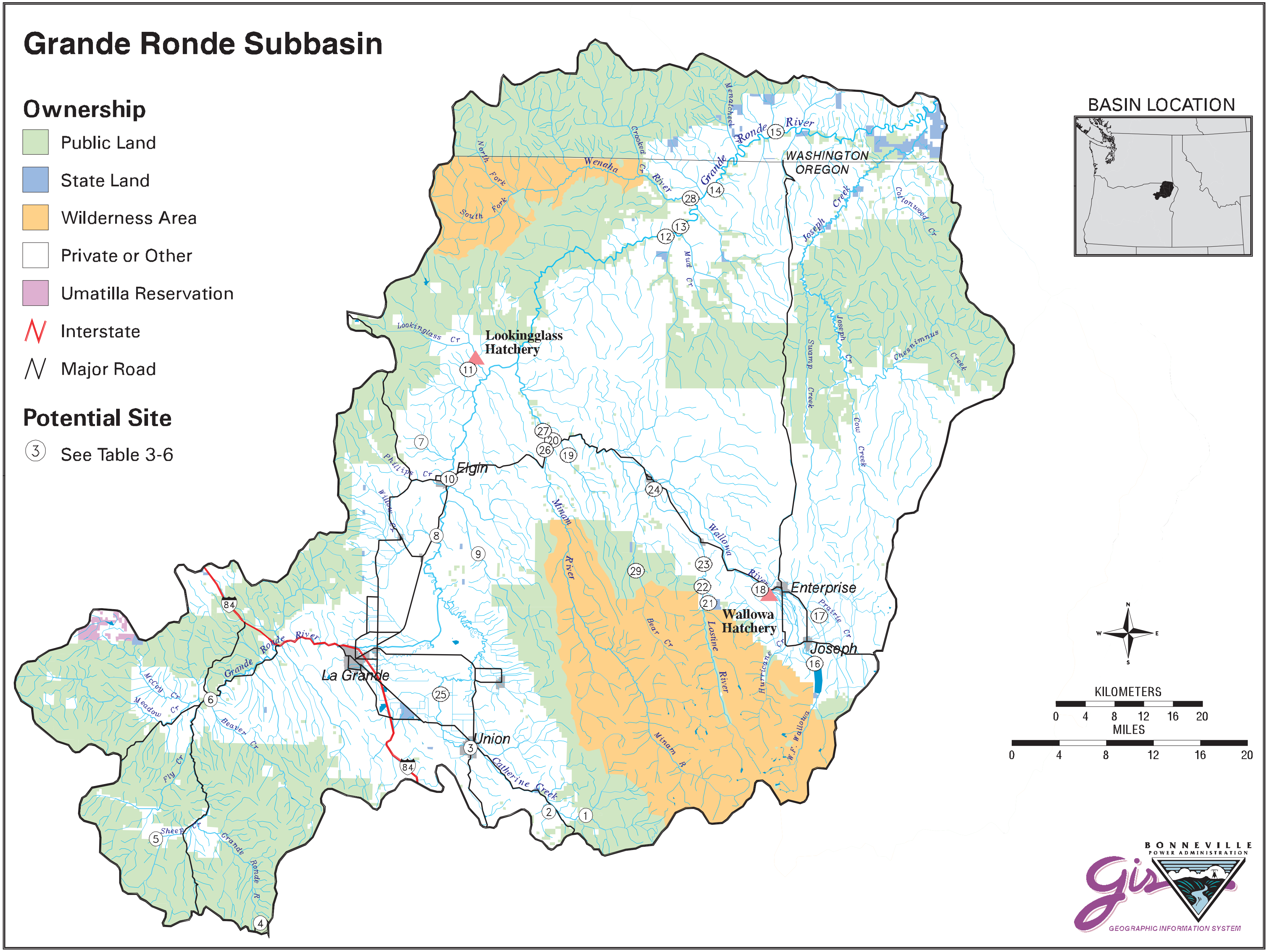
Note: y=13,892.235-6.936x p,0.01, r2=0.29

2.1.1.2 Grande Ronde River

The Grande Ronde River historically supported diverse and healthy runs of spring chinook salmon. Escapement of naturally produced chinook salmon to the Grande Ronde River was estimated at 12,200 fish in 1957 (ODFW et al. 1990). The major spring chinook salmon production areas within the Grande Ronde Subbasin were the Minam, Wenaha, Wallowa, Lostine and upper Grande Ronde rivers (see Map 3). Present escapement level and recent trends indicate that Grande Ronde spring chinook salmon are in imminent danger of extinction.

Progeny-to-parent ratios have been below 1.0 (replacement) for the past eight completed brood years (BY) (Carmichael et al. 1998a). Current adult escapement levels for the Lostine River have been between 34-152 from 1994 to 1998. Escapement levels of the Wenaha and Minam rivers show similar declining trends. Trend analyses of spring chinook salmon redds in index areas on the Wenaha, Lostine, and Minam rivers illustrate the negative trend in redd counts and the low spawner escapement levels (see Figures 2-2, 2-3, and 2-4). The Wenaha and most of

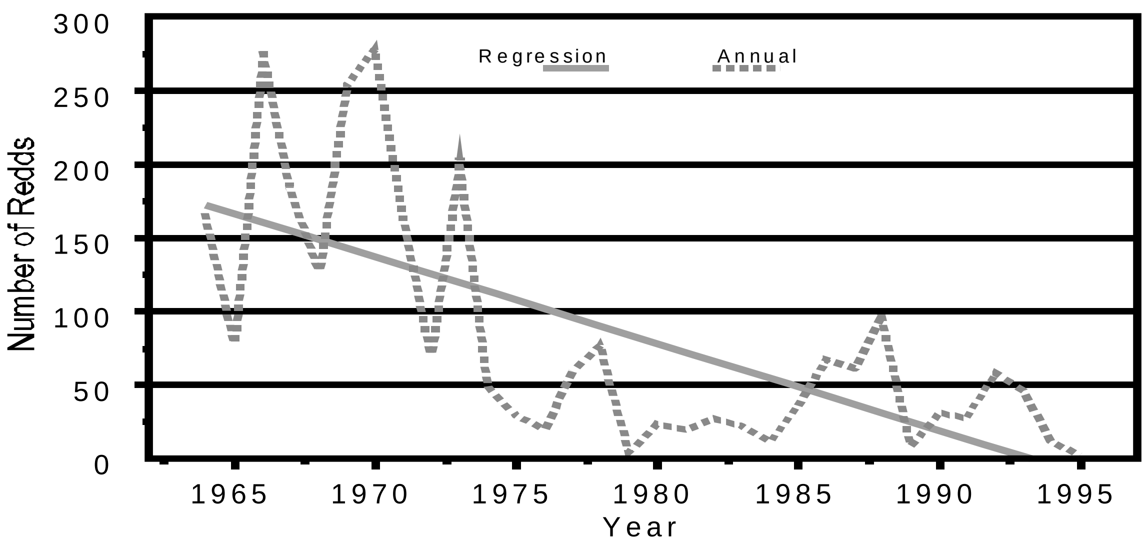

Imnaha Subbasin
Ownership
Public Land
State Land
Wilderness Area
Hells Canyon NRA
Private or Other
Major Road
Potential Site
See Table 3-6
BONNEVILLE POWER ADMINISTRATION
GEOGRAPHIC INFORMATION SYSTEM
BASIN LOCATION
Juvenile Outmigrant Trap
Imnaha River
Cow Creek
Camp Cr
Horse Cr
Lighting Cr
Imnaha
Big Sheep Creek
Little Sheep Creek
Imnaha Grange
Grouse Cr
The Saddle
Crazyman Cr
Gumboot Satellite Facility
Lick Cr
Imnaha River
Blue Hole
KILOMETERS
0 2 4 6 8 10
MILES
0 2 4 6 8 10


Grande Ronde Subbasin
Ownership
Public Land
State Land
Wilderness Area
Private or Other
Umatilla Reservation
Interstate
Major Road
Potential Site
See Table 3-6
BASIN LOCATION
WASHINGTON
OREGON
Lookingglass Hatchery
Wallowa Hatchery
Elgin
La Grande
Union
Enterprise
Joseph
Grande Ronde River
Wenaha River
Minam River
Wallowa River
Lostine River
Catherine Creek
Joseph Creek
Chesnimnus Creek
Lookingglass Cr
Phillips Cr
Bear Cr
Hurricane Cr
Prairie Cr
Beaver Cr
McCoy Cr
Meadow Cr
Fly Cr
Sheep Cr
Mud Cr
Crooked Cr
Menatchee Cr
Cottonwood Cr
Swamp Creek
Cow Creek
North Fork
South Fork
84
KILOMETERS
0 4 8 12 16 20
MILES
0 4 8 12 16 20
BONNEVILLE POWER ADMINISTRATION
GEOGRAPHIC INFORMATION SYSTEM

Map 3

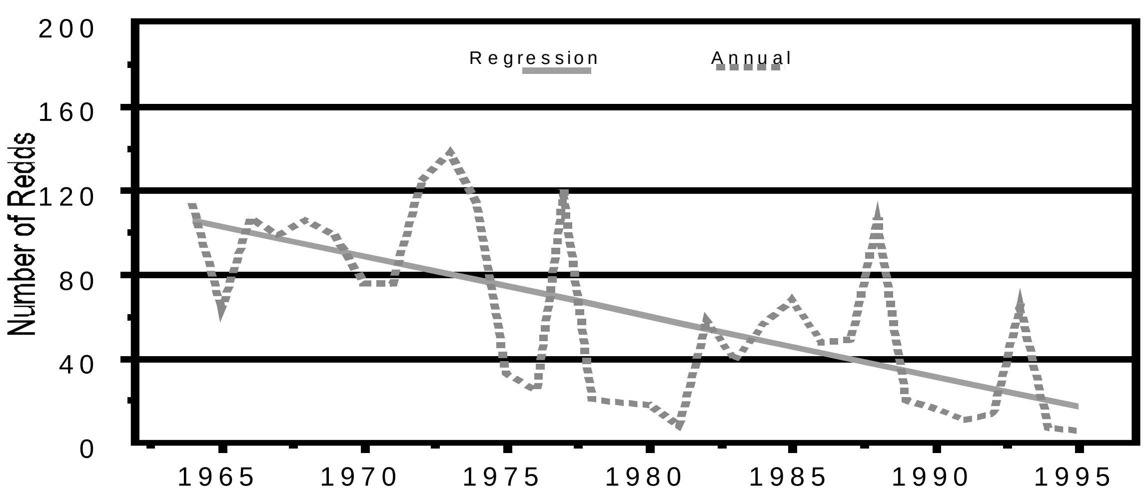
the Minam **watersheds** are classified as wilderness areas with pristine habitat, but have had equal or greater declines in escapement than those observed in many other streams in the basin.

Figure 2-2 Regression Analyses of Wenaha River Chinook Salmon Redd Counts, 1964 – 1995



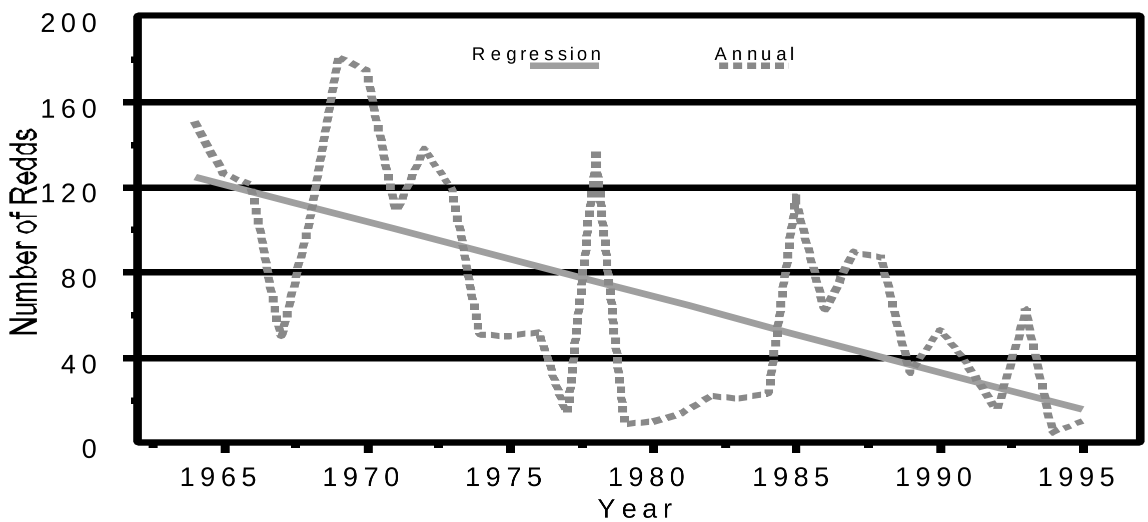
Source: Lothrop 1998; (y=11,781.78-5.91(x), R Sq. =0.46, p<0.01).

Figure 2-3 Regression Analyses of Lostine River Chinook Salmon Redd Counts, 1964 – 1995



Source: Lothrop 1998; (y=5,729.9-2.86(x), R Sq. = 0.43, p<0.01).

Figure 2-4 Regression Analysis of Minam River Chinook Salmon Redd Counts, 1964 – 1995



Source: Lothrop 1998; (y = 7,026.9-3.51 (x), R Sq. = 0.38, p<0.01).

2.1.2 Biodiversity and Productivity

Salmonids are well-known for their diversity of life history strategies, ecological adaptations, and genetic variation. These factors are linked to salmonid productivity and to long-term persistence (Independent Scientific Group 1996). The health and abundance of salmon returning to their **natal** watersheds has an enormous impact on overall ecological health of the watershed. A growing number of studies indicate that salmon **escapement** is significant beyond its obvious importance for the reproduction of the species (Gresh et al. 2000, Cederholm et al. 1999, Bilby et at. 1998). The precipitous decline of salmon and steelhead over the past three decades has impacted the ecosystems of the Imnaha and Grande Ronde rivers. For thousands of years, while salmon runs were plentiful to Northeast Oregon, these rivers were supplied with nutrients brought in from the ocean by returning adults. Within the last 30 years, that organic source has dramatically declined.

A growing number of studies document the importance of Pacific salmon adults transporting significant amounts of nutrients from the northern Pacific Ocean back to land (Cederholm et al. 1999). Decomposing salmon carcasses are now recognized as a source of marine-derived nitrogen that in large part determines the nature of the food web in a stream and the growth and survival of young salmon (Gresh et al. 2000). For example, a significant positive relation has been found between the level of marine nitrogen in Washington coastal coho smolts and the level of production of smolts (Bilby 1997). As marine nitrogen content increased, so did the number of smolts produced, up to a point. Similar observations have been made in individual river systems from Alaska to Washington (Piorkowski 1997, Larking and Slaney 1997, Bilby et al. 1996, Kline Jr. et al. 1993, and Mathisen 1972).

2.1.3 The Nez Perce Tribe's Need

The reason for the Nez Perce Tribe's involvement in fish management and master planning issues in a location outside its current reservation borders may not be commonly understood. It is the history and the law that establishes this connection, and these issues are not so well assimilated by society at large as they are for the Nez Perce. The following section presents a brief background to enhance the understanding of this connection.

The Nez Perce were once one of the largest Plateau tribes in the Northwest (Walker 1978). Historically, they occupied a territory of over 13 million acres* that included what is today north central Idaho, southeastern Washington and northeastern Oregon. Events that occurred during the last 130 years disrupted Nez Perce occupancy and association with northeast Oregon (see Map 4).

2.1.3.1 Recent History of the Nez Perce in Northeast Oregon

In 1855, the Nez Perce signed their first treaty with the United States (Ruby and Brown, 1986). In the treaty negotiated at Walla Walla, the Nez Perce defined the boundaries of their territory and established a 7.7 million acre reservation for sole Nez Perce occupancy (see Map 4). The United States gained possession of the remaining five million acres of Nez Perce territory and in exchange for the treaty and the lands, the United States promised to deliver various articles, sums of money and to keep white settlers from trespassing on the reservation. Compensation for the land transfer identified in the treaty was delayed until 1860, when the United States delivered some of the articles described in the treaty of 1855 (Haines 1955).

In 1860, trespassers discovered gold near Orofino, Idaho, which launched further trespass, the establishment of settlements, and the inevitable conflicts and disputes between the Indians and the whites (Haines 1955). To accommodate the increasing desires of settlers for Nez Perce land, a new treaty was drawn up between selected band leaders (instead of all the leaders as in the Treaty of 1855) and the United States in 1863. The treaty allowed the United States to gain millions of acres of lands and reduced the Nez Perce reservation to a 780,000 acre area.

Several bands of Nez Perce occupied the area of northeast Oregon including the Imnaha and Wallowa valleys (Haines 1955). Though the 1863 treaty sought to relieve these Nez Perce bands of their land, they were not represented in the signing, did not accept any compensation, and continued to act under the 1855 treaty. The 1863 treaty was ratified by Congress in 1868 (McWhorter 1952, Haines 1955, and Josephy 1965). A Major Wood, who had been sent to negotiate with the Nez-Perce in the Wallowa country, reported in a letter to Washington DC:

> The non-treaty Nez Perces cannot in law be regarded as bound by the treaty of 1863 and insofar as it attempts to deprive them of the right to occupancy of any land its provisions are null and void. The Nez perces undoubtedly

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* Information for the Master Plan came from many sources. In general, this Master Plan uses the U. S. Customary System of measures. Data from sources that used the Metric System have not been converted. See the metric conversion chart on the inside of the back cover.

> were at liberty to renounce the treaty of 1855, the government having violated the treaty obligations.

The Nez Perce bands quietly resisted attempts to remove them from northeastern Oregon (Haines 1955). By 1872, friction in the Wallowa country between white settlers and the non-treaty Nez Perce had escalated to the point where federal action was required (McWhorter 1952). Therefore, in response to recommendations of his Indian Affairs staff, President Grant issued an Executive Order setting aside the greater portion of the Wallowa Valley as a reservation for the Nez Perce occupants on June 16, 1873. The governor of Oregon, Leonard P. Grover, protested the action, and convinced the Commissioner of Indian Affairs to advise the return of the newly created reservation to the public domain (McWhorter 1952, Josephy 1965). Under pressure from Northwest politicians and citizens of the state, the President rescinded his order on June 10, 1875, and re-opened the valley to settlers.

The Nez Perce War followed the ordered removal of Nez Perces residing in the Wallowas in 1877. After a four-month running battle with the United States Army and various citizen militia, the Nez Perce made a last stand a short distance from the Canadian border in the Bear Paw Mountains of Montana. Although many Nez Perce continued on to Canada (McWhorter 1952), three hundred seventy-five tribal members surrendered and were sent to Indian Territory in Oklahoma (Ruby and Brown, 1986). Nez Perce leaders, including Chief Joseph, were eventually sent to the Colville Reservation in northeastern Washington but were never allowed to return to the Wallowas.

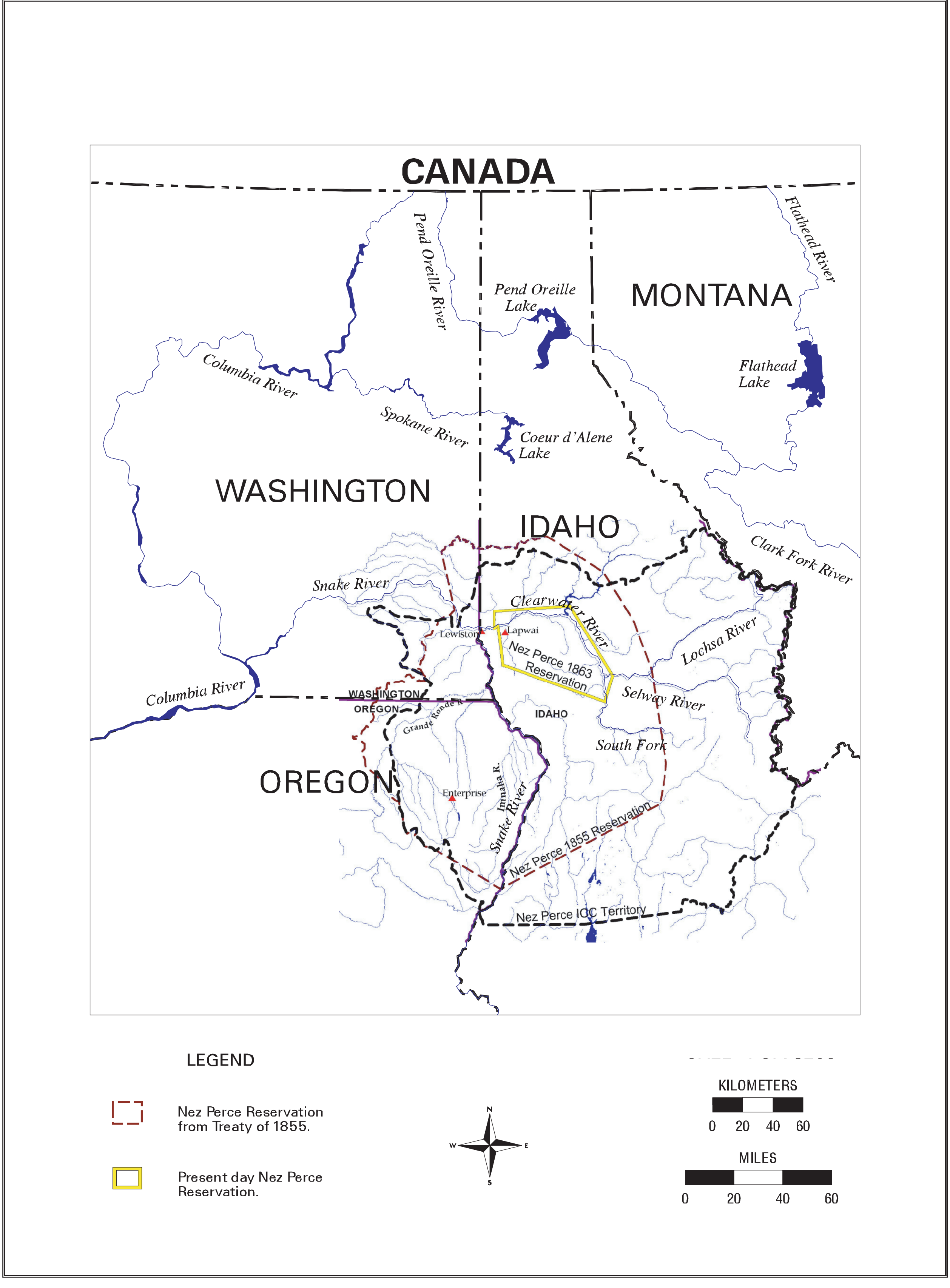
2.1.3.2 Fish to Fulfill Treaty Rights

The Nez Perce have always fished. Salmon have served as a primary food source, trade item and cultural resource for thousands of years. The economy of the Nez Perce people has evolved around Northwest salmon runs. Hunting and fishing rights guaranteed in treaties recognize the dependence on salmon. For example, the 1855 treaty with the Nez Perce in Article 3 states:

> 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…

No subsequent treaty or agreement between the Nez Perce Tribe and the United States altered or affected this treaty-reserved right. These treaty-reserved fishing rights are the legal basis for the Tribe's involvement, as co-managers, in salmon restoration efforts in northeast Oregon and elsewhere.

In 1905, the *United States vs. Winans* case established what a “right” implied. The case involved a non-tribal member who attempted to prevent tribal members from fishing at a traditional site by buying and then claiming absolute title to the land (American Indian Resource Institute 1988). The Supreme Court ruled against this claim and established two important precedents. First, hunting and fishing rights are not rights granted by the government to tribal signatories, but rather they are rights reserved by the tribes in exchange for lands (American Indian Resource Institute 1988). Second, tribal members cannot be barred from accessing their



Map 4
Nez Perce Reservation

usual and accustomed fishing sites since their reserved right is essentially an easement over private as well as public lands (Cohen 1982).

Many Northwest tribes that historically relied on fishing also have language in their treaties that secures the right of taking fish “in common with citizens of the territory.” This is an important concept for the Indian fishery off-reservation and in the Columbia River.

In 1974, a case tried in Washington Federal District Court established what was meant by the right of tribes to harvest fish “in common“ with the citizens of the territory. Judge Boldt’s decision relied heavily on understanding the situation under which the treaties were written. The court determined two distinct entities were involved during treaty making, Indian tribes and the United States, not just individual tribal members and individual citizens of the state (American Indian Resource Institute 1988). The separation of two political entities effectively denied the states’ assertion that all citizens have the same rights with respect to harvesting fish.

The understanding that there are only two entities involved was then applied to actual allocation of harvestable fish. The court’s interpretation was that harvest in common meant equal distribution between the two entities, or that each is allowed a 50/50 share (American Indian Resource Institute 1988). Judge Belloni applied the 50/50 principle to Columbia River fisheries in *U.S. v. Oregon* in 1975 (Nez Perce Tribe, et al. 1995). In their treaties ceding land to the United States, the Nez Perce Tribe had reserved the right to harvest fish in a manner that allows them to maintain a way of life. But although the rights to take fish and regulate the fishery resource have been clearly upheld in numerous courts, these rights are meaningless if there are no fish to be taken or resources to be managed (Nez Perce Tribe, et al. 1995).

The legal, historic, economic, social, cultural, and religious significance of the fish to the Nez Perce Tribe continues today. The Nez Perce Tribe has a need to restore and sustain salmon runs in northeast Oregon. The Tribe has pursued avenues to increase salmon runs throughout the years to maintain their cultural heritage, including planning and researching the Northeast Oregon Hatchery program over the last 12 years.

2.1.4 Lower Snake River Compensation Program’s Need

In 1945, Congress authorized Public Law 74, which authorized the construction of four dams on the lower Snake River to provide hydroelectric power generation and navigation (Armacost 1979). These dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) were constructed from 1961-1975. It was estimated by federal and state fish and wildlife agencies that the four dams would result in a 48 percent reduction in annual production of chinook salmon in all populations above Lower Granite Dam (U.S. Army Corps of Engineers 1975). As a result, Congress authorized the Lower Snake River Compensation Plan (LSRCP) in 1976 (Public Law 94-587) to mitigate for losses of salmon, steelhead and other resources that resulted from construction of the four lower Snake River dams. Mitigation goals for hatchery-produced spring chinook salmon under the LSRCP were 3,210 adults for the Imnaha River and 5,820 adults for the Grande Ronde River.

2.1.4.1 Residents of Oregon Harvest Needs

It has been almost 30 years since sport anglers have been able to fish for spring chinook salmon in Northeast Oregon, however, it is assumed that Oregon fishermen would like to once again harvest salmon. ODFW began keeping track of salmon harvest through a punch card system in the 1950s. Sport harvest in the Imnaha River averaged about 200 fish annually in the early 1950s and 1960s, and between 1959 and 1970 sport harvest averaged 520 adults in the Grande Ronde Subbasin annually. Due to declines in the return of salmon to both rivers, sport fishing has been closed since the mid-1970s (see Chapter 5 for more information).

Harvest goals identified by co-managers in subbasin plans were to provide opportunity for an annual non-selective sport harvest of 700 fish (350 tribal and 350 sport) in the Imnaha Subbasin (NPT et al. 1990) and 4,000 fish (2,000 tribal and 2,000 sport) in the Grande Ronde Subbasin (ODFW et al. 1990).

2.1.4.2 Lookingglass Hatchery

Lookingglass Hatchery was built as a part of the LSRCP program to produce spring chinook salmon juveniles for release in the Imnaha and Grande Ronde rivers. The hatchery is located 16 miles north of Elgin, Oregon on Lookingglass Creek, 2.2 miles from its confluence with the Grande Ronde River (see Map 3). Lookingglass Hatchery began operation in 1982.

As previously explained, with the initiation of the CPP, Lookingglass Hatchery was required to function as the primary facility for essentially eight separate groups of fish with associated fish health and monitoring and evaluation requirements (see Table 1-2). However, the physical facilities were designed and constructed for only two groups of fish to be cultured under different fish health and rearing requirements. As a result, production of fish for these conservation programs is being carried out at a facility that was not designed to meet the current program requirements. Through this project, an independent review of Lookingglass Hatchery that evaluated the ability of the facility to meet program requirements was recently completed. In summary, the review documented that due to insufficient space and water at Lookingglass Hatchery, it is impossible to meet CPP needs (Montgomery Watson 1999a). The following is an overview of the more critical findings documented in the report.

- Pathogen-free water for incubation and early rearing is a limiting factor at Lookingglass Hatchery. Facility capacity for chilled pathogen-free water and space is not enough to incubate half of the CPP. Currently, there is no chilled pathogen-free water at Lookingglass Hatchery because the entire system that provides it has experienced serious mechanical problems. Co-managers have been attempting to repair the system for the past two years.
- The existing well that provides pathogen-free water to the facility has been unreliable and has failed the past two years. The existing wells are not recharging and potential for development of supplemental groundwater and/or surface water sources is not promising. An ozone treatment system would be necessary to provide another source of pathogen-free water.

- The water supply from Lookingglass Creek is also insufficient for program needs from July through early November when the average stream flow typically falls below the water right of the hatchery. Typically during this period, the entire creek flow is diverted to the hatchery, which negatively impacts resident fish in Lookingglass Creek (including ESA-listed bull trout). It may be necessary to pump water from the outfall back up to the intake to operate the facility during this time.
- Intake icing continues to be a major constraint during winter months.
- To meet the recommended rearing densities (see Table 3-1), provide adequate separation of stocks, and meet requirements for fish health and monitoring and evaluation studies, it would be necessary to construct 21 to 49 additional raceways (there are currently 18 raceways) at Lookingglass Hatchery. There may be room for an additional six raceways, however, this space would also be allocated to the ozone treatment system and there is insufficient single pass water for more raceways.
- Other additional rearing units necessary to meet the CPP include 109 incubator stacks and 63 troughs.
- Statistical analysis of fish health data presented by Groberg et al. (1999) strongly supports the belief that the prevalence of *Renibacterium salmoninarum* (pathogen causing bacterial kidney disease) infection has been increasing at the hatchery over the past several years.
- The pathologists conducting the review concluded that: "Considering the anticipated loading of the hatchery facility with the presently permitted components of the ESA-listed chinook salmon stocks, it is likely that the prevalence and severity of infectious diseases and resultant losses among these stocks will increase markedly in the future if the facility continues to operate under the present water supply and fish rearing capacity scenario" (Montgomery Watson 1999a).
- Recommendations of ODFW pathologists included:
    1. Develop a pathogen-free water supply sufficient for rearing sensitive and listed stocks (ozone treatment),
    2. Maximize low density rearing for juveniles (at a Density Index (DI) of 0.04 lbs./ft.^{3} x inch), and
    3. Physically and functionally structure the hatchery to prevent contamination among separate programs and stocks, which will require extensive engineering and redesign of the facility (Groberg et al. 1999).

2.1.5 Federal Endangered Species Act

The NMFS has a need to restore spring chinook salmon in the Imnaha and Grande Ronde rivers as required by the Endangered Species Act. Fish produced under the Currently Permitted Program will be used towards recovery of these populations. NMFS has also come to the conclusion that the Lookingglass Hatchery facility and water supply are inadequate for safe rearing and separation of the different stocks of listed chinook salmon. In a letter to the NPPC, October 21, 1999, NMFS states,

> NMFS has issued a Biological Opinion on this proposal [Grande Ronde River spring chinook including captive brood stock and conventional supplementation programs] and has a Section 10 permit pending as we believe that this project is important to recovery of listed Snake River spring chinook. We have also reviewed a report on the Lookingglass Hatchery, where these recovery programs are currently centered, that clearly shows the facility and water supply are inadequate for the safe rearing and separation of the different stocks of listed chinook. The NEOH proposal is the vehicle through which appropriate facilities can be designed and developed…(Stelle 1999).

Chapter 3 Proposed Alternative and Other Alternatives

In this chapter:

- Goals and Objectives
- Development of Alternatives
- Proposed Alternative

This chapter describes how alternatives were developed and evaluated to meet the needs of the conservation program for Imnaha and Lostine spring chinook salmon. Though co-managers have initiated the program, full implementation cannot be achieved because of the problems described in Section 2.1.4.2. Alternatives to achieve implementation of the CPP were developed and evaluated using the goals and objectives for the program, and technical criteria defined by the co-managers. The results of the evaluation of alternatives and a description of the proposed alternative are also described in this chapter.

3.1 Goals and Objectives for the Currently Permitted Program

3.1.1 Original Goals and Objectives of the LSRCP

Under the original LSRCP program, prior to the change in focus from mitigation to conservation, ODFW had the following program goals and objectives for Imnaha and Grande Ronde spring chinook salmon populations under the LSRCP (Carmichael et al. 1998a,b):

- Establish an annual supply of broodstock capable of meeting production goals.
- Restore and maintain natural spawning populations.
- Re-establish historic tribal and recreational fisheries.
- Establish a total return number of spring chinook salmon that meets the LSRCP compensation goal.
- Operate the hatchery program so that the genetic and life history characteristics of hatchery fish mimic those of the **wild fish**, while achieving management objectives.

These goals have been incorporated into the goals and objectives that the NPT and ODFW developed cooperatively for the refocused program. If smolt-to-adult return (SAR) ratios improve and the numbers of naturally-produced spring chinook increase, these original goals and objectives will be in effect to fulfill mitigation responsibilities under the LSRCP.

3.1.2 Goals and Objectives of the Currently Permitted Program

The CPP reflects the redirection of the LSRCP program from mitigation to a focus on conservation and restoration. To develop alternatives to implement full production of the CPP, NPT and ODFW first developed management goals and objectives for the program. The co-managers defined goals as the endpoint toward which effort is directed. Objectives are smaller, measurable steps taken to attain the goal.

Objectives are measurable but are not necessarily time-limited. The time necessary to achieve objectives and transition from one goal to the next will depend on improvements made in the major limiting factor for program success - smolt-to-adult survival rates. It is unknown at this time just how long these improvements will take. Current SAR's for wild/natural Snake River spring/summer chinook salmon generally average 0.36 percent, with hatchery-reared chinook salmon from Lookingglass Hatchery averaging 0.13 percent (Carmichael et al. 1998a).

Terms used in the *Artificial Production Review* (NPPC 1999) (see box) were incorporated into the goals of the Northeast Oregon Hatchery Program. Co-managers have the following goals and objectives for the program:

In the short term: preservation/conservation of species. Accomplish this goal in one to two salmon generations or 5 to 10 years. The short-term goal has two parts:

- Prevent extinction of Imnaha and Lostine spring chinook salmon; and
- Provide potential for recovery once out of basin (smolt-to-adult) survival improves.

The short-term goal has two objectives:

- Maintain an annual escapement of chinook salmon from natural and artificial production of no less than 700 adults in the Imnaha River; and 250 adults in the Lostine River. *Time necessary to reach objective* – Imnaha River has met the objective in 3 of the last 5 years. It is expected that the Lostine will reach its objective 4-5 years after implementation of full production. These escapement levels were developed by co-managers as triggers for altering broodstock management under the CPP (see Chapter 4).
- Maintain genetic attributes and life history characteristics of the **naturally spawning** chinook aggregate.

In the mid-term: restoration (recovery). Initiation of actions to meet the mid-term goal is dependent on results of monitoring and evaluation. The mid-term goal has one part:

- Restore natural populations of Imnaha and Lostine spring chinook salmon above ESA delisting levels and provide an annual sport and tribal harvest.

The mid-term goal has three objectives:

- Achieve an annual escapement of 2,000 adult chinook salmon in the Imnaha (ESA delisting level) and 500 in the Lostine from natural production. The ESA delisting level for the Grande Ronde is 2,500 naturally produced adults of which the Lostine River spawning aggregate is a component. The Lostine River comprises approximately

20 percent of adult spawner capacity in the Grande Ronde River (Carmichael and Boyce 1986), therefore 20 percent of the delisting level was used as the natural production goal.

Time necessary to reach objective – This objective cannot be met until smolt-to-adult survival averages 4 percent (Nemeth and Kiefer 1999).

- Maintain genetic attributes and life history characteristics of the naturally-spawning chinook aggregate.
- Provide tribal and sport harvest opportunity consistent with recovery efforts.

In the long-term: mitigation (compensation), which would be permanent for the foreseeable future. At this point the program would take on LSRCP program goals listed in Section 3.1.1. Initiation of actions to meet the long-term goal is dependent on results of monitoring and evaluation. The long-term goal has one part:

- Restore Imnaha and Grande Ronde spring chinook salmon escapement and harvest to historic levels.

The long-term goal has four objectives:

- Utilize natural and artificial production to provide benefits expected from the Lower Snake River Compensation Plan – 3,210 adults for the Imnaha River and 1,625 adults for the Lostine River returning annually. *Time necessary to reach objective* – This objective cannot be met until hatchery produced smolt-to-adult survival averages 0.65 percent.
- Maintain natural self-sustaining population of 3,820 in the Imnaha and 1,716 in the Lostine River. *Time necessary to reach objective* – until naturally produced smolt-to-adult survival averages 6 percent (Nemeth and Kiefer 1999).
- Maintain genetic attributes and life history characteristics of the naturally-spawning chinook aggregate.
- Provide harvest of naturally and artificially produced adults additional to natural spawning, nutrient enhancement, and hatchery broodstock goals.

The conceptual monitoring and evaluation plan that will determine when short-term and mid-term goals have been accomplished so that the next phase can begin is described in Appendix D.

Definitions of Modes from the Artificial Production Review

This is the preservation/conservation mode.

Rationale		Implications	
Biological Problem	Motivation	Duration	Assumptions
Extremely low population abundance causes potential for extinction and losses of genetic diversity. Limiting factors (i.e., habitat degradation) are correctable	Conserve genetic resources of fish populations faced with imminent demise – which might include using methods including captive propagation and cryopreservation.	Temporary – until causes of natural population decline are rectified.	Genetic characteristics can be maintained via artificial propagation. Limiting factors (i.e., habitat problems) can be corrected in the immediate or distant future.

This is the restoration mode.

Rationale		Implications	
Biological Problem	Motivation	Duration	Assumptions
Low natural production, but potential for increase exists because habitat capability is sufficient or is being enhanced through restoration activities.	Hasten rebuilding of population to above ESA listing levels.	Temporary – recognizes that duration may be long term but habitat will be or is adequate to support fish populations without artificial propagation.	Artificially produced population can coexist with and does not jeopardize fitness or target and other natural populations. Limiting factors (i.e., mainstem habitat problems) have been addressed and are in the process of being restored.

This is the mitigation mode.

Rationale		Implications	
Biological Problem	Motivation	Duration	Assumptions
Habitat has been permanently blocked or altered by human activities resulting in a decline in survival and/or capacity of the fish population.	Replace or compensate lost habitat capacity of naturally produced fish with artificially produced fish for harvest and supplementation.	Permanent for the foreseeable future. However, changes in the environment or removal of Snake River dams may make mitigation unnecessary.	Artificially produced population can coexist with and does not jeopardize fitness or target and other natural populations. Harvest, ocean capacity, mainstem habitat does not limit production, therefore there is excess capacity in other life stages.

Source: Adapted from Northwest Power Planning Council. 1999. Artificial Production Review.

3.2 Criteria Used to Develop and Screen Alternatives

The independent review of Lookingglass Hatchery found that production of fish under a conservation program requires a different approach in fish culture and facility requirements than typical conventional hatchery production (Montgomery Watson 1999a). This is supported by the findings of the Scientific Review Team (Brannon et al. 1999) and the twenty guidelines recommended for hatchery practices in the Council's Artificial Production Review (NPPC 1999).

During the process to develop goals and objectives for the program, the co-managers determined that the following were key in implementing a conservation production program:

- Facilities that could provide maximum quality, performance, and survival to adult of artificially produced fish (i.e., low density rearing, segregation, natural-type rearing).
- Facilities capable of producing desired life history stage with desired characteristics.

When the LSRCP program was refocused as a conservation program, and problems surfaced for producing the fish, it became apparent that the ability of existing hatchery facilities to accommodate the fish culture requirements for operating a conservation program was limited.

The NPT determined the next step in developing the conservation production program for the Imnaha and Lostine populations was to develop criteria for rearing fish that would meet the goals and objectives established for the program. The NPT, CTUIR, and ODFW cooperatively developed criteria for rearing fish under this program as shown in Table 3-1. Criteria were developed for adult holding, incubation, early rearing, and final rearing. Sources used for development of the criteria were IHOT Policies and Procedures (1995), the Nez Perce Tribal Hatchery NATURES Design Team (unpublished data), and recommendations from regional fish culture, pathology, and monitoring and evaluation experts. These criteria were consistent with the recommendations of the Scientific Review Team specific to incubation and rearing activities (Brannon et al. 1999) (see box).

Recommendations of the Scientific Review Team

Guideline 1 – Technology should be developed and used to more closely resemble natural incubation and rearing conditions in salmonid hatchery propagation.

Guideline 4 – To mimic natural populations, anadromous hatchery production strategy should target natural population parameters in size and timing among emigrating anadromous juveniles to synchronize with environmental selective forces shaping natural population structure.

Guideline 6 – Supplementation hatchery policy should utilize ambient natal stream habitat temperatures to reinforce genetic compatibility with local environments and provide the linkage between stock and habitat that is responsible for population structure of stocks from which hatchery fish are generated.

Guideline 7 – Salmonid hatchery incubation and rearing experiences should use the natal stream water source whenever possible to enhance home stream recognition.

Table 3-1 Criteria for Spring Chinook Facility

LIFE STAGE	ATTRIBUTE	PREFERRED	ACCEPTABLE
ADULT HOLDING	WATER TEMPERATURE	* 50-55 F, <56 F	* Daily Peak <62 F for 6 hours
	DISSOLVED OXYGEN	* Not less than 7 ppm at discharge * More than 95% saturation	
	WATER SOURCE	* Surface * The greater the distance from spawning area the better	* Ground (Cost, constant temp issue)
	DENSITY	* 10 cubic feet per fish	* 8 cubic feet per fish
	FLOW RATE	* > 1 gpm per fish	* 1 gpm per fish
	TURNOVER RATE	* >= one turnover per hour	* < one turnover per hour but at least 7 ppm D.O. @ discharge
	FISH HEALTH	* One container per stock * One or more quarantine areas	
	OTHER	* No adult transportation, minimize handling * Incorporate chemical delivery system	* Less than five hours total adult transportation (including handling)[1]
INCUBATION	WATER TEMPERATURE DISSOLVED OXYGEN	* Mimic natural temperature within equipment constraints * 41 to 53 F water supply * Not less than 7 ppm at discharge	* Constant temperature < 48 F
	WATER SOURCE	* Pathogen free water required	* Demonstrated low pathogen surface water (spring)
	DENSITY	* One female per incubation container prior to ponding * Single water supply per female	* Pool females after eggs eyed (use IHOT) * Reuse water serially
	CONTAINERS FLOW TO EYE-UP FLOW FROM EYE-UP ON	* Trays or jars with 25% and 5% exceedence calculated for fish health mngt and spawn timing * Whatever is required to minimize egg jostling (refer to IHOT criteria) * Whatever is required to maintain 7 ppm at discharge	* Trays or jars with 10% and 5% exceedence calculated[2] * Minimum 0.3 gpm per incubation unit (tray or jar), whatever is required to limit egg jostling. (refer to IHOT criteria)
	FISH HEALTH	* On-station automated formalin dispensers	* Combine females after eye-up, but segregate by high, med, low BKD titer. * Consider research needs
EARLY REARING (to 200/lb.)	WATER SOURCE WATER TEMPERATURE	* Pathogen-free, either well or treated from natal basin * Mimic natural temperature within equipment constraints	* Untreated in emergency short term, (less risk as fish get larger) * Constant temperature < 46 F
	DISSOLVED OXYGEN	* Discharge over 7 ppm	
	DENSITY INDEX	* DI = 1.2 to 0.5 at first feeding * DI = 0.3 at transfer to outside ponds	* DI = 0.76 at transfer to outside ponds acceptable
	FLOW INDEX	* FI = 0.75 at transfer to outside ponds	* FI = 1.25 or less
	FLOW REQUIRED	* Turnover rate 1.5 to 2.25/hr	

[1] If adult transport is necessary transport time greater than 5 hours (including handling) is unacceptable.

[2] Troughs are unacceptable incubation containers for this program.

LIFE STAGE	ATTRIBUTE	PREFERRED	ACCEPTABLE
	FISH HEALTH	* High, medium, and low titer segregation * Consider variety of trough sizes to aid segregation * No specific trough size required for fish health	* Two level BKD titer segregation
	OTHER	* Minimize handling, incorporate chemical treatment	
FINAL REARING **(EXCLUDING ACCLIMATION** **(TO 22 FISH PER POUND)**	WATER SOURCE WATER TEMPERATURE DISSOLVED OXYGEN	* Pathogen-free to 100 fish/lb. desirable w/in natal basin * Untreated from natal basin after 100 fish/lb. * Mimic natural peaks less than 65 F * No more than 60 F for more than 6 of 24 hours * Discharge >7 ppm * 95% saturation	* Pathogen-free to 100 fish/lb. outside natal basin * Untreated surface water after 200/lb. * Ambient natural peaks <70 F for not more than 3 of 24 hours
	DENSITY INDEX	* DI = 0.1 at release	* DI = 0.13 at release
	FLOW INDEX	* FI = 0.68	* FI = 0.81
	FLOW REQUIRED	* Turnover rate 1.5 to 2.25/ hr	
	FISH HEALTH	* Accommodate low, med, high BKD titer segregation * Minimize handling and treatment * Maximize physical separation between raceways (impermeability) * Consider variety of raceway sizes to promote segregation * No specific facility configuration required for fish health	
	OTHER	* Minimize handling and incorporate chemical treatment	
FINAL REARING **(ACCLIMATION)**	WATER SOURCE	* Untreated from natal basin	
	WATER TEMPERATURE	* Mimic natural peaks less than 65 F * No more that 60 F for more than 6 of 24 hours	
	DISSOLVED OXYGEN	* 7 ppm at discharge * 95% saturation	
	DENSITY INDEX	* DI = 0.1 at release	* DI = 0.13 at release
	FLOW INDEX	* FI = 0.68	* FI = 0.81
	FLOW REQUIRED	* Turnover 1.5 to 2.25/hr	
	FISH HEALTH	* Accommodate low, medium, high BKD titer segregation * Minimize handling and treatment * Maximize physical separation between raceways (impermeability) * Consider a variety of containers and direct stream release to promote segregation flexibility * No specific facility configuration required for fish health	
	OTHER	Minimize handling and incorporate chemical treatment * Volitional release	

Source: NPT, CTUIR ODFW December 1999.

3.3 Alternatives

Using the criteria in Table 3-1, co-managers developed alternatives for facilities to meet program needs (see Table 3-2).

Table 3-2 Alternatives Considered

Alternative	Description
Modify Lookingglass Hatchery	Modify Lookingglass Hatchery to meet program needs.
Use existing facilities elsewhere in the Basin	Use existing facilities in the Columbia Basin in conjunction with Lookingglass Hatchery to implement the full CPP.
Use new facilities in conjunction with Lookingglass Hatchery	Construct new facilities on the Imnaha and Lostine rivers. The Upper Grande Ronde, Catherine Creek and Lookingglass Creek production will continue to occur at Lookingglass Hatchery. ODFW and CTUIR will pursue the appropriate funding avenue for facility modifications at Lookingglass so it will be consistent with the production criteria for the CPP.

Using the criteria in Table 3-1, co-managers evaluated the alternatives.

3.3.1 Modify Lookingglass Hatchery

In this alternative, Lookingglass Hatchery would be modified to meet full program needs. Potential modifications at the facility to meet the CPP were evaluated during the Lookingglass Hatchery Review (Montgomery Watson 1999a). The most critical constraints at the sites that could not be overcome with capital improvements were insufficient space and water supply.

From 21 to 49 new raceways would be required to meet the production criteria and associated fish health segregation and monitoring and evaluation needs (see Table 3-1). Twenty-one raceways could be provided for an estimated cost of $1.5 to 2.0 million. However, there is adequate physical space at Lookingglass Hatchery for only six new raceways and this space has been designated by the Corps of Engineers (USACE) for an ozone treatment facility. Regardless, even if the space for additional raceways were available, the water supply is incapable of providing the needs for the existing raceways.

The current incubation and early rearing water supply is reliant upon using a well that was designed for 4-6 weeks of ice control, not production of water for fish culture. The well water supply is insufficient for incubation and early rearing of the entire CPP.

Required water supply for raceway rearing of juveniles under the CPP would exceed the existing water right of the hatchery 12 months of the year. During the late summer and fall (late July through early November), the water right of the hatchery typically exceeds the average flow in Lookingglass Creek and water is rationed at the facility. The water deficit is worse in dry years. During these times all the water from the creek is diverted into the hatchery, which conflicts with the need to pass resident species, including ESA-listed bull trout.

The potential to develop supplemental sources for a water supply was evaluated (Montgomery Watson 1999a). The following is a summary of the findings:

- Development of additional groundwater supply is not promising. In fact, decreasing static water levels in the existing wells have been observed over time. The static level of the production well ranged from 150-160 feet from 1988 to 1992 but in 1999 was at 243 feet.

- Development of Jarboe Creek, a small tributary near Lookingglass Hatchery, is not promising. Jarboe Creek would not significantly increase the hatchery water supply and typically goes underground in July through September when water is needed most.

- Development of a multiple pass rearing system may be feasible. However, the problems with a reuse system include the potential for increased fish disease and more reliance upon mechanical systems (filters, pumping, backup generators). A reuse system would also be expensive and would require increased manpower and maintenance needs.

- Development of an ozone treatment system to provide pathogen-free water has been investigated by the Corps of Engineers. Cost estimates for this system range from $7 to 8 million. This treatment system would not increase the amount of water available, however. To meet the needs of the CPP, an ozone system would have to be combined with a reuse system.

Based on these and other findings, the Lookingglass Hatchery Review report and the co-managers concluded that even with modifications it was impossible to meet the needs of the CPP at Lookingglass Hatchery and additional facilities are necessary (Montgomery Watson 1999a, Eddy 1999, Lofy 1999, Ashe 1999). Nevertheless, with some modifications Lookingglass Hatchery has the potential to meet a portion of the CPP's needs. With installation of an ozone treatment system and some facility improvements, approximately half (650,000 smolts) of the CPP could be reared at Lookingglass Hatchery under acceptable production criteria (see Table 3-1).

3.3.2 Use Existing Facilities Elsewhere in the Basin in conjunction with Lookingglass Hatchery

Under this alternative, co-managers would use existing facilities in the Columbia Basin to implement the full CPP. Co-managers would transport eggs and fish to existing hatchery facilities that were able to provide sufficient space and water to meet production criteria. Lookingglass Hatchery could be used in conjunction with these other existing facilities.

The first evaluation of whether other facilities in the Columbia River Basin could be used to rear fish from Northeast Oregon was conducted in 1995. With the guidance of the NEOH Technical Work Group (TWG) composed of ODFW, NPT, CTUIR, and BPA, Montgomery Watson evaluated existing facilities in the Northeast Oregon region for expansion capabilities. Their assessment was based on published information, site visits, and discussions with agency, tribal and fisheries personnel. The assessment is in the Northeast Oregon Hatchery Final Siting Report (Montgomery Watson 1995b). The following facilities were evaluated (see Map 3 for some locations): Wallowa Hatchery, Lookingglass Hatchery, Irrigon Hatchery, Umatilla Hatchery, Lyons Ferry Hatchery, and Springfield Aquaculture Facility. Each of these facilities was eliminated from consideration for one or more of the following reasons: 1) poor expansion potential, 2) inadequate water supply, 3) poor water quality, and/or 4) distance from the Grande Ronde and Imnaha subbasins.

In 1999, following completion of the Lookingglass Hatchery Review and agreement among co-managers that it was impossible to meet the CPP needs at Lookingglass Hatchery, existing facilities were evaluated again. Facilities screened included all **anadromous** fish hatcheries in the Columbia River Basin and one on the Oregon coast (see Appendix E). Despite the fact that the preferred strategy of the production criteria is to rear fish in their natal watershed, the review included all Columbia Basin facilities because the use or expansion of existing facilities (if possible) could offer significant economic savings in capital and operating costs.

Those facilities that currently rear spring chinook were grouped and evaluated first because it was assumed that these facilities would most likely have the appropriate water temperatures and facility qualities (see Appendix E, Table E-1). Those facilities that currently rear species other than spring chinook were also evaluated (see Appendix E, Table E-2). All facilities were initially screened for authorization. For example, Round Butte Hatchery on the Deschutes River was constructed by Portland General Electric (PGE) to mitigate for fishery losses caused by Pelton/Round Butte Hydroelectric Complex. This facility was eliminated from further consideration because it is a privately-funded facility with essentially no administrative or mitigation ties to the LSRCP program. Of the 32 facilities that currently rear spring chinook, only five did not qualify. Of the 30 facilities that currently rear species other than spring chinook only seven did not qualify (see Appendix E). Information from Integrated Hatchery Operation Team reports (IHOT 1995), IHOT audit database (Montgomery Watson) and interviews with operating agencies were used to conduct the screening process.

Facilities were then screened against production criteria developed by co-managers (see Table 3-1). A pathogen-free water source for incubation and early rearing was one of the most important requirements identified in the production criteria and thus was critical to the screening process applied in this document. Because pathogen-free water sources are only available from ground water (wells) or treated surface water (ozone), facilities with this type of water supply were fairly rare. Only 11 facilities had a pathogen-free water source for incubation (see Tables 3-3 and 3-4). Of these, only the following five had the required temperature profile for incubation:

- Oxbow Hatchery, located on the **mainstem** Columbia River just upstream of Bonneville Dam – 357 miles from the Wallowa Valley;
- Sawtooth Hatchery, located in central Idaho on the Salmon River. Fish health constraints due to whirling disease – 529 miles from the Wallowa Valley;

- Leavenworth Hatchery, located in north central Washington – 394 miles from the Wallowa Valley;
- CleElum Hatchery, located in central Washington. Facility houses existing supplementation experiment – 387 miles from the Wallowa Valley;
- Irrigon Hatchery, located along the Columbia River near Umatilla – 244 miles from the Wallowa Valley.

Although these facilities met water pathology and temperature criteria, they were disqualified because all of these facilities would require several hours of travel time and are outside the window for acceptable transport time of adults (< 5 hours). Therefore adults would have to continue to be held and spawned at Lookingglass Hatchery. The CPP requires four spawning periods each week (one stock per day). Transporting eggs from Lookingglass Hatchery to another facility for incubation would require sufficient manpower and other resources to accommodate four trips per week. Although co-managers developed transport time criteria for adults, none was derived for eggs or juveniles. However, based on several studies, the USFWS has determined acceptable transport times for eggs. Transport of **green eggs** or unfertilized **gametes** is acceptable from four hours after the kill of adult to fertilization. Fertilization more than four hours after gametes were collected reduced survival (Piper et al. 1982).

Of these five facilities, only Irrigon Hatchery is near an acceptable transport time. Irrigon Hatchery was constructed to rear steelhead for release into the Imnaha and Grande Ronde rivers. Although this facility has the capability to chill enough water for incubation it does not have the space or water temperature profiles required for juvenile rearing of the CPP. As a result, it is not possible to meet the CPP target size of 20 fish per pound. There is also not enough space at this facility to provide necessary segregation and rearing space of the entire CPP.

In addition, the steelhead program at Irrigon Hatchery will be converted from a non-native stock program to a native stocks program over the next eight years. There is also the possibility that the focus of this program will transition from mitigation to conservation as co-managers direct efforts at preventing extinction and enhancing natural spawning populations. Although production numbers are not expected to increase, it is expected the native steelhead stock(s) program at Irrigon Hatchery will require additional space and water similar to the situation with spring chinook salmon at Lookingglass Hatchery.

In addition, the Nez Perce Tribe requested assistance from the *US v. Oregon* Production Advisory Committee to identify facilities and to review facilities that had the capability to fill program needs, if only in the short term, with ODFW and CTUIR (Whitman 1999, Stelle 1999, ODFW 1999). This request for emergency space was made because in 1999, Lookingglass Hatchery was unable to accommodate incubation and early rearing. The only alternative to terminating production of the CPP was to use Oxbow and Irrigon hatcheries. As discussed above, using these facilities would involve 4-6 hours of transportation, which increases the risk to these stocks, both through chance of accident or equipment failure and increased mortality due to increased handling, stress, etc. Despite the extra effort to ensure high survival (sperm motility check of each male, air transport of gametes from Lookingglass to Oxbow and Irrigon), these facilities had a low hatching success rate. Predicted egg-to-smolt survival for these fish is only 60 percent, which is unacceptable for a propagation program for listed fish.

Table 3-3 Existing Facilities in the Columbia River Basin with Pathogen-free Water Supply for Incubation that Currently Produce Spring Chinook

Hatchery	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Incubation Temperature (41-53°F or <48 constant)	Distance from Imnaha Subbasin[1]
Columbia River mainstem – below Bonneville Dam								
Clackamas	ODFW	Clackamas River near Estacada, OR	Spring chinook Steelhead	N N	ODFW Mitchell Act PGE City of Portland	Clackamas River Well	52°F & O-zone River Water	424 miles 8 hours 11 hours
Bonneville	ODFW	Columbia River, west of Cascade Locks, OR	Spring Chinook Coho Steelhead Fall Chinook	Y[2] N N N	Mitchell Act COE NMFS	Tanner Creek Wells	50°F constant	357 miles 6.5 hours 9.5 hours
Columbia River mainstem – above Bonneville Dam								
Oxbow	ODFW	Columbia River near Cascade Locks, OR	Spring chinook Coho Steelhead	N N N	Mitchell Act	Oxbow Springs	45°F constant	357 miles 6.5 hours 9.5 hours
Umatilla	ODFW	Columbia River near Irrigon, OR	Spring chinook Steelhead Fall chinook	N N N	BPA	Wells	53°F constant	244 miles 4.5 hours 7.5 hours
Mid-Columbia								
Leavenworth	USFWS	Icicle Creek, Leavenworth, WA	Spring chinook Steelhead	N	Mitchell Act	Wells	44-48°F	394 miles 7.5 hours 10.5 hours
CleElum	YIN		Spring chinook	N	BPA	Wells	45°F	387 miles 7.5 hours 10.5 hours
Snake River								
Sawtooth	IDFG	Salmon River near Stanley, ID	Spring chinook Steelhead	N N	LSRCP	Salmon River Wells	39-50°F	529 miles 10 hours 13 hours
Lyons Ferry	WDFW	Snake River near Dayton, WA	Tucannon sp Chinook Snake River fall chinook Steelhead	Y Y N	LSRCP	Wells	53°F constant	257 miles 5 hours 8 hours

1. Distance from Imnaha satellite facility in miles – first hour value is transport time for gametes and second value is transport time for fish. Transport time for fish includes actual travel time plus loading and unloading time. Distance from Lostine River facility subtract 60 miles or 1.5 hrs.
2. Bonneville Hatchery currently houses freshwater rearing of captive broodstock to adult.
Source: Data from IHOT reports and personal communications with operating agencies.

Table 3-4 Existing Facilities in the Columbia River Basin with Pathogen-free Water Supply for Incubation that Produce Species other than Spring Chinook

Hatchery	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Incubation Temperature criteria met? (41-53°F)	Distance from Imnaha Subbasin[1]
Grays River	WDFW	West Fork Grays River	Fall Chinook Coho Steelhead	N	Mitchell Act	West Fork Grays River Wells Unnamed stream	48-50°F[1]	497 miles 9.5 hours 12.5 hours
Abernathy	USFWS	Abernathy Creek	Fall Chinook	N	Mitchell Act	Abernathy Creek Well	55°F constant	468 miles 9 hours 12 hours
Beaver Creek (currently closed)	WDFW	Elochoman River near Cathlamet, WA	Steelhead Sea run Cutthroat	N N	Mitchell Act	Elochoman River Beaver Creek Well – 1 cfs	42-43°F; nonpathogen-free water has to be added	477 miles 9 hours 12 hours
Irrigon	ODFW	Columbia River near John Day Dam	Steelhead Trout Spring chinook	N N Y[2]	LSRCP	Wells	53°F constant some chilling capacity to 41F for incubation	244 miles 4.5 hours 7.5 hours

1. Distance from Imnaha satellite facility in miles – first hour value is transport time for gametes and second value is transport time for fish. Transport time for fish includes actual travel time plus loading and unloading time. Distance from Lostine River facility subtract 60 miles or 1.5 hrs.
2. In 1998 and 1999 spring chinook from the Grande Ronde and Imnaha were incubated at Irrigon due to facility failure at Lookingglass Hatchery.

Source: Data from IHOT reports and personal communications with operating agencies.

In summary, as a result of extensive review and analysis in 1999 and 2000, the co-managers determined there are no facilities (alone or used in conjunction with Lookingglass Hatchery) in the Columbia Basin have the necessary space and water to meet program criteria. As a result, in 2000, although enough adults are expected to return to produce a full program, production will be reduced by at least 25 percent and segregation for fish health or monitoring and evaluation needs will be inadequate. Unfortunately, there are no alternatives other than those mentioned above for production of the CPP in the short term. Although these are undesirable because they are extremely risky, temporary and result in reducing production, co-managers believe that the odds for sustaining the runs are better by using these alternatives in the short term than by further constricting the survival bottleneck faced by these populations.

This alternative does not meet the needs of the program.

3.3.3 Use New Facilities in conjunction with Lookingglass Hatchery

Under this alternative new incubation and rearing facilities would be constructed in natal subbasins to rear fish under this program. These facilities could work in conjunction with a modified Lookingglass Hatchery (as discussed in Section 3.3.1) to meet the needs of the entire program.

Montgomery Watson (1995a,b) identified and screened potential sites for new hatchery facilities in Northeast Oregon when the master planning project was first initiated. Although the focus of this plan is different than the original planning efforts (achieving the NPPC "doubling goal") the information developed in relation to site selection and evaluation is still relevant. Since problems at Lookingglass Hatchery have occurred, the site investigations performed by Montgomery Watson have proven useful and help identify areas where relief could be provided to meet the needs of the CPP.

An initial list of potential facility sites in the Imnaha and Grande Ronde Subbasins was developed by the fisheries co-managers. Montgomery Watson, with assistance from the NEOH TWG (see Section 3.3.2), evaluated site locations, potential for a main production facility for one or more of the basins or several smaller satellite facilities, and provided conceptual designs for fish production facilities (see Conceptual Design and Final Siting Reports, Montgomery Watson 1995a,b) (see box).

Site evaluations for facilities were conducted in several phases. The first phase involved a review of available water quality and water quantity data, definition of fish propagation criteria specific to the program (not the same as shown in Table 3-1), definition of production and release objectives specific to the program, and definition of water and space requirements. Once the criteria were defined, site evaluations were carried out by project team field visits. The site reconnaissance teams included project staff with training in engineering and biology. Sites were evaluated for physical and environmental characteristics and a site database was developed. Following the site visits, site screening was conducted based on the project criteria and the site evaluations to identify a prioritized listing of sites for development of a program to meet the goals.

Summary of Support Documents for Facility Siting and Design

- Northeast Oregon Hatchery Final Siting Report (Montgomery Watson 1995b).

The NEOH Technical Work Group (BPA, ODFW, CTUIR, and NPT) provided technical guidance for these documents. Though the focus of the master plan has changed, the information about site selection and evaluation is still relevant. Site evaluations using screening criteria for Imnaha and Grande Ronde spring chinook included available water quality and quantity data, physical and environmental characteristics, and space requirements. In the Grande Ronde, 28 sites were evaluated, 11 of these in the Wallowa River Basin. In the Imnaha, 10 sites were evaluated. Rankings and recommended alternatives for facility locations are provided. Information on water temperature, streamflow, well logs, and site maps in relation to proposed facilities are also included.

- Northeast Oregon Hatchery Project Conceptual Design Report (Montgomery Watson 1995a).

The Conceptual Design has site layouts and further evaluates water temperature and flow requirements for proposed facilities. Alternative sites were selected for each proposed facility. Due to the change in focus of this program, the overall design requirements of the proposed facilities have also changed. The site layouts presented in this Report will be updated to be consistent with present management criteria (i.e., rearing containers at the Imnaha will consist of separate tanks and/or raceways rather than one long rearing channel).

- Imnaha Site Production Wells Installation and Testing, and Lostine Site Production Wells Installation and Testing, Montgomery Watson, 1998 and 1999b, respectively.

In developing plans for new facilities on the Imnaha and Lostine rivers, the availability of sufficient good quality water was one of the critical factors evaluated. These documents review the availability of groundwater at sites identified for incubation and rearing facilities.

- Cultural Resource Survey Report, Lostine Facilities, 1997, and Cultural Resource Survey Report, Imnaha River at Marks Ranch, 1998. Jason Lyon, Nez Perce Tribe Cultural Resource Department, Lapwai, Idaho.

These reports present the results of archeological surveys done by the Nez Perce Tribe Cultural Resource Department at proposed facility sites. Nothing of archaeological or cultural significance was found at the sites; but future activities would be monitored.

- Imnaha Site Production Wells Installation and Testing (Montgomery Watson 1998).

Based on the results reported in this document, groundwater potential is sufficient for incubation and a portion of early rearing (to 500 fish/lb.) of the entire program. There is potential for development of additional wells at the site to increase supply as well as treatment of surface water. If groundwater were used for incubation and early rearing some chilling would be necessary.

- Lostine Site Production Wells Installation and Testing (Montgomery Watson 1999b).

Based on these results in this report, groundwater potential is sufficient for incubation and early rearing of the entire program (250,000). There is potential for development of additional wells at the site to increase supply as well as developing a treatment system for surface water.

Screening criteria for potential sites are in Table 3-5. Sites investigated are listed in Table 3-6 and shown on Maps 2, 3 and 5. Results of screening can be found in Tables 27 through 34 in the *Final Siting Report* (Montgomery Watson 1995b). Through the screening process the NEOH TWG selected preferred and alternative sites for construction of new production facilities in May 1992 (Blaylock 1992). Sites selected were then carried into the conceptual design phase, which involved well drilling/testing and drafting of conceptual facility designs in September and October 1992 (Montgomery Watson 1995a). Further groundtruthing of the preferred sites occurred in 1998 and 1999 when the NPT conducted well tests, cultural resource surveys and gathered information on temperature data from surface water supplies.

This is the only alternative that meets the CPP at the production criteria developed for the program. In addition, this alternative would provide facilities and fish rearing conditions that are consistent with guidelines developed by Brannon et al. (1999) associated with facilities and water source (see box). This is the NPT's Proposed Alternative.

Recommendations from the Scientific Review Team

Guideline 6 - Supplementation hatchery policy should utilize ambient natal stream habitat temperatures to reinforce genetic compatibility with local environments and provide the linkage between stock and habitat that is responsible for population structure of stocks from which hatchery fish are generated.

Guideline 7 - Salmonid hatchery incubation and rearing experiences should use the natal stream water source whenever possible to enhance homestream recognition.

Guideline 9 - Hatchery programs should dedicate significant effort in developing small facilities designed for specific stream sites where supplementation and enhancement objectives are sought, using local stocks and ambient water in the facilities designed around engineering habitat to simulate the natural stream, whenever possible.

Table 3-5 Screening Criteria for Potential Sites

Concern	Criteria
Water Quality	• Disease potential • Water temperature • General minerals • Other pollutants (phosphates, oil, grease) • Offsite risks
Water Quantity	• Availability • Dependability • Intake structure • Pipeline ROW • Bypass reach (length and location) • Pumped versus gravity source • Cost of water supply (construction, O&M)
Location on River	• River mile • Spawning distribution (natural run) • Attraction potential
Environmental Concerns	• Wetlands (other than **riparian** zone) • Terrestrial wildlife and habitats • Threatened and endangered species • Water quality impacts of facility • Community impacts • Scenic/aesthetic • Accessibility
Size of Parcel	• Space for raceways and ponds • Space for sedimentation ponds • Space for trapping
Site work Costs	• Topography • Contouring and diking (flood control) • Pipeline and intake structure • Utilities • Costs of acquiring site • Soils and groundwater • Access
Security	• Intake structure and water supply • Pipeline • Raceways/ponds
Permitting	• Land use • Shorelines designation • Flood hazard
Property Ownership	• Facility site • Pipeline ROW and intake structure • Time to acquire site
Source: Montgomery Watson 1995a,b.	

Table 3-6 Sites Investigated

Imnaha Subbasin Sites	Grande Ronde Subbasin Sites	
1. Indian Crossing	1. Catherine Creek N&S Fork confluence	15. Cottonwood Creek
2. Gumboot Creek (existing facility)	2. Catherine-Milk Creek confluence	16. Wallowa Lake
3. Grouse Creek-Imnaha confluence	3. Catherine Creek at Union	17. Hayes Fork-Prairie Creek
4. Big Sheep-Lick Creek confluence	4. Vey Meadows	18. Wallowa Hatchery
5. Big Sheep Creek	5. Sheep Creek	19. Big Canyon Creek
6. Big Sheep-Little Sheep confluence	6. Beaver Creek	20. Minam River –Wallowa River confluence
7. Little Sheep Creek	7. Sanderson Springs-Mill Creek	21. ODFW Bighorn sheep range
8. Gene Marr Ranch	8. Lower Willow Creek near Elgin	22. Strathearn Ranch
9. Horse Creek	9. Indian Creek near Elgin	23. Lostine Dam
10. Wayne Marks Ranch	10. Grande Ronde near Elgin	24. Clearwater Ditch Diversion – Lostine River
	11. Lookingglass Hatchery	25. Davis Dam-Catherine Creek
	12. Wildcat Creek Area	26. Minam above Wallowa River
	13. Fish Ladder	27. Wallowa River below Minam confluence
	14. Flora Grade	28. Wenaha River above Troy

Source: Montgomery Watson 1995b.

3.4 Proposed Alternative

The Proposed Alternative would construct new facilities and modify existing facilities for a conservation, integrated recovery production program for Imnaha and Lostine rivers spring chinook salmon. These new facilities would make it possible to meet the already-approved production program for Imnaha and Lostine rivers spring chinook (see Figure 3-1).

The production goal for Imnaha spring chinook salmon is 490,000 smolts and the goal for Lostine spring chinook salmon is 250,000 smolts as authorized by NMFS through Section 10 of the ESA. The production goal for Lostine River chinook may increase to 350,000 in the long term.

The Proposed Alternative would require:

- Construction of a new incubation and rearing facility in the Imnaha River and modifications of the existing Gumboot facility to accommodate the Imnaha component of the Lookingglass Hatchery production; and

- Construction of a new incubation and rearing facility in the Lostine River to accommodate the Lostine component of the Lookingglass Hatchery production.
- Modification of Lookingglass Hatchery to accommodate the Catherine Creek and Upper Grande Ronde component of the Lookingglass Hatchery production.

The modifications necessary at Lookingglass Hatchery to meet approximately half of the CPP needs are briefly discussed in Section 3.2.1. The Proposed Alternative supports the pursuit of these modifications, based on further development by the co-managers. However, this Master Plan has evolved into an endeavor undertaken primarily by the Nez Perce Tribe. The Nez Perce Tribe has specific co-management responsibilities for fisheries resources within the lands of the 1855 Treaty, which include the Lostine and Imnaha watersheds, and thus, the focus of the Proposed Alternative is on actions taken within these two watersheds. Nevertheless, based on the cursory evaluation, the Catherine Creek and Upper Grande Ronde portions of the CPP could be accomplished by modifying Lookingglass Hatchery. The Nez Perce Tribe will assist co-managers in further evaluating facility needs and providing other components of the NPPC master planning process to develop a solution for the entire CPP.

The following sections describe the specific components of the Proposed Alternative in the Imnaha and Grande Ronde (Lostine) subbasins.

3.4.1 Actions in the Imnaha River Subbasin

The Proposed Alternative would construct a new incubation and rearing facility in the Imnaha River Subbasin and modify or expand the existing Gumboot adult collection and acclimation facility to accommodate spawning and potentially egg incubation. Production parameters used for sizing this program are shown in Table 3-7.

3.4.1.1 Facilities

The following facilities are necessary to implement the Proposed Alternative. The adult collection facility and acclimation facility currently exists on the Imnaha River (see Map 2). The incubation and rearing facility is proposed for construction under this master plan.

Adult Collection Facility

Adults will be collected at the existing LSRCP weir facility at Gumboot Creek. The facility is located approximately 29.5 miles south of Imnaha, Oregon at RM 49 and at an elevation of 3,760 feet. Access is provided by U.S. Forest Service Road 3955. A main power line parallels the Imnaha River at the site. Trapping began at this site in 1982 and the facilities were completed in 1988. The facility was constructed with two weirs (electric and a picketed lead), fish ladder, and adult holding pond, which is also used for juvenile acclimation and release. Adults moving upstream in the Imnaha River are currently impeded by a Daishin floating weir and diverted to the fish ladder. They swim up the ladder and are trapped in an adult holding area until sampled.

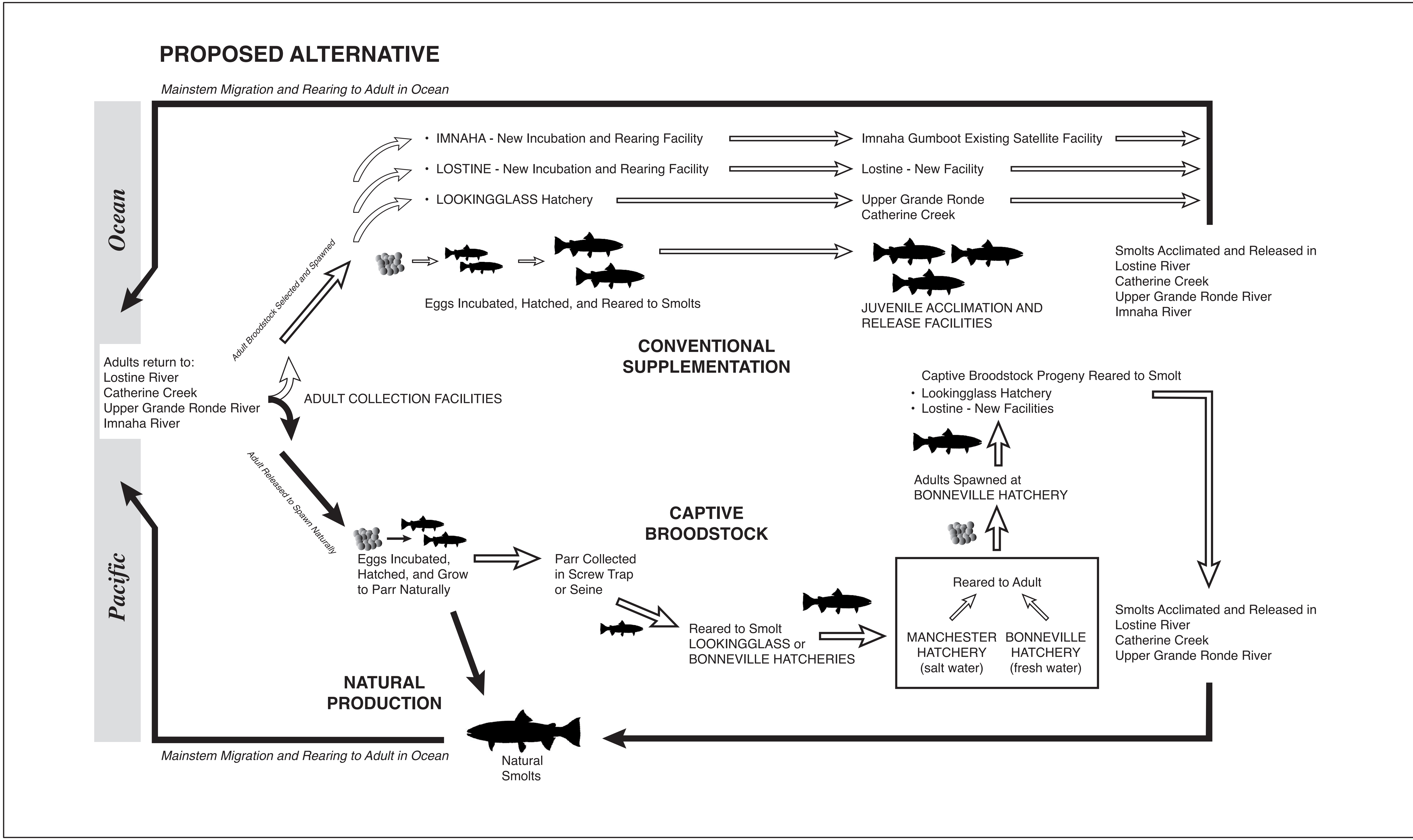


Figure 3-1 Proposed Alternative

Table 3-7 Number of Fish Expected at each Life-history Stage to Produce a Full Program of 490,000 Smolts, as Authorized under the LSRCP

Production Parameter	**Number**
Number of adults to collect	320
Adult survival rate to spawn	80%
Number of adults surviving to spawn	256
Ratio of males to females	1:1
Number of females	128
Fecundity per female	4,500
Number of eggs to incubate	576,000
Egg to smolt survival	85%
Number of smolts to release	490,000
Smolt to adult survival	Range 0.043% to 0.562%
Adults returning to subbasin	210 to 2,754
Assumptions: Based on past production experience of this stock at Lookingglass Hatchery, a 20 percent adult prespawning mortality and an egg-to-smolt mortality of 15 percent was used for programming (ODFW 1998b). An 85 percent survival rate for egg to smolt was used because this is the rate in the current Section 10 permit application. Mortality associated with handling, trapping and tagging is estimated to be minimal, less than 1 percent (ODFW 1998b). Anticipated adult returns are based on the range of observed SARs for the Imnaha program (Eddy 2000).	

Currently, after sampling occurs, fish selected for broodstock are transported 3-4 hours to Lookingglass Hatchery. Under the proposed alternative, fish selected for broodstock will not be transported off station but would be moved into the juvenile acclimation pond on site. Dimensions of the pond are 25’4” x 125’ x 5’7”. Although the pond was originally constructed to accommodate adult holding as well as juvenile acclimation, it has not performed this function satisfactorily. In addition, the existing weir and fish ladder have not performed their function satisfactorily, which has resulted in an inability to fish the entire run, as well as some adult mortality in 1999. The existing weir is not able to fish effectively during high flows and typically more than a quarter of the adult return passes by the facility before the weir is installed. This is a concern for broodstock collection protocols and monitoring and evaluation of the program (see Chapter 5 for more information). Some modifications will be necessary at the facility (see Table 3-8). These renovations were also recommended by Montgomery Watson (1999a). The feasibility of locating a weir to intercept adults elsewhere in the subbasin will be examined during the design phase of this project. The potential for developing a pathogen-free water source to incubate eggs at the facility will also be analyzed during the design phase.

The Gumboot facility is currently operated jointly by NPT and ODFW and funded through the LSRCP (see Table 1-1). Operation of the facility for direct and indirect **take** of an ESA-listed species is authorized through NMFS Section 10 permit and Section 7 consultations (see Table 1-3).

Table 3-8 Modifications at the Gumboot Facility

Modification	Purpose/Reason	Comments
Provide Main Grid Electrical Service	Reliable power source and allow for equipment upgrades i.e., chillers/heaters/ozone/ computers.	Nearest residential service 6 miles down-river. Explore possibilities of a drop or substation from large main lines at site.
Provide residential phone service	Reliable communications and allow for fax and email.	Nearest residential service 6 miles down-river.
Improvements to adult weir	Allow for collection throughout the run	Current weir setup cannot be fished during high flows and has caused mortality.
Improvements to fish ladder	Double or triple the ladder width and increase flow volume	To provide for better attraction and easier migration into the holding pond.
Improvements to adult/juvenile holding area	Water system protection (i.e., sand filter), anti-jump structures, spray treatment system, formalin treatment system, segregation pens, and spawning area improvements.	Reduce adult pre-spawn mortality by improving holding conditions and eliminating transportation off-station.

Incubation and Rearing Facility

The proposed site is on the Marks property located approximately 6 miles upstream from the town of Imnaha, Oregon at RM 24.25 and at an elevation of approximately 2400 ft. (see Map 2). This site was selected from 10 potential sites on the Imnaha through the screening process conducted by the NEOH TWG and Montgomery Watson (1995b).

The following information describes some of the most important reasons for siting the facility at this particular location.

Water Supply – During the initial screening process, the potential for groundwater development was an important factor for siting facilities in the Imnaha Subbasin. Well logs and geologic formations in the Imnaha suggest the area is not conducive to large production type wells. The well logs available for the Imnaha area are all domestic wells, which in general show relatively poor production, with many drilled to over 100 feet below the water table before encountering enough water for domestic use. The best production potential, based on geology and well logs, appeared to be along the river upstream from the town of Imnaha (Montgomery Watson 1995b).

Water for the proposed facility would be supplied from two sources: groundwater from wells and surface water from the Imnaha River. Incubation and early rearing will require pathogen-free water, which can be provided either through treated surface water or groundwater. Final rearing will occur on untreated surface water. To evaluate groundwater potential, some exploratory wells were drilled at the proposed site. To evaluate surface water potential, NPT analyzed available flow and temperature data from the Imnaha River and compared it to production facility needs.

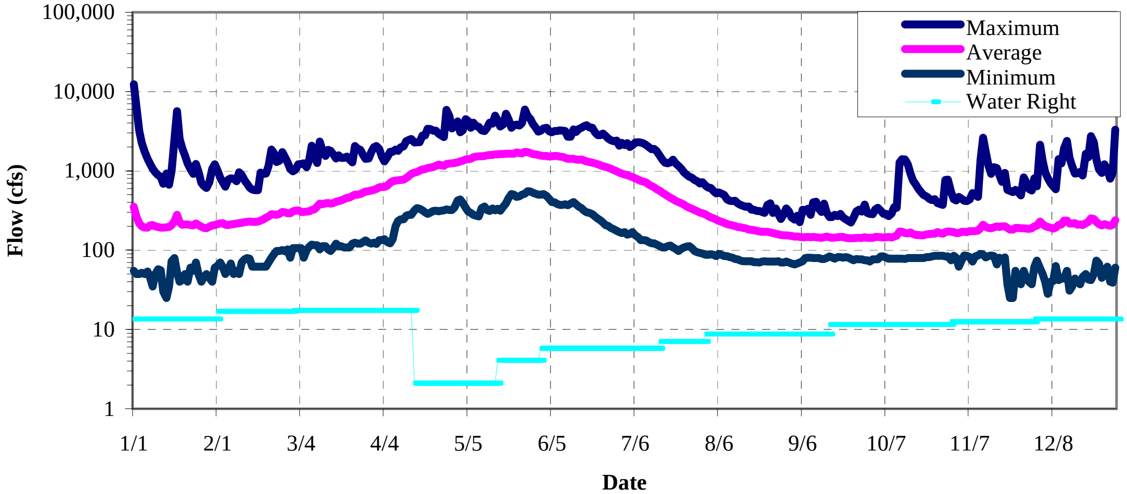
Water Quantity - The maximum flow required to rear the full Imnaha program under conditions consistent with Table 3-1 is 17.3 cfs (14.5 cfs for smolts and 2.8 cfs for early rearing) (1 cfs = 449 gallons per minute). This maximum flow will be required for a short period of time (February through April) during the transition portion of rearing when both smolts and **fry** are on hand. In comparison to the amount of water in the Imnaha River, this is 25 percent of the lowest average minimum recorded during the period this flow would be required (see Figure 3-2). Water use would be non-consumptive; all water withdrawn would be returned to the Imnaha River following treatment in settling ponds.

Incubation and early rearing will require pathogen free water, which can be provided either through treated surface water or groundwater. In 1992, one test well was drilled at the Wayne Marks Ranch site on the east side of the river (the proposed facility location is on the west side of the river). Production potential from this well was 350 gpm. In 1998, two production wells were drilled on the west side of the river. One of these produced very little groundwater and the other was projected to have production potential of 225 gpm for short periods of time (100-125 gpm recommended for extended pumping). Water quality was good and temperature range was 52-54 degrees F (Montgomery Watson 1998).

Based on these results, groundwater potential is sufficient for incubation and a portion of early rearing (to 500 fish/lb.) of the entire program. However, chilling would be necessary to meet program incubation requirements. There is potential for development of additional wells at the site to increase supply as well as treatment of surface water. Ozone-treated surface water would provide a source of pathogen-free water for incubation and rearing from the natal watershed, and the groundwater could act as a backup to the ozone system and provide a means to manipulate water temperatures.

Water Quality - Water quality of groundwater and surface water at the proposed site is appropriate for fish culture use (Montgomery Watson 1995a,b) although surface water temperatures of the Imnaha River periodically reached levels that exceeded criteria for juvenile rearing during July, August and September. In 1998, the NPT installed thermographs at the site to determine if rearing juveniles at this site during the summer months was feasible. Although the current database is for only one year, air temperatures recorded during the summer of 1998 in Northeast Oregon were some of the hottest on record. Results of this analysis are presented in Figures 3-3, 3-4, 3-5, and 3-6. The thermograph data demonstrated that temperatures exceeded the temperature criteria of 70°F, but these peak water temperature events were typically of short duration during the day.

Figure 3-2 Mean, Minimum and Maxiumum Flow of the Imnaha River (1928-1998) and Predicted Water Use at the Proposed Facility.



Source: USGS Gauge 13292000 – Imnaha River at Imnaha, Oregon, 6 miles downstream of the proposed facility.

Figure 3-3 Mean, Minimum, and Maximum Daily Water Temperatures of the Imnaha River at Marks Ranch, 1998

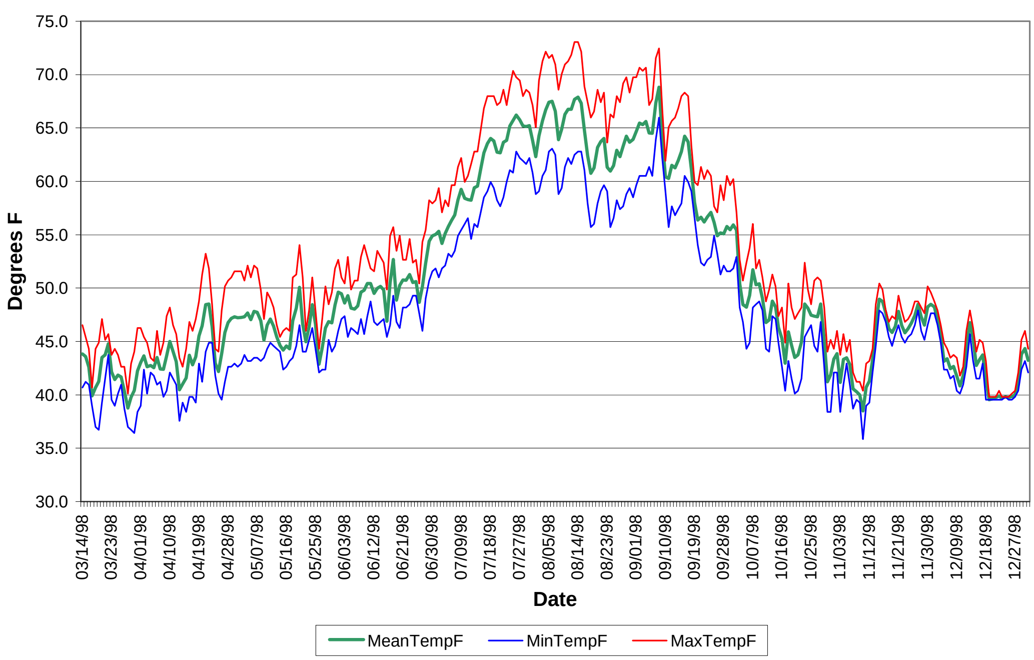


Figure 3-4 Water Temperature Data at Mark's Ranch Site, Imnaha River, July 1998

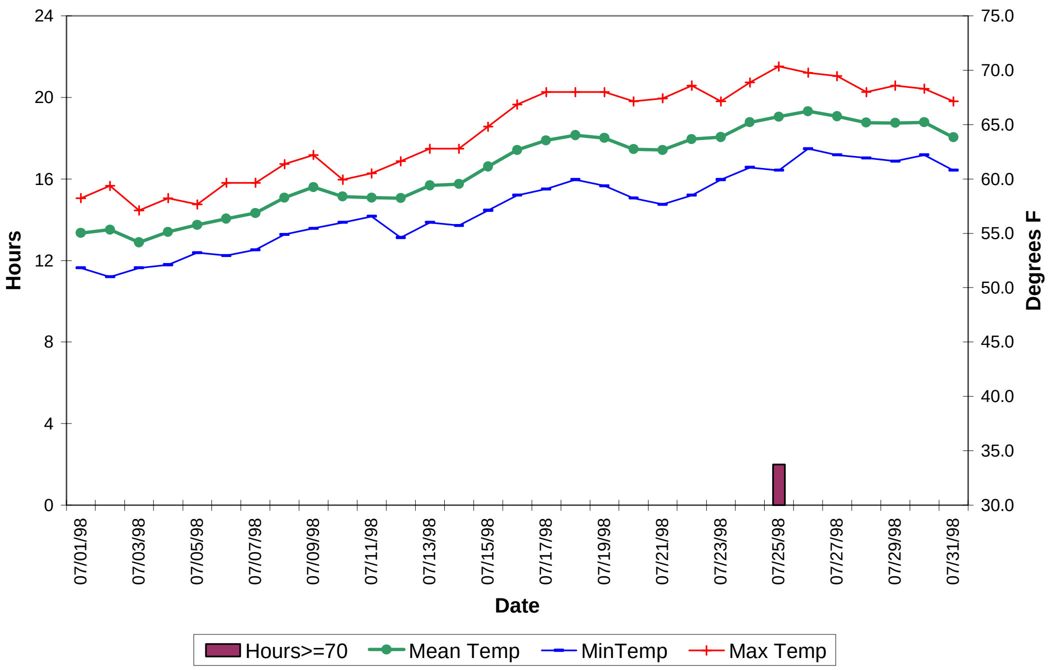


Figure 3-5 Water Temperature Data at Mark's Ranch site, Imnaha River, August 1998

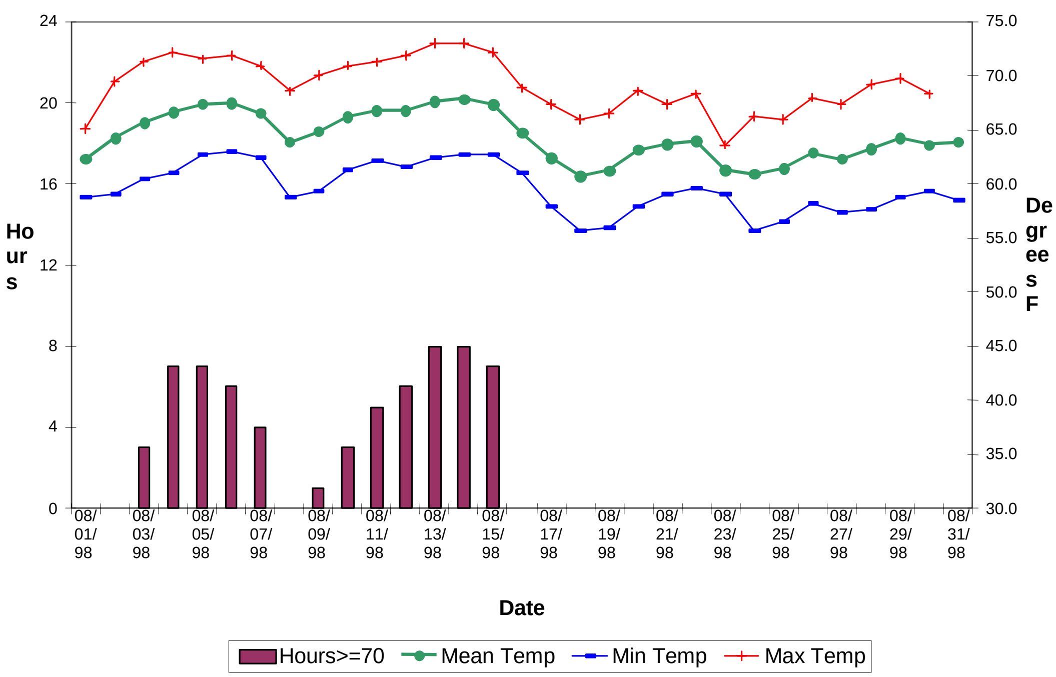
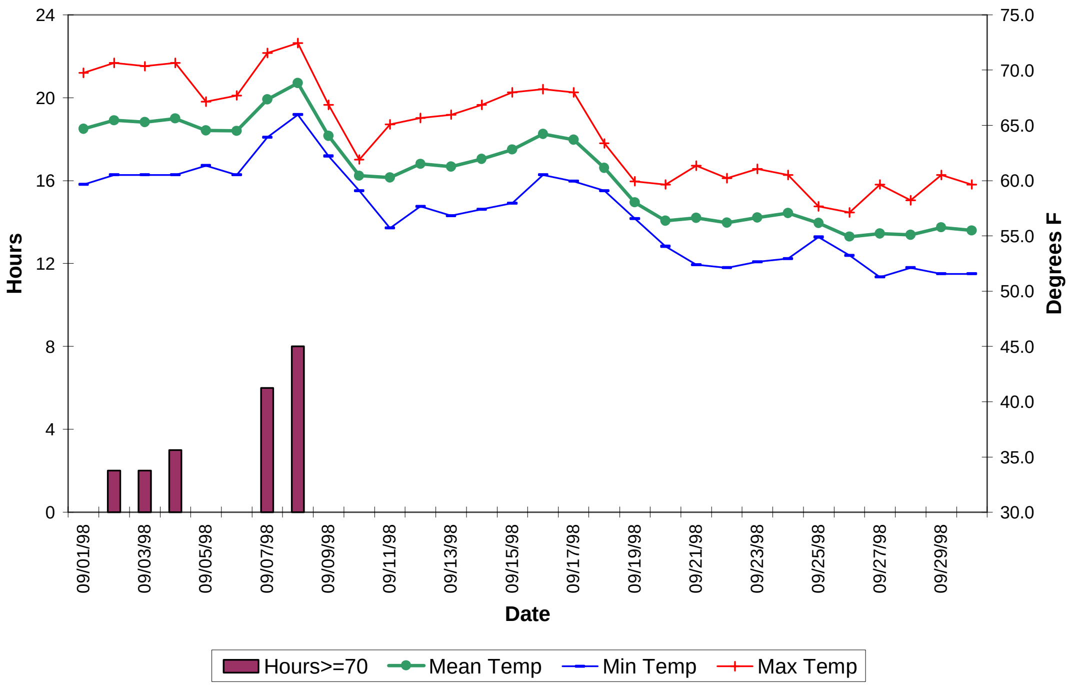


Figure 3-6 Water Temperature Data at Mark's Ranch site, Imnaha River, September 1998.



NPT discussed these finding with Montgomery Watson and FishPro, Inc. personnel. Both engineering consultants have dealt with hatchery facilities that use surface water for culturing salmon and were confident that these temperatures did not pose a serious problem. They provided examples of several options that could be used to perform the minimal amount of cooling needed at this site during this time period. Montgomery Watson (1995a) also performed an analysis of temperature data from the USGS gauge at Imnaha. Using an upper limit of 63°F, they determined water temperatures during July and August would require cooling of 7 to 8°F.

In 1994, there was a mass wasting event in the upper Imnaha Subbasin that resulted in turbid water and was associated with the mortality of adults being held at the Imnaha satellite facility. Some concern has been expressed about the possibility of another of these events and the effect it might have on a fish culture facility. This issue was discussed with several habitat biologists and USFS personnel who concluded that there is always the possibility of a summer turbidity event in the Imnaha Subbasin given the steep terrain and granitic soils found in the upper watershed. However, if mass wasting occurs it will most likely be a natural event. Due to the Wilderness designation of the upper watershed, domestic sheep grazing permits no longer exist and logging and road building. Kevin Martin (November 1999) noted that the upper Imnaha Subbasin is healing from the sheep grazing that occurred in previous years and that it is one of the most healthy and unaltered watersheds in the Snake River Basin.

Given the precious nature of the fish that would be cultured at this facility, the potential for this type of event should not be ignored. In developing the conceptual design of these proposed conservation facilities, emergency backup systems would be planned. Options considered include pre-settling basins, sand filtering system, oxygen infiltration system, and emergency reuse systems.

Disease Risk - The Marks Ranch site is not expected to have a high disease risk for the following reasons:

- The proposed site is approximately 25 miles downstream from where most spawning occurs resulting in a greater spatial segregation between spawning area and the hatchery intake than occurs on Lookingglass Creek. Problems with carcasses stacking up on the hatchery intake at this site are not expected.
- The quantity of flow in the Imnaha River is much greater than Lookingglass Creek, therefore the dilution factor is also much greater.
- During the initial screening process, the disease potential for sites in the vicinity of Marks Ranch were evaluated as “Low w/temp and flow control” (Montgomery Watson 1995b).
- The physical space at the proposed site will allow for spatial segregation and very low rearing densities that will improve the ability to manage fish health.

To ensure that this facility can provide an environment where disease risk from the incoming water supply is not an issue, an ozone treatment system was included in the conceptual facility design. Cost estimates for this facility also included ozone treatment (Montgomery Watson 1999a).

Icing and Flooding - Based on historic observations at this location in the Imnaha Subbasin, freezing or impacts of ice flows from the upper river are not anticipated to pose major problems. One of the reasons for selecting the Marks property as a hatchery site is that it sustained only minor flooding for a short period during the 500-year flood event of the winter of 1996-97. The previous recorded high flow since June 1928 was 10,100 cfs; high flow in January 1997 was 20,200 cfs. During that event, minimal flooding (less than a foot deep) occurred on the south quarter of the property; the location of the proposed site for hatchery buildings and rearing containers did not flood.

Acclimation and Release Facility

The existing acclimation and release facility at Gumboot does not have sufficient space to accommodate the entire production of 490,000 smolts at one time (Montgomery Watson 1999a). As a result, current operations “double-load” or consecutively run two groups of fish through the facility, which reduces acclimation time for each group to about two weeks (preferred acclimation time is about 4 weeks).

Co-managers are considering two options under the proposed alternative to address this situation:

1. Continue to double-load (acclimate two groups) in the existing facility or direct stream release small groups of fish upstream of the acclimation facility. Since fish will be

reared for the majority of their life on Imnaha River water at the new incubation and rearing facility, acclimation in the upper watershed prior to release may not be critical.

2. Modify the existing facility (construct additional ponds) or construct new facilities to accommodate full acclimation of the full program.

Co-managers selected potential site locations for additional facilities (see Table 3-9). Each has constraints. Co-managers agreed that the most beneficial location for additional acclimation facilities would be upstream of the existing facility because most of the spawning habitat is upstream. However, winter conditions in the Imnaha Subbasin are typically severe, making access and operation of a facility in this location difficult. During the preliminary design phase of this process, the biological benefit of each option will be compared to the cost to determine the preferred option.

Table 3-9 Potential Locations for Additional Acclimation and Release Facilities for Imnaha Spring Chinook Salmon Smolts

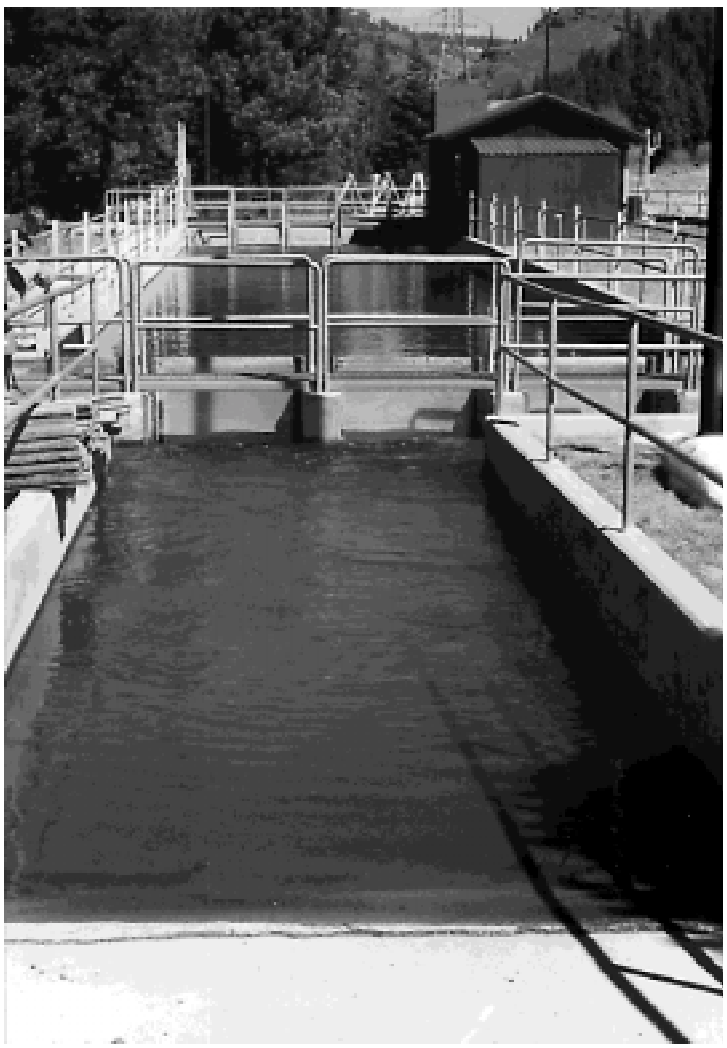
Potential Sites – from the mouth upstream	Considerations/Constraints
College Creek	Site may be considered too low in the drainage.
Stock Pond – Pallette Ranch	On private property downstream from Gumboot Acclimation Facility
Mahogany Creek	Location close to Gumboot Acclimation Facility; concerns regarding displacement of spawners by adult collection site
Ollocott Campground	USFS managed location 2-3 miles upstream of Gumboot Collection Facility; snowbound in the spring, flow and ice conditions
Coverdale Campground	USFS managed location, 7-8 miles upstream of Gumboot Collection Facility; snowbound in the spring, water flow and ice conditions
Indian Crossing Campground	USFS managed location, 10-11 miles upstream of Gumboot Collection Facility; snowbound in the spring, water flow and ice conditions End of roaded area
Multiple sites between Ollocott and Indian Crossing	USFS managed location, snowbound in the spring, water flow and ice conditions Poorly maintained secondary roads
Wilderness Above Indian Crossing	USFS managed location; snowbound in the spring, no roads, water and ice flow conditions Consider helicopter plants of pre-smolts in late fall and allow temperature and other migration triggers to provide time for acclimation.

3.4.1.2 Conceptual Design and Cost Estimates

Adult Collection/Juvenile Acclimation Facility

The existing facility at Gumboot is shown in Photo 3-1. The proposed modifications to this facility are listed in Table 3-8.

Photo 3-1 Gumboot Facility



Incubation and Rearing Facility

Conceptual design of the proposed incubation and rearing facility at the Marks Ranch site was prepared by Montgomery Watson (1995a) (see Figure 3-7). Overall design requirements of the facility have changed from one long rearing channel displayed in Figure 3-7 to separate rearing containers. In addition, because of insufficient groundwater to provide a pathogen-free water source for the entire early rearing phase, an ozone treatment system has been included in the cost estimates. Upon acceptance of this master plan, the preliminary design phase will be initiated. During this phase the facility design will be updated to meet present production criteria needs.

Cost estimates for the new facilities are shown in Table 3-10. Cost estimates for construction of facilities were prepared by Montgomery Watson (1999a). Appendix F contains a detailed explanation of how the costs were derived.

Table 3-10 Estimated Cost Expenditures and Future Needs for the Imnaha Subbasin

Expenditure	Estimated Cost
Planning (includes design @ 6-12 percent of construction costs, and about $150,000 in NEPA costs)	$700,000 to 1,150,000
Land Purchase – approximately 10 acres	$50,000 to 220,000
Construction (includes capital, engineering, construction administration, inspection, testing, overhead and taxes) (Montgomery Watson 1999a)	Depends on final design; about $7,500,000 +/- 35% contingency
O&M (LSRCP may cover some of the cost)	$492,000
M&E (LSRCP may cover some of the cost)	$590,000*

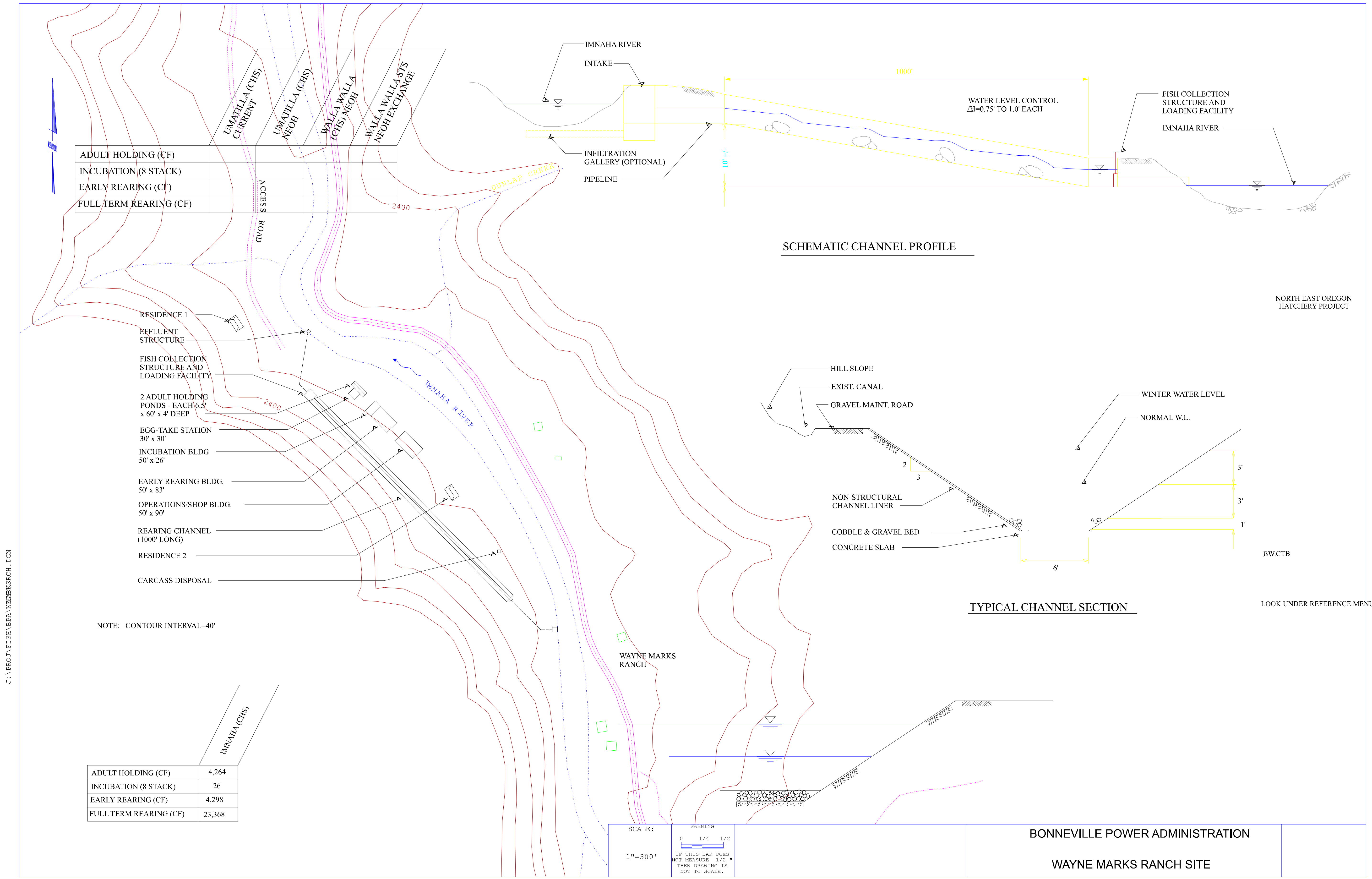
*This cost for M&E is additional to ongoing research, monitoring and evaluation in the Imnaha Basin and the Grande Ronde Basin, currently $2.2 million.

Notes: Estimates are in 2000 dollars; estimates based on Montgomery Watson 1999a.

3.4.2 Actions in the Grande Ronde River Subbasin

The Proposed Alternative would construct a new incubation and rearing facility in the Lostine River watershed. The production goal for Lostine spring chinook is 250,000 smolts. This production has two integrated components - conventional and captive brood production. The program is designed to scale down the captive broodstock component as numbers of conventional and natural adults increase and eventually shift to full conventional production (described in Chapter 4). If additional production (above 250,000) is deemed necessary in the future, NPT will pursue modifications to the facility and production program through the proper

Figure 3-7 Conceptual Design for the Marks Ranch Site



forums. Table 3-11 outlines number of adults required, estimated survival rates and numbers at each **life stage** to produce 250,000 smolts.

Table 3-11 Number of Fish Expected at Each Life-history Stage to Produce a Full Program of 250,000 Smolts, as Authorized under the GRESP

Production Parameter	Number
Number of adults to collect	185
Adult survival rate to spawn	80%
Number of adults surviving to spawn	148
Ratio of males to females	1:1
Number of females	74
Fecundity per female	4,000
Number of eggs to incubate	296,000
Egg to smolt survival	85%
Number of smolts to release	250,000
Smolt to adult survival	Range 0.043% to 0.562%
Adults returning to subbasin	107 to 1,405
Assumptions: Based on past production experience of this stock at Lookingglass Hatchery, a 20 percent adult prespawning mortality and an egg-to-smolt mortality of 15 percent is anticipated (BIA 1998). An 85 percent survival rate was used for egg to smolt because this rate is in the Section 10 permit application. Mortality associated with handling, trapping and tagging is estimated to be minimal, less than 1 percent (BIA 1998). Anticipated adult returns were calculated from SARs observed for the Imnaha program (Eddy 2000).	

3.4.2.1 Facilities

The following facilities are necessary to implement the proposed alternative. The existing Lostine River adult collection and acclimation facilities were constructed by BPA under BPA Project 9800701 in 1997 and 1998 (see Map 5). The incubation and rearing facility is proposed for construction under this master plan.

Adult Collection Facility

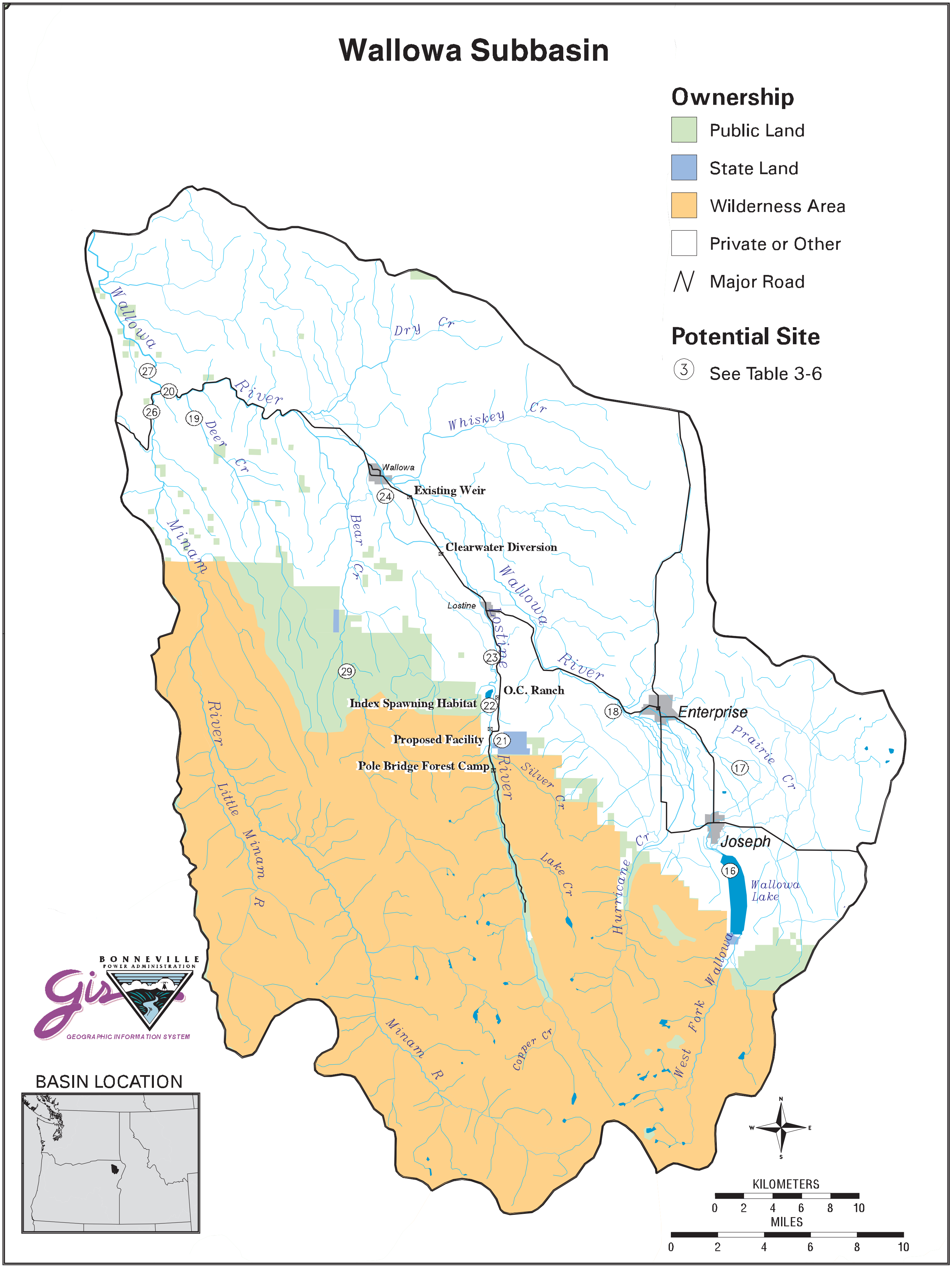
Adults would be collected at an existing temporary, picket-style weir installed in the Lostine River approximately one mile upstream of the confluence with the Wallowa River (see Photo 3-2). The weir spans the complete river channel at a near 45-degree angle to river flow. It consists of tripods constructed from 2” diameter steel pipe, connecting steel stringers, and aluminum pickets. The trap/holding facility consists of a V-trap structure encased on three sides by aluminum panels to create a holding pen. The weir is a movable facility that is installed in April to June of each year and dismantled and removed in September or October. Further design information is contained in the 100 percent Design Memorandum (Montgomery Watson 1997).

Photo 3-2 Existing Weir on the Lostine River

In the three years this facility has been operated, NPT has determined that the existing weir is not able to fish effectively during high flows and therefore misses a portion of the adult return. This is a concern for broodstock collection protocols and monitoring and evaluation of the program (see Chapter 5 for more information). As a result, the NPT will be testing an auxiliary weir that is designed to withstand higher flow events in 2000. This auxiliary weir is located approximately one mile upstream of the existing facility at the Clearwater Diversion structure (see Map 5). The picket weir facility will still be necessary to collect adults during the lower flow periods. These facilities are operated by the NPT with funding provided through BPA (see Table 1-1). Adult collection operations are authorized under a Section 7 consultation and a Section 10 permit application.

Incubation and Rearing Facility

The proposed site for this facility is on the Lundquist property at River Mile 12, at an elevation of about 3,680 feet and approximately 6 miles upriver from the town of Lostine (see Map 5). This site is directly upstream from the preferred site selected during the NEOH screening



Wallowa Subbasin
Ownership
Public Land
State Land
Wilderness Area
Private or Other
Major Road
Potential Site
3 See Table 3-6
Wallowa
Existing Weir
Clearwater Diversion
Lostine
O.C. Ranch
Index Spawning Habitat
Proposed Facility
Pole Bridge Forest Camp
Enterprise
Joseph
Wallowa Lake
Wallowa River
Dry Cr
Whiskey Cr
Deer Cr
Bear Cr
Minam River
Little Minam R
Minam R
Lostine River
Silver Cr
Lake Cr
Hurricane Cr
Copper Cr
West Fork Wallowa
Prairie Cr
BONNEVILLE POWER ADMINISTRATION
GEOGRAPHIC INFORMATION SYSTEM
BASIN LOCATION
KILOMETERS
0 2 4 6 8 10
MILES
0 2 4 6 8 10

process of 4 possible sites on the Lostine River (Montgomery Watson 1995a, b). This site is above all irrigation diversions on the Lostine River and is immediately upstream of the Lostine Acclimation facility.

General requirements of incubation and rearing facilities are included in the Conceptual Design (Montgomery Watson 1995a) and Final Siting Reports (Montgomery Watson 1995b). The following information describes some of the most important reasons for siting the facility at this particular location.

Water Supply - Water would be supplied from two sources, groundwater from wells, and surface water from the Lostine River. Incubation and early rearing will require pathogen-free water, which can be provided either through treated surface water or groundwater. Final rearing and adult holding would occur on untreated surface water. To evaluate groundwater potential, some exploratory wells were drilled at the proposed site (Montgomery Watson 1999b). To evaluate surface water potential, NPT analyzed available flow and temperature data from the Lostine River and compared it to production facility needs.

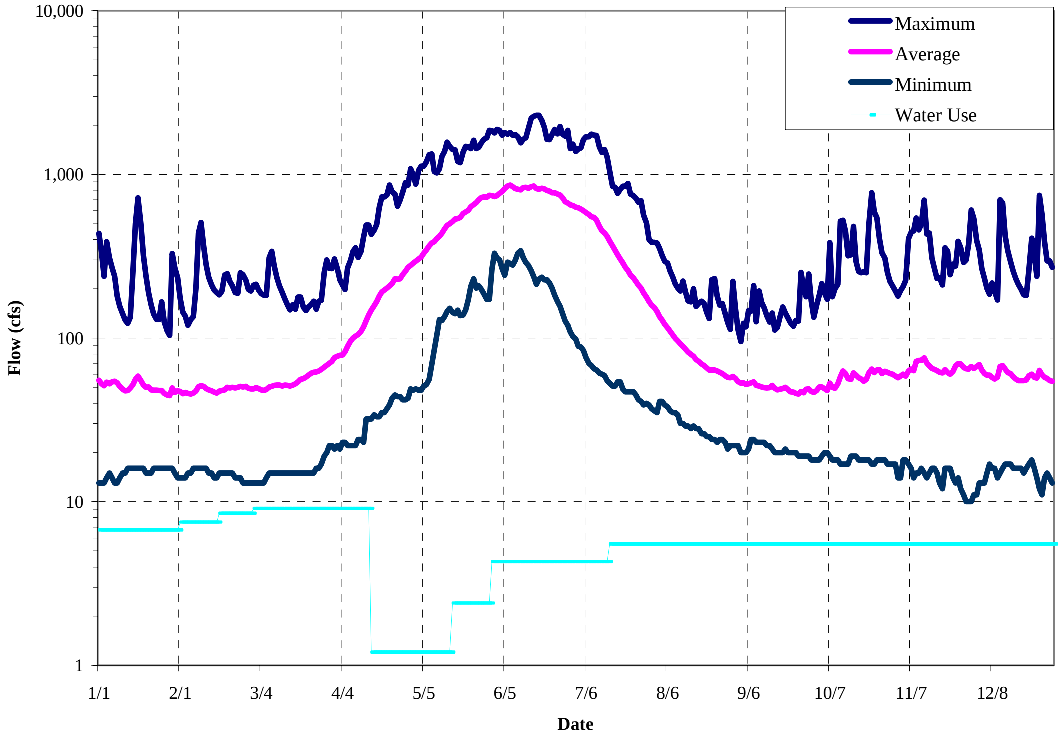
Water Quantity - The maximum flow required to rear the full Lostine program under conditions consistent with Table 3-1 is 9.1 cfs (7.8 cfs for smolts and 1.3 cfs for early rearing). This flow would only be necessary during the transition portion of rearing when both smolts and fry are on hand (February to April), which is for a short period. In comparison to available flow, this is 60 percent of the lowest average minimum recorded in the Lostine from November to February (see Figure 3-8).

Incubation and early rearing will require pathogen-free water, which can be provided either through treated surface water or groundwater. Two groundwater exploration wells were drilled at the proposed facility site from December 1998 to January 1999 (Montgomery Watson 1999b). Production potential from one well was estimated at 400 to 500 gpm. Production of 400 gpm can be sustained for long-term pumping with no significant impact on domestic wells in the area. Pumping at 500 gpm may be possible for periods of a few weeks. Another well at the site, which has not yet been developed for testing, may be able to produce approximately 100 gpm. This supply is adequate to meet program needs. Water temperature was a constant 45^{o} F. Use of water would be non-consumptive; all water withdrawn would be returned to the Lostine River following treatment.

Water Quality - Water quality of groundwater and surface water at the proposed site is appropriate for fish culture use (Montgomery Watson 1995b and 1999b). Limited water temperature data was available from the Lostine River near the proposed facility site, so the NPT installed thermographs at the site to monitor surface water temperatures. Water temperatures recorded by thermographs adjacent to the site during the summer months have ranged from 38.7^{o}F to 63.6^{o}F (see Figure 3-9).

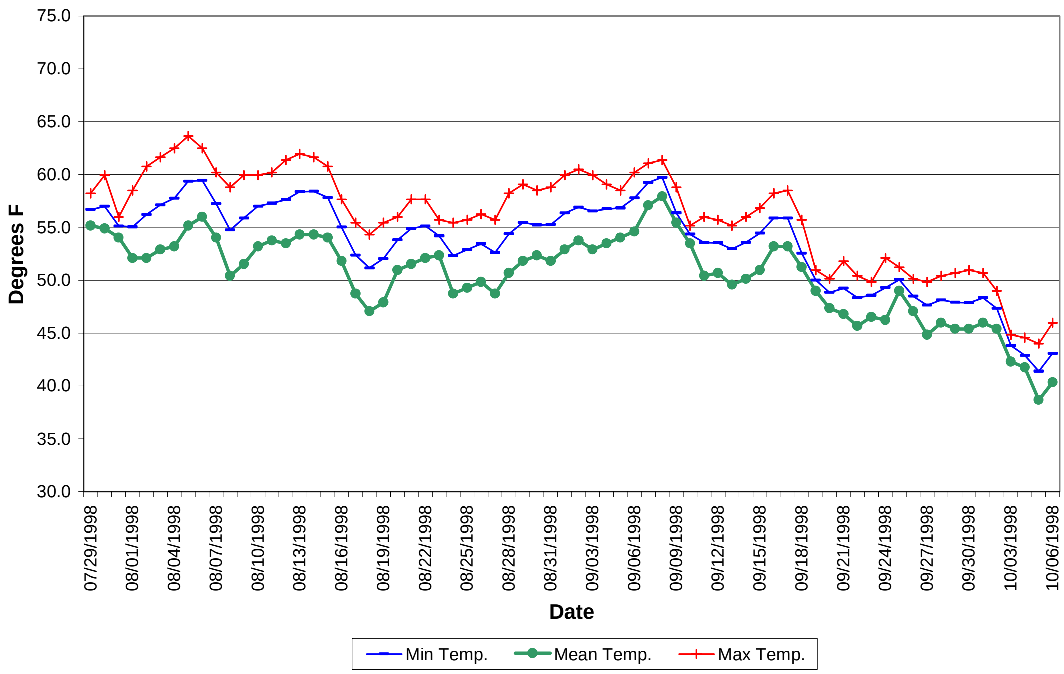
Disease Risks - The location for the proposed Lostine facility is upstream of most of the currently used spring chinook spawning habitat in the Lostine River. However, to ensure that this facility can provide an environment where disease risk from the incoming water supply is not an issue, ozone treatment is included in the conceptual facility design and cost estimates.

Figure 3-8 Mean, Minimum and Maximum Flow of the Lostine River (1925-1998) and Predicted Water Use at the Proposed Facility.



Source: USGS Gauge 13330000 – Lostine River 3.5 miles south of Lostine, Oregon.

Figure 3-9 Mean, Minimum, and Maximum Daily Water Temperatures of the Lostine River adjacent to the Proposed Facility Site, August - September 1998



Icing and Flooding - The consideration of potential icing and flooding played an important part in the selection of this site for the proposed facility. In 1998, this site was monitored during several days of -20°F temperatures (during this time crews at Lookingglass were fighting ice around the clock) and the section of river adjacent to the site did not freeze. Only small amounts of shore ice were observed. Large quantities of 45°F groundwater up-welling in the area may retard icing events.

This site was also observed during 1999, when the Lostine River reached the fifth highest flow on record and massive flooding occurred in the watershed. During this event the proposed site did not flood. In addition, the existing acclimation facility, which is directly downstream of the proposed incubation and rearing facility and is closer to the river and lower in elevation, did not flood.

Acclimation and Release Facility

The existing acclimation and rearing facility is located on the private property of Stuart Coleman, slightly downstream of the proposed incubation and rearing facility (see Photo 3-3).

Smolts will continue to be acclimated at the facility until the incubation and rearing facility is operational. After the incubation and rearing facility is operational, fish can be released directly from their rearing containers. The existing facility may become a component of the incubation and rearing facility or be dismantled.

This facility is operated by the NPT with funding provided through BPA (see Table 1-1). Operation of the facility is authorized under a Section 7 consultation and a Section 10 permit application (see Table 3-1).

3.4.2.2 Conceptual Design and Cost Estimates

Incubation and Rearing Facility

A conceptual design for the Lundquist site is shown in Figure 3-10. The design will be updated in the next design phase but will be similar to this figure with separate rearing containers (raceways). An ozone treatment system was included in the cost estimates at this site, although sufficient groundwater is available to provide pathogen-free water for incubation and early rearing of the entire program. The ozone system at this facility would most likely act as a backup to the groundwater supply. Significant cost savings would occur if this were eliminated from the facility.

Cost estimates for the new facilities are in Table 3-12. Cost estimates for construction of facilities were prepared by Montgomery Watson (1999a). Appendix F contains a detailed explanation of how the costs were derived.

Photo 3-3 Existing Acclimation and Rearing Facility-Stuart Coleman Property

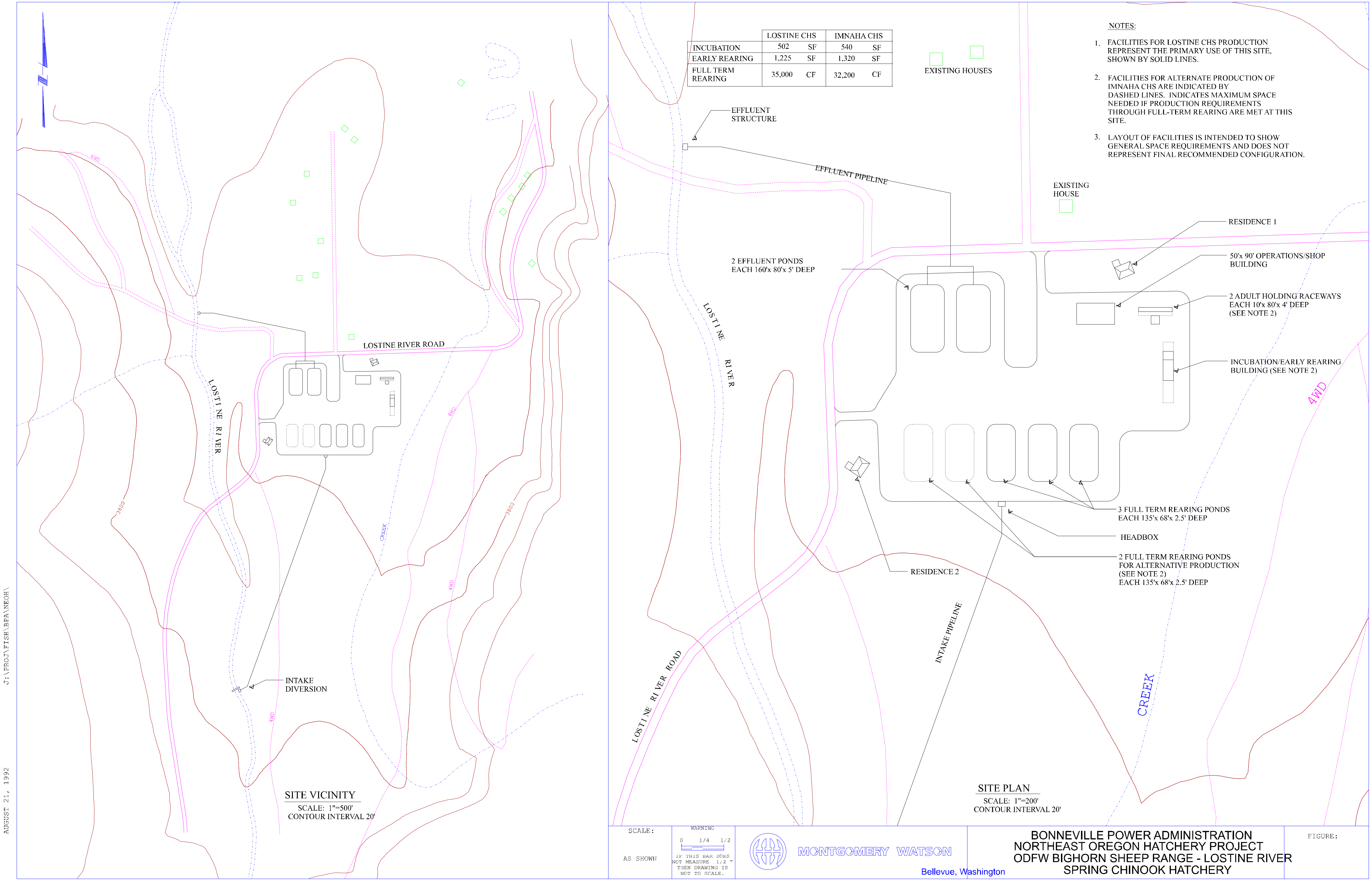
Table 3-12 Estimated Cost Expenditures and Future Needs for the Lostine River

Expenditure	Estimated Cost
Planning (includes design @ 6-12 percent of construction costs, and about $150,000 in NEPA costs)	$532,000 to 814,000
Land Purchase – approximately 7 acres	$35,000 to 154,000
Construction (includes capital, engineering, construction administration, inspection, testing, overhead and taxes) (Montgomery Watson 1999a)	Depends on final design; about $4,700,000 +/- 35% contingency
O&M (LSRCP may cover some of the cost)	$436,000
M&E (LSRCP may cover some of the cost)	$170,000*

*This cost for M&E is additional to ongoing research, monitoring and evaluation in the Grande Ronde Basin and the Imnaha Basin, currently $2.2 million.

Notes: Estimates are in 2000 dollars; estimates based on Montgomery Watson 1999a.

Figure 3-10 Conceptual Design for the Lundquist Site



3.4.3 Coordination and Management Structure

The proposed incubation and rearing facilities on the Imnaha and Lostine rivers would be managed in conjunction with the existing adult collection/juvenile acclimation and release facilities, with the intent to restore and increase natural production of anadromous fish resources in the Imnaha River and the Lostine River, respectively.

Co-managers of the Imnaha and Lostine Complexes would be the Nez Perce Tribe and Oregon Department of Fish and Wildlife. Co-managers agree to work cooperatively to achieve project goals. Co-managers agree to operate these facilities in a prudent and cost effective manner. The Nez Perce Tribe would function as the lead agency for the Imnaha River and Lostine projects and therefore, would be primarily responsible for planning, operation and maintenance, and monitoring and evaluation of the facilities described in the master plan. BPA is primarily responsible for construction of the facilities. The proposed facilities would be responsible for production of fish for the conservation program, and if successful, would then be responsible for LSRCP mitigation responsibilities.

NPT would prepare an Annual Operating Plan (AOP) to coordinate project operations with its co-managers. The AOP would include:

- Details of day-to-day project operation
- A fish production plan that identifies species, stocks and number of fish produced by the project during the fiscal year
- Tasks required to complete general project objectives
- An identification of personnel and job positions required to complete the tasks and duties outlined in the AOP
- Design and implementation steps for the supplementation components of the project, including, research, monitoring and evaluation.

Chapter 4 Production of the Currently Permitted Program

In this chapter:

- Details of the Production Program

The Imnaha and Grande Ronde (GRESP) conservation/restoration programs have been authorized by NMFS ESA Section 10 permits 847 and 1011, respectively (see Table 1-3). Both permits have either expired or been modified; current program activities are described in Section 10 permit applications submitted to NMFS in 1996 and 1998. Section 10 permits for these activities have not been granted due to processing delays not related to the substance of the permits (Pollard, March 31, 2000). However, co-managers have been operating these programs as outlined by the permit applications since their submittal, and refer to the fish production from these programs as the Currently Permitted Program (CPP). Under the Proposed Alternative, the Imnaha and the Lostine components of the CPP would be produced in the proposed new facilities. This chapter provides a technical description of these components.

4.1 Imnaha River Program

The Imnaha River Subbasin conservation/restoration program has been authorized by NMFS through Permit 847, which expired on March 31, 1998. A new permit application was submitted in January 23, 1998 for the period of April 1, 1998 to March 31, 2003 (ODFW 1998b).

The Imnaha program received scientific scrutiny during its development and during the process of acquiring appropriate permits. NMFS conducted both peer and public review of Section 10 permit applications. In granting its permits, NMFS determined that the direct take of listed fish for hatchery broodstock will be beneficial to the threatened species, either by improving knowledge through research or enhancing the survival of the listed species (Mike Delarm, April 3, 2000).

The following sections give a detailed description of the fish culture and management aspects of the CPP from adult collection to release of juveniles.

4.1.1 Broodstock Selection

Adult spring chinook of hatchery and natural origin returning to the Imnaha River would be used for broodstock.

4.1.1.1 Reasons for Choosing Broodstock

The uniqueness of Imnaha River chinook salmon was recognized before the Lower Snake River Compensation Plan hatchery program was started (Carmichael et al. 1998b, Mundy and Witty 1998). This recognition led to a decision to use only endemic stock for the hatchery program and to use some natural fish for hatchery broodstock each year. Beginning with the 1982 brood year, naturally-produced returning adults were trapped for broodstock at the Gumboot weir facility located at RM 47. Broodstock in subsequent years has been composed of hatchery-origin and natural-origin fish. Table 4-1 shows the total number of adults collected for broodstock, however, due to prespawning mortality the number of adults actually spawned is slightly different (see Table 4-2).

Table 4-1 Total Escapement, Number of Broodstock Collected, and Number and Origin of Natural Spawners in the Imnaha River just prior to the Initiation of the LSRCP Program to Present (1979–1999)

Year	Total Escapement	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1979*	192	0	0	192	0	0
1980*	125	0	0	125	0	0
1981*	307	0	0	307	0	0
1982	1,262	28	0	1,234	0	0
1983	990	64	0	926	0	0
1984	1,178	36	0	1,142	0	0
1985	1,844	115	14	1,573	142	0
1986	1,165	315	21	788	51	0
1987	644	83	22	484	55	0
1988	928	140	68	609	111	3
1989	697	105	187	297	108	0
1990	627	81	159	199	188	49
1991	959	51	262	198	448	70
1992	1,353	54	331	205	763	79
1993	1,724	58	394	430	842	66
1994	311	20	31	118	142	55
1995	432	38	30	204	160	44
1996	535	72	61	266	136	34
1997	517	23	149	129	216	63
1998	586	77	57	255	197	44
1999	1,676	22	254	287	1,113	80

Notes: Jacks are included in the estimates. Total escapement is the sum of total natural spawners estimated from redd counts and fish retained for hatchery broodstock.
*Estimates prior to 1982 are based on redd counts above the location of the weir and not expanded for those fish spawning below the weir location.
Data sources: Parker (1997) and data from ODFW files, LaGrande office.

All broodstock listed in Tables 4-1 and 4-2 are Imnaha stock with the exception of part of the 1984 brood year stock, when an estimated 1.5 percent of the 1986 smolt release was from Lookingglass broodstock. This Lookingglass contribution resulted from some Lookingglass juveniles being mixed with the Imnaha juveniles during an ice-up at Lookingglass Hatchery in 1985 (Carmichael et al. 1986b).

Table 4-2 Actual Broodstock Spawned

Year	Broodstock Collected	Prespawning Mortality		Killed, not Spawned	Actual Parents		Hatchery Broodstock of Natural Origin (%)
		n	%		Natural	Hatchery	
1982	28	4	14		24		100
1983	64	4	6		60		100
1984	36	11	31	7	18		100
1985	131	32	24	33	61	1	98
1986	340	127	37	79	120	11	92
1987	105	10	10	13	70	9	89
1988	205	13	6	56	112	24	82
1989	293	22	8	113	86	72	54
1990	240	35	15	57	64	84	43
1991	313	12	4	225	39	37	51
1992	385	88	23	68	40	189	17
1993	452	50	11	6	50	346	13
1994	51	6	12	2	15	28	35
1995	68	7	10	0	36	25	59
1996	133	26	20	30	55	22	71
1997	172	52	30	1	15	104	13
1998	134	21	16	0	59	54	52
1999	276	24	9	0	21	231	8
Data sources: Carmichael and Messmer (1995) and data from ODFW files, LaGrande office.							

4.1.1.2 Genetic or Ecological Differences

The Imnaha River spring chinook salmon appear to be a genetically distinct population. In 1989 and 1990, sub-yearling chinook were sampled from various Snake River Subbasin populations, including the Imnaha River. The sampled fish were **electrophorectically** analyzed by NMFS for **enzymatic frequencies** associated with 39 **loci** (Waples et al. 1993). The Imnaha grouped with natural populations from the Grande Ronde Subbasin (Lostine River, Catherine Creek, and Minam River populations) before it grouped with natural populations from the Salmon River Subbasin (Upper Salmon and Secesh Rivers and Johnson, Marsh and Valley creeks) (Neeley et al. 1993). However, the Imnaha differed significantly from all Grande Ronde and Salmon River populations evaluated (Waples et al. 1993). Imnaha River hatchery-produced fish did not differ from naturally-produced fish. More information is available in Neeley et al. (1993).

In the event of extinction of the Imnaha stock, other stocks from this subgroup would be considered first as a source of broodstock for reintroduction. Otherwise, only stock endemic to the Imnaha would be used for broodstock in the conservation production program.

4.1.2 Broodstock Collection

The goal of the program is to collect broodstock from across the entire returning adult population as a representative sub-sample of the whole population. Currently, adult collection occurs at the existing Imnaha satellite facility at RM 47. Unfortunately, the existing weir is unable to fish effectively during high flows and typically more than one quarter of the adult return passes by the facility before the weir is installed. In addition, this facility is located upstream of some spawning habitat and there has been a concern that the existing weir may be responsible for some spawner displacement. This is a concern for broodstock collection protocols and monitoring and evaluation of the program (see Appendix D).

Facility improvements, redesign or operation of another type of weir at the Gumboot site or the operation of a weir located lower in the Imnaha River Subbasin will be evaluated during the engineering and design phase of this program. If improvements to the facility are identified to make the existing weir more effective, these modifications would occur under the Proposed Alternative and adult spring chinook would continue to be trapped at the existing weir facility. (See Section 3.4.1.1 and Appendix D for more information.) Operation of the weir and trap would follow the basic adult trapping procedures agreed to by co-managers, using LSRCP Annual Operation Plan procedures, IHOT guidelines (IHOT 1995), and standard fish culture practices. The weir would be operated from approximately late June to late September (flows permitting). Captured adults would be sampled on a daily basis if possible. They would be anesthetized, measured, examined for external marks, coded-wire tags (CWT), or **PIT** tags. Hatchery and natural origin fish are distinguishable because hatchery-produced fish would be marked differentially. Adults for natural spawning would be released upstream of the weir following recovery from anesthetic. Those adults selected for broodstock would be given erythromycin and oxytetracycline injections, an **opercle** punch, and an identifying tag.

Co-managers need to collect 320 adults to reach the program production goal of 490,000 smolts (see Table 3-7). Fish would be selected for broodstock or released above the weir to spawn naturally according to a sliding scale or other management tools as agreed to by co-managers. Fish not needed for broodstock or to meet natural spawner goals above the weir would be outplanted into other tributaries in the subbasin. The sliding scale tool currently used for broodstock management (see Table 4-3) is discussed in detail in the Section 10 Permit Application to NMFS (ODFW 1998b, see Appendix A). The scale has an underlying premise, that at low population levels the greatest risk to persistence is demographic risk of extinction. In the sliding scale, fewer constraints are placed on the number of hatchery fish spawning naturally and the number of naturally-produced fish spawned in the hatchery when population levels are low. Thus, fish benefit from the survival advantage provided by the hatchery. As population levels increase, demographic risks are of less concern and greater constraints are placed on the hatchery program to control the genetic risks associated with hatchery rearing (domestication selection).

Co-managers adopted additional management guidelines to define when further intervention actions, such as implementation of captive broodstock, should occur (see Table 4-4).

Table 4-3 Sliding Scale Developed for Allocation of Imnaha River Spring Chinook Salmon Collected at the Gumboot Weir to Natural Spawning or Hatchery Production

Estimated total adult escapement to the Imnaha River mouth	Ratio of hatchery to natural adults at the mouth	Maximum % natural adults to retain for broodstock	Maximum % hatchery adults to retain for broodstock	Maximum % adults of hatchery released above the weir	Minimum % of broodstock of natural origin
<50	Any	0	0	a	NA
51-700	Any	50	≤50	a	a
701-1000	Any	40	a	70	20
1001-1400	Any	40	a	60	25
>1400	Any	30	a	50	30

NA – Not applicable.

a – Percentages determined as a result of implementing other criteria, therefore not a decision factor.

Source: ODFW 1998b.

4.1.2.1 Proposed Number of Each Sex

To achieve full program production, 160 females and 160 males would be retained for the Imnaha River Program. These numbers were derived using the assumptions identified in Table 3-7 and are contained in the Section 10 Permit application (see Appendix A). Males and females would be collected proportionally across the run for broodstock.

4.1.3 Adult Holding

Although the Gumboot facility was constructed for adult holding and spawning, under the current program, adults collected for broodstock are transported about 3-4 hours (not including handling) to Lookingglass Hatchery for holding and spawning. Under the Proposed Alternative, adults would be held in the adult holding pond at the Gumboot facility until spawning occurs. Using the adult holding criteria in Table 3-1, this would require 3,200 ft.^{3} (10 ft.^{3}/fish) and a flow of 320 gpm (1 gpm/fish). The existing pond has 13,000 ft.^{3} (40.6 ft.^{3}/fish) and the facility has a water right of 4,443 gpm from June 1 to June 30, and 6,732 gpm from July 1 to October 31 (Montgomery Watson 1999a).

Typical pre-spawning mortality under the current program is 20 percent (ODFW 1998b) (see Table 4-2). The Proposed Alternative offers the potential to reduce mortality by holding the adults at the Gumboot facility in their natal watershed until spawning, thereby eliminating the stress caused by transportation. This action should result in more adults surviving to spawn and could reduce the number of adults collected for broodstock.

During holding, fish would be treated with formalin to prevent fungal infections. Treatments would be administered under protocols outlined in a prescription from a consulting veterinarian. No feeding of the adults would occur.

Table 4-4 Management Guidelines

Escapement Level	Start Captive Brood Program	Collect for hatchery broodstock and spawn	Release to spawn naturally above weir	Outplant (hatchery fish only) to Big Sheep, Lick Creeks, and other habitat	Harvest for Tribal Ceremonial Use	Harvest for Tribal Subsistence	Constraints on % of hatchery or natural for release or broodstock	Recreational Harvest
<300 for 2 consecutive years*	Yes	No	No	No	**	**	No	No
51-700	No	Yes	Yes	No	Yes	**	No	No
>700 (see criteria below)	No	Yes	Yes	Yes	Yes	Yes	Yes	**

Criteria and Priorities for fish trapped at the weir:

a. Retain natural adults at the maximum allowable percentage defined in the sliding scale up to that needed to achieve the egg take goal of 576,000 green eggs.

b. Retain hatchery adults to meet broodstock needs at the rate equal to the number allowable to meet the minimum percentage of broodstock that must be natural origin. Spawn all fish that are collected for broodstock.

c. Do not retain more than 320 (160 females and 160 males) adults for combined natural and hatchery broodstock. See Table 3-7.

d. Release hatchery fish above the weir up to the rate equal to the percentage of adults released above the weir that can be hatchery origin.

e. Hatchery fish that are excess to what is needed for broodstock and releases above the weir will be outplanted to Big Sheep and Lick Creek or harvested.

f. No more than 10% of males placed above the weir will be hatchery origin jacks. All other hatchery jacks will be spawned with the total hatchery jack contribution to fertilization not to exceed 10 percent of the eggs.

*Co-managers would submit a modification to the existing permit application to initiate a captive broodstock component for the Imnaha program.

** Decision would be made on a case-by-case basis.

4.1.4 Spawning

4.1.4.1 Selection Method

All live adults retained for broodstock will be spawned. Beginning in late July-early August, the fish selected for broodstock will be checked weekly for ripeness. Sex and age (i.e., four, five, and six year-old females and three, four, five, and six year-old males) of ripe fish are identified and then these fish are moved to a separate holding tank and spawned the following day. Information collected is then used to develop a spawning matrix (see Appendix G), which is currently used to determine matings during spawning.

Ripe females that die and are spawnable, (i.e., are recovered within several hours after death), will be spawned if feasible. Fertilization success for prespawn mortalities in 1997 ranged from 45 to 95 percent (ODFW 1998b). All spawned males, except jacks, are recycled (put back in pond to spawn again) when low numbers of adults are available for broodstock. In the last two years, some females have ripened before males have matured and are available to spawn.

So, co-managers began using hormone injections in 1999 to speed up the ripening of males to match spawn timing with females. Jacks will not make up more than 10 percent of the males being spawned and when large numbers of jacks are available, their semen is pooled.

4.1.4.2 Fertilization/Mating

Fertilization currently involves a complicated spawning matrix that uses the number of ripe males and females available on a specific spawning day (see Appendix G). The purpose of using the spawning matrix is to avoid giving any individual a selective advantage and to maximize the number of genetic crosses. Modification of spawning methods may become necessary as new information becomes available. At that time, the NPT and ODFW will work cooperatively to develop and improve genetic management procedures for the program.

The following priorities have been established by co-managers for the use of semen during fertilization.

1. Use fresh semen whenever possible. Recycled males may be used when low numbers of broodstock are available. Hormone injections of gonadotropin may be used on male chinook salmon 7-10 days prior to the date females are anticipated to be ripe.
2. Sperm-on-ice from fish passed at weir or collected for cryopreservation on the spawning ground.
3. **Cryopreserved** semen (see Section 4.1.4.3).

Prior to fertilization, each male's sperm is checked for motility immediately prior to combining gametes. Males that are surplus to that needed for fertilization of eggs would have their sperm cyropreserved. As part of the risk aversion plan, co-managers would store sperm at two separate locations.

4.1.4.3 Cryopreserved Gametes

Since 1994, co-managers have been cryopreserving semen samples from Imnaha River spring chinook salmon adults held for broodstock and from post-spawned fish collected on the spawning grounds. ODFW cryopreserved 53 samples from 1994-1995. NPT cryopreserved 158 semen samples from 1996-1998. These samples may be included in the development of spawning matrices, however, use of cryopreserved semen in a conventional hatchery program has not proven as effective as fresh semen. NPT researchers report a 28-80 percent loss of fertilization using cryopreserved semen (Paul Kucera, no date). Therefore, cryopreserved semen is only used for fertilization in the current program as a last resort. Whenever a cryopreserved sample is used in a matrix cell, the following selection criteria will be used.

- Select a sample based on year class (i.e., avoid potential relatedness to the female as described in other sections of this spawning protocol).
- Select a random sample once the proper year class is chosen.
- Activate part of the sample and check for motility.
- Evaluate motility as either present or absent.

- If motility is present, use the sample in the matrix.
- If motility is absent, do not use sample and select another random sample.

Whenever a cryopreserved sample is used in a matrix cell, it would be backed-up with another cryopreserved semen sample. Back-up semen will be added to the matrix cell no earlier than 30 seconds after the initial semen sample. This timing will allow the initial semen sample, if it is viable, a chance to fertilize each egg.

4.1.4.4 Disposition of Carcasses

All carcasses are currently landfilled. Under the Proposed Alternative, carcasses would be used for stream enrichment and nutrient enhancement. Carcasses would be returned to the Imnaha River in the upper watershed (primarily above the Gumboot facility) following fish health clearance.

4.1.5 Incubation

Under the Proposed Alternative, incubation would occur either at the Imnaha satellite facility until eggs are eyed and then be transferred to the proposed facility at the Marks Ranch, or unfertilized gametes would be transferred to the proposed facility at the Marks Ranch for the entire incubation period. Following fertilization, eggs would be placed in individual incubation units (e.g., Heath stack incubators).. Each family group (or possibly matrix cell) would be incubated separately until eye-up. Prophylactic formalin treatments may be used to prevent fungal infection. Bacterial Kidney Disease analysis would take place before eye up, and the need for segregation or culling would be determined according to egg health. **Shocking** would occur at approximately 600 **temperature units** (TUs) about October 25 to November 5. At eye-up, eggs would be shocked, mortalities picked and females may then be pooled for the remainder of the incubation period. Incubation would occur on pathogen-free water. Use of darkness, **diel** water temperatures (if treated surface water is used) and **substrate** during incubation would mimic natural-type conditions (see Section 4.1.9 for more information).

Incubation conditions described above are consistent with the preferred criteria for fish culture developed by co-managers for the CPP (see Table 3-1) and guidelines recommended by Brannon et al. (1999).

4.1.6 Early Rearing (to 200/lb.)

Spring chinook fry would be transferred from incubation units to rearing tanks when they have **buttoned-up** and are able to begin feeding. This transfer activity is known as ponding and generally occurs around 1600 TUs in late February through March. Fish size at this stage average approximately 1200 fish per pound, with an average length of 1.4 inches.

Pathogen-free water would be used during the early rearing stage. The water source would be groundwater from wells, or ozone treated surface water from the Imnaha River. If groundwater is used, water temperatures would be modified to mimic natural rearing temperatures to the extent possible.

Fish would be reared at the proposed facility at relatively low densities. Rearing fish at high densities can create problems such as increased fingerling mortality from disease and increased smolt mortality after release (NMFS 1995). The Scientific Review Team (Brannon et al. 1999) identified low density rearing as being important in their guidelines on hatchery practices. Groberg et al. (1999) recommended that low density rearing of juveniles be maximized for fish health management purposes. The final density index for the early rearing phase would be from 0.30 lbs./(ft.^{3} x inch) (preferred) to 0.76 lbs./(ft.^{3} x inch) (acceptable) (see Table 3-1). A full program reared at the preferred density would require 3,500 ft.^{3} of rearing space and at the acceptable density, would require 1,380 ft.^{3}. To achieve a flow index (FI) of 0.75 lbs./(gpm x inch) (preferred), 1400 gpm would be necessary; for a FI of 1.25 (lb./(gpm x inch) (acceptable), 850 gpm would be necessary.

Natural-type rearing that would occur at this life stage would include low densities and rearing tanks that have patterned colored side walls, filtered light, and limited direct sunlight (see Section 4.1.9 for more information).

Early rearing conditions described above are consistent with the preferred criteria for fish culture developed by co-managers for the CPP (see Table 3-1) and guidelines recommended by Brannon et al. (1999).

4.1.7 Final Rearing

Fish would be reared in the early rearing tanks for about four months or until they are approximately 200 fish/lb. At this time (in May-June), fish would be ponded to raceways or larger rearing containers. Juveniles would remain in raceways or larger rearing containers until the following spring (March-April) when they are approximately 20 fish/lb. Surface water from the Imnaha River would be used for rearing in the raceways.

Fish would be reared at low densities (final rearing DI of 0.10 lbs./ft.^{3} x inch), which is consistent with NMFS' recommendation that final rearing densities for spring chinook not exceed a DI of 0.13 lbs./ft.^{3} x inch (NMFS 1995). This would require 44,500 ft.^{3} of rearing space for the full program of 490,000 smolts (see Table 4-5). Other natural-type rearing activities that would occur in the raceways include: natural substrate coloration and patterns, shade cover, in-pond structures (i.e., trees), natural light, natural diet training, and minimal handling, transportation, and human-fish interactions.

Early and final rearing conditions described above are consistent with the preferred criteria for fish culture developed by co-managers for the CPP (see Table 3-1) and guidelines recommended by Brannon et al. (1999).

The program goal for survival from green egg to smolt is 85 percent (ODFW 1998b). A breakdown of anticipated loss at each life stage and resultant fish production at each life stage is in Table 4-6.

Table 4-5 Smolt Density and Loading for the Imnaha Program

Total number of smolts	490,000
Smolt size (fish/lb.)	20
Total Weight (lbs.)	24,500
Total Volume (cubic feet)	44,500
Density Index (lbs./ft.^{3} x inch)	0.10
Total flow (gallons per minute)	8,900
Flow Index (lbs./gpm x inch)	0.50

Table 4-6 Anticipated Loss and Resultant Survival for Each Life Stage

Life Stage (Anticipated Loss)	**Predicted Number at each life stage**
Green eggs	576,000
Eyed eggs (5% Loss)	547,200
Initial Ponding (2% Loss)	536,000
Smolts (8% Loss)	490,000

4.1.8 Acclimation and Release

Just prior to when the fish reach the smolt life-history stage (after approximately 18 months of hatchery rearing), they would be moved to the acclimation facility(ies) in March and held until mid-April. They would be held at a DI of 0.10 lbs./ft.^{3} x inch.

After approximately three to four weeks of acclimation, the tail screens on the pond would be removed and the fish would be allowed to leave volitionally. Approximately two weeks later, all remaining fish would be forced from the pond. The mandatory release timing is to coincide with travel conditions and timing in the mainstem. If fish stay longer, their chances of making it to the ocean are reduced.

As explained in Section 3.4.1.1, the existing acclimation and release facility at Gumboot does not have sufficient space to accommodate the entire production of 490,000 smolts at one time. A portion of the production may be direct-stream released in small groups farther upstream of the acclimation facility, or the acclimation facility may acclimate different release groups sequentially. Since the fish would be reared for most of their life on the Imnaha River water at the new incubation and rearing facility, acclimation in the upper watershed prior to release may not be critical.

4.1.9 Natural-Type Rearing

The natural-type rearing concept, also known as Natural Rearing Enhancement System (NATURES), modifies standard hatchery aquaculture practices to mimic natural conditions (see Table 4-7). For example, water temperature, photoperiod, density, and/or rearing containers during each life history stage can be modified or managed to mimic natural conditions. The overall goal is to produce a fish that experiences similar timing, development and conditioning as its wild counterpart so that smolt-to-adult survival is increased and **domestication** behavior traits are avoided. Table 4-7 depicts natural-type rearing strategies that would be implemented under the Proposed Alternative.

Improvements in fish survival (Maynard et al. 1996) have been documented using NATURES techniques. For example, fish reared in earthen ponds and in tanks with substrate, cover, and in-stream structure had better coloration for the stream environment than did fish reared in barren gray tanks, similar to those found in conventional raceways (Maynard et al. 1996). These fish had an almost 50 percent higher post release survival than did their conventionally reared counterparts.

4.1.10 Fish Health Management

A comprehensive fish health monitoring and disease control program has been ongoing for the Imnaha River chinook salmon since 1982. This program is described in Groberg et al. (1999) and would be continued at the proposed facilities. The goals of the activities occurring under this program are to: 1) provide a healthy and robust hatchery smolt whose survival will not be impaired by health constraints; and 2) conduct the fish health program such that it integrates concerns for both natural and hatchery populations to minimize infectious disease interactions between both populations.

Fish health monitoring objectives are:

1) Monitor adult mortalities and spawned adults for presence of viral, bacterial, fungal, and parasitic agents.
2) Conduct monthly monitoring of hatchery reared juveniles to assess presence of viral, bacterial, fungal and parasitic agents.
3) Monitor preliberation of hatchery-reared smolts annually.
4) Conduct examinations at all life stages when unusual loss or anomalies occur to determine cause of loss and recommend preventative and therapeutic treatment.

Fish health procedures used for disease prevention include:

- Prior to spawning, adults will be disinfected topically. Ovarian fluid will be drained from eggs.
- Adults will be sampled for diseases.
  - Viruses – A minimum of 60 spawned fish will be sampled for culturable viruses using ovarian fluid and caeca/kidney/spleen pools not to exceed 5 fish per pool. A minimum of 24 subsamples per week of sex fluids (ovarian or milt) from individual fish will also be assayed for culturable viruses.

  - o Bacterial Kidney Disease – All spawned females and prespawning mortality will be sampled for *Renibacterium salmoninarum* (the causative agent of bacterial kidney disease) by enzyme-linked immunosorbent assay (ELISA). Incubation and rearing segregation strategies will depend upon results.
  - o Prespawning mortality – A minimum of 20, or all mortality less than 20 will be examined for systemic bacteria by culture and *Ceratomyxa shasta* by microscopy.

- Juveniles will be monitored monthly. A minimum of 10 moribund and/or dead fish, or those available if less, for BKD and systemic bacteria. Examine 5-grab sampled fish per raceway every other month and any moribund fish for erythrocytic inclusion body syndrome (EIBS). If EIBS is detected, expand monitoring on that raceway to 10 fish per month. Examine gill and skin wet mounts from a minimum of five fish.
- Chemical treatments may be used to treat disease outbreaks or as preventative treatment.
  - o Feeding of Aquamycin under an Investigative New Animal Drug study for BKD. Supplemental Aquamycin or Erythromycin may be given to high BKD progeny.
  - o Oxytetracycline treatments may be given for bacterial cold water disease.
  - o Formalin flush treatments would be given as one hour treatments for two consecutive days after fin clipping operations and for Ichthyobodo infestations.

4.1.11 Captive Broodstock Option

The Proposed Alternative includes a captive broodstock option. The sliding scale management criteria contains a provision to begin a captive broodstock program for Imnaha River spring chinook salmon if escapement to the Imnaha is fewer than 300 adults for two consecutive years (see Table 4-4). A captive broodstock program is a short-term, emergency approach to help a population increase rapidly and reduce its risk of extinction. Captive broodstock technology for restoring salmon stocks is experimental. Recent reviews of captive broodstock strategies for recovery of Pacific salmon have concluded that uncertainty about culture methods and potential risks is high, but that the techniques could be a valuable short-term tool to prevent extinction and assist in recovery (Flagg et al. 1995; Schiewe et al. 1997). Given the precipitous decline of Imnaha River spring chinook adult returns over the past three decades, drastic measures may be necessary to prevent extirpation. The Proposed Alternative has the following framework for implementing a captive broodstock program in the Imnaha River.

If escapement is fewer than 300 adults for two consecutive years, the co-managers would collect naturally-produced juveniles, or select juveniles produced from conventional production, rear them to maturity, spawn the mature adults, and release their progeny back into the Imnaha River. Adults that return from the captive broodstock program would be released to spawn naturally or used for hatchery broodstock.

Table 4-7 Natural-type Rearing Applications at each Life Stage

Life Stage	Natural-Type Rearing Application
Adult Holding	• Low density (one adult per 140 ft.3 or more) • Water overspray, and shading to mimic natural conditions • No transportation • Minimal handling • Natal water source
Incubation	• Darkness • Diel water temperatures (within limits if groundwater is used) • Substrate (potentially) in the incubation trays (may pose fish health constraints) • Natal water if treated surface water is used
Early Rearing	• Low densities (final early rearing DI 0.30 lbs./ft.^{3} x inch) • Rearing tanks with natural colored patterned walls • Filtered light and limited direct sunlight • Diel water temperatures (within limits if groundwater is used) • Natal water if treated surface water is used
Final Rearing and Acclimation	• Low densities (final rearing DI 0.10 lbs./ft.^{3} x inch) • Natural substrate coloration and patterns • shade cover, • in-pond structures (i.e., trees) • natural light • natural diet training • Minimal handling, transportation, and human-fish interactions • Natal water source

This program would be contingent on the availability of facilities, funding, and procurement of appropriate permits under ESA. Although the facilities described in the Proposed Alternative would provide for the rearing of captive broodstock progeny, rearing of the captive broodstock would have to occur elsewhere.

Co-managers would also consider and use on-going evaluations of captive broodstock strategies to guide the program. For example, in 1995 a captive broodstock program was initiated in the Grande Ronde River Basin as part of an effort to prevent extinction of spring chinook salmon populations in the Basin, develop endemic broodstock, and to evaluate captive rearing strategies. Juvenile chinook salmon were collected from the Lostine River, Catherine Creek, and the upper Grande Ronde River. The program uses facilities at Lookingglass Fish Hatchery, Bonneville Fish Hatchery (BH), Irrigon Fish Hatchery, and Manchester Marine Laboratory (MML). The ESA Section 10 permit application (ODFW 1996) contains a detailed description of collection, rearing, transportation, and spawning strategies as well as experimental designs for the Grande Ronde captive broodstock program. The option for a captive broodstock program for the Imnaha would be similar to the Grande Ronde captive broodstock program and would follow the description presented in Section 4.2.9.

4.1.12 Rationale for Number and Life History Stage at Release

This program proposes to decrease the demographic risk of extirpation and potentially assist the recovery of spring chinook salmon in the Imnaha River by increasing egg-to-smolt survival through hatchery incubation and rearing of juvenile fish in their natal stream. A larger number of adult returns, brought about by a greater number of juveniles produced than would be expected from natural production, are expected to contribute to and enhance the natural spawning run.

Smolts have been chosen as the preferred life stage to release because they have proven to provide a substantial egg-to-adult survival advantage when compared to the survival of sub-smolt releases in Northeast Oregon (ODFW 1996, ODFW 1998b). Programmed releases would be made as smolts similar in size to natural fish.

In addition to release of smolts, other life stages of fish may occasionally be released into the Imnaha River and its tributaries. Adults collected at the weir that are not needed to meet hatchery broodstock goals and natural spawning goals above the weir may be outplanted in tributaries to the Imnaha River. This is described in the Section 10 permit application (ODFW 1998b). Current targets are 150 pairs (300 adults) for Big Sheep and Lick creeks. Juveniles (fry or pre-smolts) in excess of program goals may also be released. Decisions regarding these types of releases would be determined by co-managers on a case-by-case basis during Annual Operations Plan meetings.

The number of smolts to be released is 490,000. This production goal was originally established under the Lower Snake River Compensation Plan. During the planning for LSRCP, smolt-to-adult survival was predicted to be 0.65 percent, which would have returned 3,210 hatchery-origin adults to the Imnaha River. Unfortunately, smolt-to-adult return rates for this program have been much lower, averaging 0.13 percent with a range of 0.043 percent to 0.546 percent (Eddy 2000). Using the range of smolt-to-adult return rates from the current program, an anticipated 210 to 2,754 adults would return. Seven hundred adults is the target set by co-managers to avoid the demographic risk of extinction (see Section 4.1.2). Using natural-type methods and natal water for rearing is expected to enhance smolt-to-adult return rates.

After monitoring adult returns, co-managers may adjust smolt production (increase or decrease) in the future to meet program goals.

The natural production potential of the Imnaha River Subbasin is much higher than the anticipated return of adults from this program. During planning for the LSRCP, the Corps of Engineers estimated that 6,700 adults escaped to the mouth of the Imnaha (USACE 1975). Based on the maximum observed adult escapement calculated from redd counts, 3,821 adults returned to spawn in the Imnaha in 1957 – the year when the highest counts on record were observed (Carmichael and Boyce 1986b). Quantity and quality of spawning habitat in the Imnaha Subbasin has remained mostly unaltered since the mid-1950s. The system presently has the same capacity to support the number of spawning adults that used the system in 1957 (Carmichael and Boyce 1986b).

Habitat capacity for smolts in the Imnaha River Subbasin has not changed since the 1950s (Carmichael and Boyce 1986b) although there are two estimates of what that habitat can produce. Carmichael and Boyce (1986b) estimated 245,260 smolts were produced from the adult escapement in 1957 (the year of peak redd counts) and consider that number to be the **carrying capacity** of the subbasin. The NPPC's Smolt Density Model estimated a total carrying capacity of 1,098,376 by multiplying a smolt density (# of fish/area) by the total amount of stream area (see Table 4-8). Though scientists disagree on the exact number the system can support, the production for this program would not overwhelm the system because the hatchery-produced smolts would not occupy the Imnaha for any length of time.

Table 4-8 Estimated Smolt and Adult Carrying Capacity of Spring Chinook in the Imnaha River Subbasin

	Smolt Capacity		**Adult Capacity**
Tributary or Stream Section	Smolt Density Model	Carmichael and Boyce (1986b)	Carmichael and Boyce (1986b)
Mouth to Big Sheep	262,526		
Big Sheep to Gumboot	435,289		
Gumboot to North Fork	43,532		
Imnaha Mainstem total	**741,347**		**3,185**
Cow Creek	2,309		
Lightning Creek	5,324		
Horse Creek	8,240		
Big Sheep Creek	370,261		516
Lick Creek	27,018		120
Total	**1,098,376**	**245,260**	**3,821**

4.1.13 Monitoring and Evaluation Activities

Currently, there are a number of research, monitoring and evaluation activities being conducted by co-managers that are associated with the existing LSRCP program in the Imnaha River (see Table 1-1). Research and monitoring activities are described in the NPT and ODFW annual statements of work for the LSRCP (Carmichael et al. 2000 or see Appendix A for 1998 statement of work), study proposals for the BPA-funded projects (8712703), ESA Section 10 applications (see Appendix A) and permits (1011, 1134, and 1152). The following briefly describes the scope of existing M&E activities in the Imnaha River Subbasin. See Appendix D for the M&E Conceptual Framework for the Proposed Alternative.

Research, monitoring, and evaluation activities for Imnaha River Subbasin chinook salmon are primarily conducted under the LSRCP (NPT and ODFW) and Imnaha River Smolt Monitoring Project (NPT). These activities can be broadly identified as fish culture monitoring, survival studies, and natural production studies.

Performance variables are quantified through: genetics monitoring, fish health monitoring, catch distribution estimates, exploitation rate estimates, straying and stray rates, productivity (including recruit per spawner estimates for hatchery and natural fish), spawn timing and distribution, natural spawner composition (H/N), age structure by origin, sex ratios, run timing, size at age, **fecundity**, and juvenile migration characteristics and survival.

4.1.13.1 Fish Culture Monitoring

Fish culture monitoring activities currently consist of documenting hatchery operational practices at Lookingglass Hatchery and the Gumboot facility. The following tasks are performed:

- Determine egg-to-fry and fry-to-smolt survival rates,
- Document abundance, size, time of release, size during rearing, and
- Monitor fish health.

4.1.13.2 Survival Studies

Survival studies on Imnaha River chinook salmon have been focused on determining optimum rearing and release strategies that will produce maximum survival to adulthood for hatchery-produced spring chinook salmon smolts. These investigations have focused on:

- Influence of size-at-release on emigration performance and survival to adulthood,
- Comparison of fish performance that are reared at different densities,
- Comparison of fish performance that are fed different diets, and
- Comparison of acclimated and direct river releases.

The smolt monitoring project is focused on:

- Estimate post-release survival of hatchery-reared chinook salmon smolts,

- Determine emigration timing of natural and hatchery-reared chinook salmon smolts,
- Evaluate the effect of water temperature and river discharge on emigration from the Imnaha River for natural and hatchery produced chinook salmon,
- Evaluate emigration timing, travel time, survival, and interrogation percentages of natural and hatchery-reared chinook through the Snake River.

4.1.13.3 Natural Production Studies

Natural production studies have mainly involved adult escapement estimation through weir operation and multiple-pass spawning ground surveys.

4.2 Lostine River Program

The Lostine River Program is a part of the Grande Ronde Endemic Spring Chinook Supplementation Program (GRESP), which began in 1995 with the development of the captive broodstock component. In 1997, the conventional component was initiated and integrated with the ongoing captive component. The GRESP received extensive scientific scrutiny during its development as well as during the process of acquiring funding and appropriate Endangered Species Act permits and consultations. Processes involved in this review were:

- Independent Scientific Panel review process through the *U.S. v. Oregon* dispute resolution process,
- NMFS Endangered Species Act (ESA) Section 10 permit process, and
- NPPC 3-Step approval process.

The supplementation program in the Grande Ronde was based on recommendations of an Independent Scientific Panel (Currens et al. 1996), which was commissioned through the *U.S. v. Oregon* forum to provide recommendations on the appropriate elements of a hatchery program to meet Grande Ronde spring chinook recovery and management goals. Following the recommendations of Currens et al. (1996), co-managers developed the GRESP.

The captive broodstock component has been authorized by NMFS through ESA Section 10 Permits 973 and 1011. Permit 973 was issued August 1995 (in response to an emergency permit application), and authorized ODFW to collect juveniles for the initiation of the captive broodstock program. Permit 1011 was issued in 1996 and replaced Permit 973 as authorization for the captive broodstock component. Permit 1011 expires December 31, 2000. Modification 1 of Permit 1011 was submitted to NMFS in 1997 to initiate the conventional component of the program. This modification expired December 31, 1997. The current program that integrates the conventional and captive broodstock components is described in ESA Section 10 Permit applications for the Lostine (BIA 1998) and for Catherine Creek and upper Grande Ronde (ODFW 1998a). The requested timeframe for permits under these applications was April 1, 1998 to December 31, 2000.

NMFS conducted both peer and public review of the permit applications that were granted and for the pending permits. In granting their permits, NMFS determined that the direct take of listed fish for hatchery broodstock will be beneficial to the threatened species, either by improving knowledge through research, or enhancing the survival of the listed species (Mike Delarm, April 3, 2000).

Implementation of the GRESP was largely funded through the elements of the NPPC's Fish and Wildlife Program (FWP). In compliance with the NPPC's Three Step process, the GRESP program underwent independent scientific review in May 1998. This review used three independent reviewers facilitated by the Pacific Northwest National Laboratory (PNNL) and focused on determining if BPA, ODFW, NPT, and CTUIR had adequately addressed concerns raised by the NPPC's Fish and Wildlife Committee, NPPC staff and outside experts (PNNL 1998). In summarizing this review PNNL states that:

> The project staff, for the most part, has responded to the technical questions of the Three-Step Process more than adequately. The various activities associated with the Grande Ronde Basin Endemic Spring Chinook Supplementation Projects appear to be well thought out and sufficiently coordinated. The provided documentation and the Project staff responses clearly demonstrate that the proposed program has been subjected to considerable technical and policy reviews. The Project staff appears to have good monitoring and evaluation protocols in place for diseases, genetic effects and other potential concerns.

4.2.1 Broodstock Selection

Adult spring chinook of hatchery and natural origin returning to the Lostine River would continue to be used for broodstock.

4.2.1.2 Reasons for Choosing Broodstock

An Independent Scientific Panel (Currens et al. 1996) of geneticists reviewed and analyzed genetic data collected from Grande Ronde Subbasin spring chinook salmon in 1996. Based on this analysis, the Panel determined that despite hatchery releases in the subbasin of non-native stock (Rapid River and Carson stock), a substantial component of the native spring chinook populations still exists. The Panel also found that the Lostine population was the most distinctive of the naturally-spawning populations in the Grande Ronde (Currens et al. 1996).

4.2.2 Broodstock Collection

Adult spring chinook returning to the Lostine River would continue to be trapped at the existing picket-style weir on the Lostine River at 0.9 RM, upstream of the confluence with the Wallowa River, or a weir facility at the Clearwater Diversion structure at approximately RM 2.25 (see Map 5) (see Section 3.4.2.1 for more information).

Trap operation protocols and adult-handling procedures would be the same as described for the Imnaha River Subbasin (see Section 4.1.2). The weir/trap would be operated from about April 15 to October 1 (flows permitting) and broodstock would be selected from across the run.

Broodstock allocation of adults collected at the weir would be determined by co-managers and submitted in ESA Section 10 Permit applications. The current broodstock management program is based on an agreement developed between the NPT and ODFW in 1997 known as the Sliding Scale Management Plan. This sliding scale is detailed and discussed in the Section 10 Permit application for adult collection on the Lostine River (BIA 1998) (also see Table 4-9). See Section 4.1.2 for further discussion about this management tool.

Table 4-9 Sliding Scale for Current Management of Broodstock Collection in the Lostine River

Estimated escapement to mouth [1]	H/N Ratio	Percent of N Retained	Percent of H Adults Retained[2]	%Hatchery (H+C) Above Weir	Percent Broodstock of Natural Origin
<250	Any	40	40	N/A	N/A
251-500	Any	20	20	≤70	≥20
>500	Any	≤20	N/A	≤50	≥30

Notes:

N= number of naturally produced adults,

H= the number of conventional hatchery produced adults and

C= the number of captive brood origin adults (BIA 1998)

1 Pre-season estimate of total escapement N + H + C.

2 Conventional hatchery adults only, all captive brood adults released to spawn naturally or outplanted.

N/A Not a decision factor for this level of escapement, percentages determined by other criteria.

Source: BIA 1998.

Co-managers adopted additional management guidelines to further define the needs for broodstock and plans for fish not needed for broodstock (see Table 4-10).

4.2.3 Adult Holding

Under the current program, adults collected for broodstock are transported to Lookingglass Hatchery for holding, spawning, incubation and rearing. Under the Proposed Alternative, adults would be transported to holding ponds located at the proposed incubation and rearing facility on the Lostine River. Reducing transport time and distance (8 miles compared to 50 miles) and holding fish in their natal watershed should reduce stress and result in higher survival of adults to spawning. If adult pre-spawning mortality is less than the anticipated 20 percent, fewer fish would be collected for broodstock.

Adult holding, handling and treatment procedures would be the same as those described for the Imnaha Subbasin program (see Section 4.1.3). Although the CPP for conventional production only requires 110 adults, eventually the full program would be produced conventionally and this would require 185 adults. Therefore, facilities must be sized accordingly. Using the adult holding criteria in Table 3-1, this would require 1,850 $ft.^3$ (10 $ft.^3$/fish) and a flow of 185 gpm (1 gpm/fish).

Table 4-10 Broodstock Management Guidelines

Escapement Level	Collect for hatchery broodstock and spawn	Release to spawn naturally above weir	Outplant (hatchery fish only) to underseeded habitat	Harvest for Tribal Ceremonial Use	Harvest for Tribal Subsistence	Constraints on % of hatchery or natural for release or broodstock	Recreational Harvest
<250	Yes	Yes	No	*	*	No	No
>250	Yes	Yes	Yes	Yes	Yes	Yes	*

Criteria and Priorities for fish trapped at the weir:

(a) Retain natural adults at the maximum allowable percentage defined in the sliding scale up to that needed to achieve the egg take goal of 172,500 green eggs initially and 296,000 green eggs eventually.

(b) Retain hatchery adults to meet broodstock needs at the rate equal to the number allowable to meet the minimum percentage of broodstock that must be natural origin. Spawn all fish that are collected for broodstock.

(c) Do not retain more than 110 adults initially (55 females and 55 males) and 185 adults (78 females and 77 males) eventually for combined natural and hatchery broodstock. See Table 3-11.

(d) Release hatchery fish above the weir up to the rate equal to the percentage of adults released above the weir that can be hatchery origin.

(e) Hatchery-reared fish additional to what is needed for broodstock and releases above the weir will be outplanted to under-seeded habitat or harvested.

(f) No more than 10 percent of males placed above the weir will be hatchery origin jacks. All other hatchery jacks will be spawned with the total hatchery jack contribution to fertilization not to exceed 10% of the eggs.

* Decision will be made on a case-by-case basis.

4.2.4 Spawning

4.2.4.1 Selection Method

Spawning would occur at the proposed incubation and rearing facility. Peak spawning would occur during the months of August and September. All adults retained for broodstock that survive until spawning would be used. Adult selection procedures for spawning would be the same as those described for the Imnaha Subbasin program (see Section 4.1.4).

4.2.4.2 Fertilization/Mating

Fertilization procedures would be the same as those described for the Imnaha Subbasin program (see Section 4.1.4). The priorities for the use of semen during fertilization would be the same except captive broodstock males could be used if there were no fresh semen available.

4.2.4.3 Cryopreserved Gametes

The procedure would be the same as described for the Imnaha Subbasin program (see Section 4.1.4).

4.2.4.4 Disposition of Carcasses

All carcasses are currently landfilled. Under the Proposed Alternative, carcasses would be returned to the Lostine/Wallowa watershed for stream enrichment and nutrient enhancement following fish health clearance.

4.2.5 Incubation

Under the Proposed Alternative, incubation would occur at the new Lostine Incubation and Rearing Facility (see Map 5). Incubation procedures would be the same as described for the Imnaha Subbasin program (see Section 4.1.5). Incubation would occur on pathogen-free water; groundwater from wells or ozone treated surface water from the Lostine River. If groundwater is used, water temperatures would be modified to mimic natural rearing temperatures to the extent possible. See Table 4-7 for natural-type rearing activities that would occur during incubation.

4.2.6 Early Rearing (to 200 fish/lb.)

Early rearing procedures (including densities, natural-type rearing environment, etc.) for the Lostine program would be the same as described for the Imnaha Subbasin program (see Section 4.1.6).

Pathogen-free water (groundwater from wells or ozone treated surface water from the Lostine River) would be used for early rearing. If groundwater is used, water temperatures would be modified to mimic natural rearing temperatures to the extent possible. A full program reared at the preferred density (see Table 3-1) would require 1,750 $ft.^3$ of rearing space, and at the acceptable density would require 690 $ft.^3$. To achieve a preferred flow index, 700 gpm would be necessary; to achieve an acceptable flow index, 420 gpm would be necessary.

See Table 4-7 for natural-type rearing activities that would occur during the early rearing stage.

4.2.7 Final Rearing

Final rearing procedures would be the same as those described for the Imnaha Subbasin program (see Section 4.1.7). Surface water from the Lostine River would be used for rearing in the raceways. Fish would be reared at preferred low densities (final rearing DI of 0.10 $lbs./ft.^3$ x inch), which would require 22,300 $ft.^3$ of rearing space for the full program of 250,000 smolts (see Table 4-11). See Table 4-7 for natural-type rearing activities that would occur in the raceways or rearing containers.

Table 4-11 Smolt Density and Loading for the Lostine Program

Total number of smolts	250,000
Smolt size (fish/lb.)	20
Total Weight (lbs.)	12,500
Total Volume (cubic feet)	22,300
Density Index (lbs./ft.^{3} x inch)	0.10
Total flow (gallons per minute)	4,550
Flow Index (lbs./gpm x inch)	0.50

The program goal for survival from green egg to smolt is 85 percent. A breakdown of anticipated loss at each life stage and resultant fish production at each life stage is in Table 4-12. The juvenile production goal for the Lostine part of the GRESP is currently 250,000 smolts. This can be composed of juvenile production from conventional and/or captive broodstock. Production from captive broodstock was designed to produce 150,000 smolts and conventional production has priority. If fewer than 250,000 conventional juveniles are produced, then the captive component makes up the difference. Captive juveniles produced in addition to program goals can be released as different life stages into other Wallowa River tributaries (see Section 4.2.12).

Table 4-12 Anticipated Loss and Resultant Survival for Each Life Stage

Life Stage (Anticipated Loss)	Predicted Number at each life stage
Green eggs	296,000
Eyed eggs (5% Loss)	282,000
Initial Ponding (2% Loss)	276,000
Smolts (8% Loss)	250,000*
* Composed of conventional or captive broodstock production.	

4.2.8 Acclimation and Release

Smolts would continue to be acclimated at the acclimation facility on the Lostine until the incubation and rearing facility is operational. After the incubation and rearing facility is operational, fish could be volitionally released directly into the Lostine River from their rearing containers. The existing facility may become a component of the incubation and rearing facility or dismantled and the equipment used elsewhere. Smolts may also be transported upstream of the facility and scatter-point released directly into the stream.

4.2.9 Captive Broodstock Component

The GRESP involves a captive broodstock component that began in 1995 and will continue until results from the monitoring and evaluation program determine it is no longer necessary. Under this program, Lostine River juvenile chinook salmon have been collected from 1994-1999. The program uses facilities at Lookingglass Fish Hatchery, Bonneville Fish Hatchery, Irrigon Fish Hatchery, and Manchester Marine Laboratory (see Figure 1-1). The ESA Section 10 permit application (ODFW 1996) contains a detailed description of collection, rearing, transportation, and spawning strategies as well as experimental designs for the GRESP captive broodstock component (see Appendix A). Release of juveniles and management of returning adults on the Lostine River is covered by the Section 10 permit application submitted by the BIA (1998) (also in Appendix A). The proposed facilities on the Lostine River are necessary to provide incubation and rearing space for the progeny of captive reared adults. The following provides a summary of the GRESP captive broodstock component.

4.2.9.1 Program Oversight and Planning

The GRESP captive broodstock program uses a Technical Oversight Team (TOT) for oversight and planning. The present TOT is responsible for overseeing daily activities, implementing technical and associated research aspects of the program, and making technical recommendations for program operations. The TOT recommends technical adjustments to the program to achieve program objectives. The TOT includes personnel from ODFW, NPT, CTUIR, and NMFS with expertise in fish culture, pathology, research, and management. There is also a member representing the TOT in a parallel process in Idaho, called the TOC (Technical Oversight Committee). Generally, the TOT and TOC are accepted by NMFS and BPA as the entities regulating the captive broodstock programs for salmon. The TOT meets about nine times per year.

4.2.9.2 Juvenile Collections

About 50-500 naturally-produced chinook **parr** (about 60-100 mm long[*]) are collected during August and September each year for captive broodstock. The exact number of parr collected is adjusted to avoid collecting more than 25 percent of the parr present in the system. Parr are collected from throughout the rearing range in the Lostine River. Personnel snorkel in the streams, locate concentrations of juveniles while not disturbing adults, then herd the juveniles downstream into a seine. If insufficient numbers of fish are collected using seines, fish may be collected in downstream migrant traps. NMFS (1995) recommends, and current procedures implement, random sampling across the run and habitat to obtain a characteristic cross-section of the population.

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[*] Information for the Master Plan came from many sources. In general, this Master Plan uses the U. S. Customary System of measures. Data from sources that used the Metric System have not been converted. See the metric conversion chart on the inside of the back cover.

4.2.9.3 Captive Rearing

Rearing the parr to maturity takes 2-6 years, involves both freshwater and saltwater rearing, and many different facilities. Parr collected from the Lostine River are initially transferred to Lookingglass Fish Hatchery after capture and reared to smolt stage. Smolts are then transferred to Bonneville Fish Hatchery (fresh water) and Manchester Marine Lab (salt water) for rearing to maturity. Adults are returned to Bonneville Fish Hatchery for final maturation and spawning.

4.2.9.4 Spawning

A spawning matrix is currently used for fertilization of gametes of captive-reared adults and is described in Appendix G. The purpose of using the spawning matrix is to promote and maximize crosses between different fish. Spawning procedures may change as new information becomes available.

4.2.9.5 Incubation and Rearing of Progeny

Embryos are segregated and incubated in incubator trays until the eyed stage. Eggs may be pooled at the eyed stage following shocking, picking, and enumeration. Currently incubation of captive broodstock eggs occurs at Oxbow and Irrigon hatcheries. Under the Proposed Alternative, eggs would be incubated at Oxbow and/or Irrigon until the eyed-egg stage and then transferred to the proposed facility on the Lostine River for the remainder of incubation and rearing. Incubation and rearing procedures for captive brood offspring would be the same as those described for conventionally produced progeny (see Sections 4.1.5, 4.1.6, and 4.1.7). Acclimation, release timing and methods for juveniles would be the same as for conventionally-produced fish as described in Section 4.1.8.

4.2.10 Fish Health Management

Co-managers have developed fish health monitoring protocols for the Grande Ronde captive broodstock program (ODFW 1996). The protocols are essentially the same as those described for the conventionally produced program (see Section 4.1.10), however, additional emphasis is placed on the life stage encompassing smolt-to-adult because of the extended rearing in captivity.

4.2.11 Rationale for the Number and Life History Stage at Release

Fish releases will be smolts similar in size to natural fish. Smolts have been chosen as the preferred life history stage for release because they result in a greater adult return than pre-smolt releases in the Grande Ronde and Imnaha systems.

The captive broodstock program is designed to produce 150,000 smolts and the initial production goal for the conventional component is 150,000 smolts. The combined production of these components is not to exceed 250,000 smolts. The program is designed to scale down the captive broodstock component as numbers of conventional and natural adults increase and eventually shift to full conventional production of 250,000 smolts.

The first group of smolts produced from the captive broodstock component will be released in 2000, so there is no data to predict what smolt-to-adult return rates may be. In designing the program, co-mangers used a 0.1 percent SAR. Current smolt-to-adult return rates for the Imnaha program average 0.13 percent with a range of 0.043 to 0.546 percent (Eddy 2000). Using this range of smolt-to-adult return rates for a full program of 250,000 conventionally-produced smolts, 107 to 1,405 adults would return. Two-hundred and fifty adults is the target set by co-managers to avoid the demographic risk of extinction (see Section 4.2).

By using natural-type methods and natal water sources, the smolt-to-adult return rate is expected to increase. After monitoring adult returns, co-managers may adjust smolt production in the future to meet program goals.

Hatchery-produced adults (either captive or conventional brood) that are not required to reach natural spawning and hatchery production goals will be outplanted to areas that historically produced spring chinook salmon but are currently underseeded or vacant. Eyed-eggs, fry, parr, and smolts not needed for program goals will also be outplanted to natural production areas. Potential locations for outplanting Lostine River origin spring chinook include the upper Wallowa River, Hurricane Creek, Prairie Creek, and Bear Creek (see Map 5). Decisions regarding these types of releases will be determined by co-managers on a case-by-case basis during Annual Operations Plan meetings.

The natural production potential of the Lostine/Wallowa watershed is much higher than the anticipated return of adults from this program. The Corps of Engineers estimated that 12,200 adults escaped to the Grande Ronde River (USACE 1975). In 1964, redd densities of 112 redds/mile were observed in the Lostine River (Carmichael and Boyce 1986a). Carmichael and Boyce (1986a) estimated the spawner capacity of the Grande Ronde to be 8,692 adults based on peak redd counts during 1956-85. Peak escapement to the Lostine River during this period was estimated at 2,143 adults. Due to habitat reductions, the capacity estimated was reduced by 20 percent to 1,716 adults (see Table 4-13). Carmichael and Boyce (1986a) believe the system presently has the capacity to support the same number of spawning adults that used the system in the 1950s, but reductions in the quantity and quality of rearing habitat have resulted in reducing the smolt production capacity.

Smolt production potential for the Wallowa Subbasin has been estimated by two parties. Carmichael and Boyce (1986a) estimate that 184,154 smolts were produced from peak escapements during 1956-85 (this estimate included a reduction for habitat losses) and considered that number to be the carrying capacity of the subbasin. The NPPC’s Smolt Density Model estimated a total carrying capacity of 1,090,900 by using total habitat available (see Table 4-13). Though scientists disagree on the exact number the system can carry, the production for this program would not overwhelm the system because the hatchery-produced smolts will not occupy the Lostine for any length of time.

4.2.12 Monitoring and Evaluation Activities

Research, monitoring, and evaluation activities for Lostine River chinook salmon are conducted under the LSRCP (NPT and ODFW), Lostine River Supplementation project (NPT), Early Life History of Spring Chinook project (ODFW), Smolt Monitoring by Non-Federal Entities (ODFW), Captive Brood (ODFW), and Captive Brood Monitoring and Evaluation project (NPT) (see Table 1-1). Specific activities are described in the ODFW annual statements of work for the LSRCP (Carmichael et al. 2000 or see Appendix A for 1998 statement of work), study proposals for the BPA funded projects (see Table 1-1 for project numbers), and ESA Section 10 applications (see Appendix A) and permits (1011, 1134, and 1152).

Table 4-13 Estimated Smolt and Adult Carrying Capacity of Spring Chinook in the Grande Ronde River Subbasin

	Smolt Capacity		**Adult Capacity**
Tributary or Stream Section	Smolt Density Model	Carmichael and Boyce (1986a)	Carmichael and Boyce (1986a)
Minam River	592,675		1,610
Lostine River	131,087	84,510	1,716[a]
Prairie Creek	1,881		
Parsnip Creek	907		
Spring Creek	2,903		
Bear Creek	49,796	5,201	10
Hurricane Creek	6,744	946	19
Mainstem	304,907	14,184	288[b]
Wallowa River total	**1,090,900**	**184,154**	**3,643**

a. Reduced 20 percent from peak escapement due to reduction in habitat quality.

b. Reduced 70 percent from peak escapement due to reduction in habitat quality.

4.2.12.1 Fish Culture Monitoring

Fish culture monitoring activities consist of documenting hatchery operational practices at Bonneville Hatchery, Lookingglass Hatchery, Manchester Hatchery, and the Lostine Acclimation Facility. Tasks to accomplish this are outlined in Section 4.1.13.1. In addition, there are some research activities associated with the multiple rearing strategies for the captive brood program including freshwater and saltwater rearing, accelerated and normal growth regimes.

4.2.12.2 Survival Studies

Survival studies on Lostine River chinook salmon have focused on determining survival to adulthood for hatchery-produced spring chinook salmon smolts. Additionally, the Early Life History and Smolt Monitoring projects determine juvenile yield and emigration timing of natural and hatchery-reared chinook salmon from the Lostine and Grande Ronde rivers. Also investigated is the effect of water temperature and river discharge on emigration timing for natural and hatchery produced chinook salmon, and emigration timing, travel time, survival, and interrogation percentages of natural and hatchery-reared chinook through the Snake River.

4.2.12.3 Natural Production Studies

Natural production studies have mainly involved adult escapement estimation through weir operation and multiple-pass spawning ground surveys. The Early Life History project also documents habitat use and abundance of naturally-produced juveniles chinook salmon.

Chapter 5 Life History and Management Background of Imnaha and Grande Ronde Spring Chinook

In this chapter:

- Life History
- Historic Harvest and Production

5.1 Description of the Imnaha River Subbasin

The Imnaha River Subbasin is located in northeastern Oregon and encompasses an area approximately 980 square miles (see Map 1). The mainstem Imnaha River flows in a northerly direction for 80 miles from its headwaters in the Eagle Cap Wilderness Area (ECWA) (elevation about 10,000 feet), to its confluence with the Snake River at river mile (RM) 192, (elevation 945 feet) (James 1984; Kucera 1989). The entire Imnaha Watershed is within the area established for sole Nez Perce occupancy under the Treaty of 1855. The Imnaha River is part of the National Wild and Scenic Rivers System. It is classified as:

1) A Wild River for a 15-mile reach from the headwaters to Indian Crossing,
2) A Recreational River for the 58-mile reach from Indian Crossing to the Cow Creek Bridge and
3) A Scenic River for the lower four miles through the Hells Canyon National Recreation Area (Wallowa County-Nez Perce Tribe 1993).

Big Sheep Creek is the largest tributary to the Imnaha River and drains an area of 342 square miles. Big Sheep Creek rises in the Eagle Cap Wilderness (elevation 9,709 feet) and flows in a northeasterly direction for approximately 40 miles until its confluence with the Imnaha River at RM 19.6 (elevation 1,965 feet). Lick Creek is the largest salmon-producing tributary to Big Sheep Creek. Lick Creek rises in the Eagle Cap Wilderness (elevation 7,740 feet) and flows in a northeasterly direction for 9.5 miles until its confluence with Big Sheep Creek at RM 31.6 (elevation 4,960 feet).

Almost 87 percent of the Imnaha River Subbasin is within the Wallowa Whitman National Forest, with management by three Ranger Districts (Eagle Cap, Hells Canyon National Recreation Area, and Enterprise). The remainder of land is mostly under private ownership and is primarily used for grazing, with some fields in hay production and fruit orchards. Water resources in the subbasin are generally sufficient to sustain anadromous fish. The Oregon chapter of the American Fisheries Society has identified the Imnaha River as a biodiversity area because it provides “critical ecological function” as a genetic reserve for bull trout (Bryson April 2000).

Imnaha (population 25), located at RM 19.5, is the only town in the subbasin.

There are 20 native and 9 exotic fish species in the Imnaha River. Table 5-1 lists native species and Table 5-2 lists exotic fish species. Exotic species are found predominantly in the lower reaches of the Imnaha River.

Table 5-1 Fish Species Originally Found in the Imnaha River Subbasin

Common name	Scientific name
Spring chinook salmon	*Oncorhynchus tshawytscha*
Summer/early fall chinook salmon	*Oncorhynchus tshawytscha*
Fall chinook salmon	*Oncorhynchus tshawytscha*
Summer steelhead	*Oncorhynchus mykiss*
Bridgelip sucker	*Catostomus columbianus*
Chiselmouth	*Acrocheilus alutaceus*
Longnose dace	*Rhinichthys cataractae*
White sturgeon	*Acispenser transmontanus*
Torrent sculpin	*Cottus rhotheus*
Leopard dace	*Rhinichthys falcatus*
Mottled sculpin	*Cottus bairdi*
Mountain whitefish	*Prosopium williamsoni*
Northern pikeminnow	*Ptychocheilus oregonensis*
Pacific lamprey	*Lampetra tridentata*
Rainbow trout	*Oncorhynchus mykiss*
Redband trout	*Oncorhynchus mykiss*
Peamouth	*Mylocheilus caurinus*
Redside shiner	*Richardsonius balteatus*
Paiute sculpin	*Cottus bildingi*
Shorthead sculpin	*Cottus confusus*
Bull trout	*Salvelinus confluentus*
Lampreys	*Lampetra* spp.
Largescale sucker	*Catostomus macrocheilus*
Speckled dace	*Rhinichthys osculus*

Source: Mundy and Witty 1998.

Table 5-2 Fish Species Recently Introduced to the Imnaha River Subbasin

Common name	Scientific name
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
Yellow perch	*Perca flavescens*
Sunfish	*Lepomis* spp
Brown bullhead	*Ictalurus nebulosus*
Common carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
White crappie	*Pomoxis annularis*
American shad	*Alosa sapidissima*

Source: Mundy and Witty 1998.

The Imnaha River was historically an important producer of chinook salmon. Escapement to the river prior to the settlement of the area by Euro-Americans is unknown, however, current runs are a small fraction of fish returning prehistorically. Fisheries managers estimated that, prior to the construction of the four lower Snake River dams, 6,700 spring chinook escaped to the subbasin annually (USACE 1975). Currently, spring chinook salmon, along with fall chinook salmon and steelhead, returning to the Imnaha River are listed as threatened under the ESA. Bull trout in the Imnaha River are also listed as threatened under the ESA. Streams in the Imnaha Subbasin with historic spawning populations of chinook salmon are the Imnaha River from the confluence of the North and South Forks to the mouth (Thompson and Haas 1960, Witty 1988), South Fork (Witty 1988), Big Sheep Creek (Thompson and Haas 1960), Lick Creek (Thompson and Haas 1960), and Lightning Creek (McClaren July 1993). Pioneers also observed salmon in Little Sheep Creek many years ago (Thompson and Haas 1960), though development of irrigation canals in the early 1900s may have resulted in the elimination of salmon from Little Sheep Creek. The Mountain Sheep Irrigation District (presently called the Wallowa Valley Improvement District) constructed a canal in the early 1900s that intercepted water from the upper half of the Big and Little Sheep Creek drainages. Ferman Warnock, who has lived many of his 93 years on the Imnaha River, has never seen salmon in Little Sheep Creek (Warnock August 1993).

Warnock reported seeing chinook spawning in October in the area of the Imnaha River between the Imnaha Grange (RM 31.3) and The Saddle (also called Saddle Falls or The Narrows) (RM 34.7) in the early 1900s (Warnock August 1993) (see Map 2). Nez Perce tribal elders have observed salmon spawning from the town of Imnaha to the river mouth (Mundy and Witty 1998). Mundy and Witty (1998) concluded that, historically, spring/summer chinook spawned in the Imnaha River upstream of the Imnaha Grange, in Big Sheep Creek, Lick Creek, Lightning Creek and perhaps Little Sheep Creek. They also suspect that an "October spawner" early-fall chinook spawned in the Imnaha River between the Imnaha Grange and Imnaha, and that a later "fall chinook" historically spawned downstream of Imnaha. There was probably overlap among the groups and spawning was not restricted by time frame to these specific areas. Runs were probably continuous from May through November and not grouped as co-managers now classify them. Fragmentation of the run was likely due to unregulated harvest in the 1800s and the beginning of the 1900s, although other factors, such as dam construction and operation, may have also contributed to the loss of segments in the run (Neeley et al. 1993).

The Imnaha Subbasin native chinook salmon that spawn in August and early September are classified as spring/summer chinook salmon. This group of fish is referred to as the Imnaha stock or Imnaha spring chinook by co-managers (hereafter referred to as spring chinook salmon). The native chinook that spawn in November are classified as part of the Snake River fall chinook ESU.

5.2 Life History and Population Biology of Chinook Salmon returning to the Imnaha River

The following section on Imnaha River chinook life history is adapted from Mundy and Witty (1998). An overview of Imnaha chinook salmon life history is followed by a more detailed description of life history characteristics for spring chinook.

Historic native runs of chinook salmon in the Imnaha River Subbasin began arriving at the mouth of the Imnaha River in early-May, peaked in June or July depending on stream flows, and ended in mid-November. Generally, chinook salmon that arrived early migrated high in the subbasin. The distribution of spawning salmon moved downstream as the migratory season progressed (Sandercock 1991). Spawning began mid-to-late July and ended late-November. Parr produced in upper reaches stayed either in the Imnaha or Snake River for a period of approximately one year before they migrated to the ocean. Parr produced in lower reaches stayed only a few months in the Imnaha and Snake rivers before migrating to the ocean. Adults would return to the natal stream after one to five years in the ocean. Some males did not migrate but stayed in the natal stream where they matured (Neeley et al. 1993).

In-subbasin and out-of-subbasin habitat changes and out-of-subbasin salmon harvest have reduced all Imnaha River salmon populations and extirpated or nearly eliminated certain segments of chinook salmon populations. Chinook that may have once spawned from late-September through October have probably been extirpated, and chinook populations that spawn in November have been reduced to a remnant population. Many genetic and heritable traits have likely been lost as a result. A highly variable environment challenges remaining traits, as do genetic consequences associated with small breeding populations such as inbreeding and genetic drift.

5.2.1 Adult Migration

The race (spring or summer chinook) is partially determined by the date of entry into freshwater and thus passage at the Columbia River dams. June 11 is used as the cut-off date for dividing counts between the two races at Ice Harbor Dam. Based on tracking of radio-tagged adult chinook, fish that entered the Imnaha River had passed Ice Harbor Dam from late April through mid-July in 1991 and from late April through early July in 1992 (Bjornn et al., 1992 and 1993). Thus, the migration times of these fish fall into both the spring chinook and summer chinook categories. However, as mentioned above, the term spring chinook is used in reference to the Imnaha stock.

Spring chinook salmon probably begin entering the Imnaha River in late-April with peak entry in mid-to-late June. Prior to the closure of spring chinook salmon sport fishing in the Imnaha River in 1979, anglers caught salmon in lower reaches of the river until June 20; the closing date of the sport fishery. Harvest of salmon, especially in low run-off years, was generally improving when the season closed. Most spring chinook salmon are probably in the Imnaha River by the end of July.

5.2.2 Adult Holding

Ken Witty (July 1998) has observed chinook holding at The Saddle and the Blue Hole (RM 59.6). The Saddle is located 8 miles downstream of the principle spawning habitat, and the Blue Hole is located near the upper end of currently used spawning habitat. Big Sheep Creek below Lick Creek also contains good holding areas for spring/summer chinook. Some channelization of Big Sheep Creek on private land has adversely affected holding habitat for salmon (i.e., from Carrol Creek to Coyote Creek and from Muley Creek to the mouth of Big Sheep Creek), but habitat is generally good in the upper reaches.

5.2.3 Spawning

5.2.3.1 Timing

Spawning of spring chinook begins in July and peaks in late August to early September. In 1949 and 1950, the Oregon Game Commission collected Imnaha River spring chinook from the spawning beds (see Section 5.3.2.1). On July 24, 1951, a weir was constructed at Coverdale (also called Cloverdale) (RM 52.7) to facilitate egg collection. Observations on spawning behavior were:

1. Most females passed Coverdale prior to July 23.
2. Surveys conducted upstream of Coverdale prior to August 1 did not reflect numbers of salmon present.
3. The majority of salmon spawn from August 10 to August 20.
4. Water temperatures ranged from 49 to 57 degrees F at the peak of spawning (Oregon State Game Commission 1951).

Multiple spawning ground surveys conducted by the Oregon Fish Commission in 1955 indicated that spawning peaked in the Imnaha River slightly prior to August 24. In other years, peak spawning may happen earlier or later (Thompson and Haas 1960).

In 1982, the Oregon Department of Fish and Wildlife began installing a weir in the Imnaha River one-half mile downstream of Gumboot Creek (RM 47) to collect spring chinook salmon broodstock as part of the LSRCP. The spawning-time distribution of unmarked spawned chinook collected at that weir from 1986 through 1989 (ODFW 1986-89 unpublished data) varied somewhat between years, but the dates generally agree with observations made in 1951(Oregon State Game Commission), and 1955 (Thompson and Haas 1960).

5.2.3.2 Distribution

Presently, most salmon in the Imnaha River spawn from the Blue Hole to Crazyman Creek (RM 42.8) (see Map 2). Some salmon have been observed spawning as far upstream as the lower reaches of the South Fork and as far downstream as Freezeout Creek (RM 29.4) (Witty 1964-90). Few spring chinook salmon currently spawn in Big Sheep and Lick creeks. The majority of spawning in Big Sheep Creek currently occurs from RM 29.4 to RM 33.4. The majority of spawning in Lick Creek occurs in the upper 2.3 miles.

5.2.3.3 Age Composition

Age composition of chinook varies from year to year in the Imnaha River (Oregon Fish Commission and ODFW unpublished data, Northeast Oregon spawning ground surveys, 1961-75). Average age composition of Imnaha wild stock spring/summer chinook, 1961-76, included 5 percent age 3, 44 percent age 4, 50 percent age 5, and 1 percent age 6. Age composition of Imnaha stock hatchery spring/summer chinook, 1982-90, included 24 percent age 3, 51 percent age 4, and 25 percent age 5 (ODFW 1997). The earlier age at return is a result of releasing hatchery smolts at a size larger than that of wild smolts (Carmichael and Messmer 1995) (see Table 5-3).

Data collected during spawning ground surveys 1968-72 depict a fairly clear length frequency curve by age group (unpublished reports, Oregon Fish Commission, Northeast Oregon salmon spawning ground counts). Three-year-old jacks range from 14 to 21 inches with most fish measuring 20 inches; four-year-old fish measure 18 to 34 inches with the greatest frequency at 31 inches; and five-year-old fish range from 28 to 44 inches with a modal frequency of 36 inches. There were not enough six-year-old fish to develop an age/length frequency.

5.2.3.4 Sex Ratio

Sex ratio data have been collected for unmarked chinook caught at the Imnaha weir from 1982 through 1992. From 1983 through 1986, the hatchery influence was negligible. From 1986 through 1993, hatchery fish could have been present in the data because not all hatchery fish were marked until 1993. Considering the potential source of bias, the male/female sex ratio for the 1982-1992 period was 1.27 = (58.6 percent males)/(41.4 percent females) (Carmichael and Messmer 1995, Carmichael et al. 1986). However, this ratio could be skewed because the Imnaha weir does not collect early migrating salmon and the Oregon State Game Commission (1951) noted that females pass Coverdale earlier than males.

Table 5-3 Percent Age Composition of Spring Chinook Salmon Returning to the Imnaha Satellite, 1996

Age group Number	Total Fish				Natural Fish[1]				Hatchery Fish			
	Male		Female		Male		Female		Male		Female	
	#	%	#	%	#	%	#	%	#	%	#	%
3_2	58	39.2	0	0.0	4	5.6	0	0.0	54	71.1	0	0.0
4_2	57	38.5	24	16.2	43	59.7	19	26.4	14	18.4	5	6.6
5_2	5	3.4	4	2.7	4	5.6	2	2.8	1	1.3	2	13.2
Number	120		28		51		21		69		7	

1. Natural fish include some unmarked age 5 hatchery fish.
Source: ODFW 1997. Age nomenclature is from Gilbert and Rich 1927.

5.2.3.5 Fecundity

Average fecundity of Imnaha River wild spring chinook varies from year to year. In 1951, 15 female chinook produced 58,157 green eggs for an average fecundity of 3,877 eggs per female. The average number of eggs per wild female spawned at the Imnaha weir 1984-87 was 4,805 eggs (Carmichael et al. 1995, Carmichael et al. 1986). During development of the 1993 annual operation plan for collection of adult salmon, managers estimated 67 females would produce 306,000 green eggs or an average of 4,567 eggs per female. Fecundity is associated with age and size, that is, larger fish tend to produce more eggs.

5.2.3.6 Egg Incubation

Spring chinook salmon eggs require approximately 1,600^0 F (890^0 C) accumulated temperature units to develop into free-feeding fry (Piper et al. 1982). According to a set of temperature data collected by the U.S. Fish and Wildlife Service at Ollokot Campground (RM 48.5) in 1987 and 1988, eggs deposited in early August would result in **emergence** of free-feeding fry in early to mid-November (Mundy and Witty 1998). Eggs deposited mid-August would emerge in mid-April; eggs deposited in early September would emerge in late May; and eggs deposited mid-September would emerge mid-June. Zero-age swim-up fry first appear in the Imnaha River in February and emerge as late as early June (Gaumer 1968). Based on the peak spawn timing of mid-August, it is suspected that most fry emerge in April.

5.2.4 Juvenile Rearing

Juvenile chinook rear in the Imnaha River and in Cow, Lightning, Horse, Big Sheep and Lick Creeks (Gaumer 1968) and most likely in lower reaches of most tributaries to the Imnaha River (Neeley et al. 1993). There is extensive movement of parr in the upper Imnaha, the middle Imnaha, the lower Imnaha and lower Big Sheep Creek from September through winter and spring until the remaining yearlings emigrate by June. Gaumer (1968) observed distinct bimodal distributions from late winter through spring, which he used to distinguish sub-yearling fry, parr or yearlings.

Some fry or small parr move in the lower Imnaha River and lower Big Sheep Creek in April (Gaumer 1968). Some fry or parr move into the lower Imnaha River and Big Sheep Creek during the spring when yearlings are also migrating. However, there is little or no evidence of parr movement in the summer months. Parr movement peaked in November in lower Big Sheep Creek and in October and November in the lower Imnaha during the years of Gaumer's study.

The lack of summertime movement could be due to high water temperatures from July into September. A major diversion of water from Little Sheep Creek and Big Sheep Creek may contribute to high temperatures in lower Big Sheep Creek and the lower Imnaha River below the mouth of Big Sheep Creek during the summer months. The diversion through the Wallowa Valley Improvement Canal supplies the Wallowa Valley water for irrigation from May through October 15, and supplies stock water for the remainder of the year (Larson 1990).

A **fyke** net fishing the mouth of the Imnaha between October 28 and November 30 in 1964 trapped juveniles of the 1963-brood ranging from 55 to 95 mm (Gaumer 1968). Some chinook parr produced in the Imnaha River entered the Snake River in the fall where they must have reared through the winter months. There is no information available regarding growth or survival of these fish. Whether juveniles were migrating from the Imnaha River into the Snake River earlier in the year is unknown.

5.2.5 Smolt Migration

The Nez Perce Tribe has operated a screw trap in the Imnaha River near the mouth of Cow Creek (RM 4) since 1994. Naturally-produced chinook salmon exhibit a protracted emigration from the Imnaha River. In 1998 and 1999, natural fish were observed at the Cow Creek smolt trap (RM 4) from the middle of February to the middle of July. In comparison, hatchery-reared fish acclimated at the Gumboot facility were first observed on April 5 (they were force-released from the facility on April 5) and the last fish were observed on May 17. However, 99 percent of the fish passed between April 5 and April 19 (Cleary 1998, in prep.). In 1999, the first volitional release of hatchery fish was implemented and fish were observed from early March to early June with the peak migration extending from the middle of March to the middle of May (Cleary 1999, in prep.).

Information on the length of smolts is collected annually. Naturally-produced chinook averaged 102 mm in 1994, 99 mm in 1995, 101 mm in 1996, 108 mm in 1997, 106 mm in 1998 and 104 mm in 1999 (Ashe et al. 1995, Blenden et al. 1996, Blenden et al. 1997, Cleary April 2000). Hatchery-reared juveniles averaged 126 mm in 1994, 123 mm in 1995, 131 mm in 1996 and 1997, 135 mm in 1998, and 134 mm in 1999 (Cleary April 2000).

Juvenile chinook produced in the Imnaha River passed Ice Harbor and McNary dams in April, May and into June during the years 1965-67 (Gaumer 1968). Lower Monumental, Little Goose, and Lower Granite dams were not in place at that time. In 1994, passage of Imnaha chinook at McNary Dam peaked in early-May. Passage of wild Imnaha chinook salmon at Lower Granite Dam peaked April 24 to May 11 in 1994 (Ashe et al. 1995), May 1 to May 11 in 1995 (Blenden et al. 1996), and April 30 to May 18 in 1996 (Blenden et al. 1997). Emigrating Imnaha chinook marked in the fall arrived at Ice Harbor Dam earlier in the spring than chinook marked in the spring (Gaumer 1968).

This downstream movement appears to be earlier than for other Snake River Basin populations. From 1988 through 1995, NMFS PIT-tagged juveniles from several Snake River natural populations, including the Imnaha, in August and September and detection of these fish as they passed mainstem dams enabled comparison of outmigrant timing (Achord et al. 1992, Matthews et al. 1992, Matthews et al. 1990, Townsend et al. 1997). The median passage time of the Imnaha population was mid-April to early May for the years of the study, and the median passage times of the other populations were two weeks or more after the Imnaha population (see Figure 5-1).

Other researchers have found that Imnaha fish migrate with the bulk of natural smolts. Walters et al. (1997) and Sankovich et al. (1997) continued the analysis of Imnaha River smolt migration characteristics from 1993 through 1996. They found that Imnaha River smolts arrived at Lower Granite Dam during the middle of the smolt outmigration.

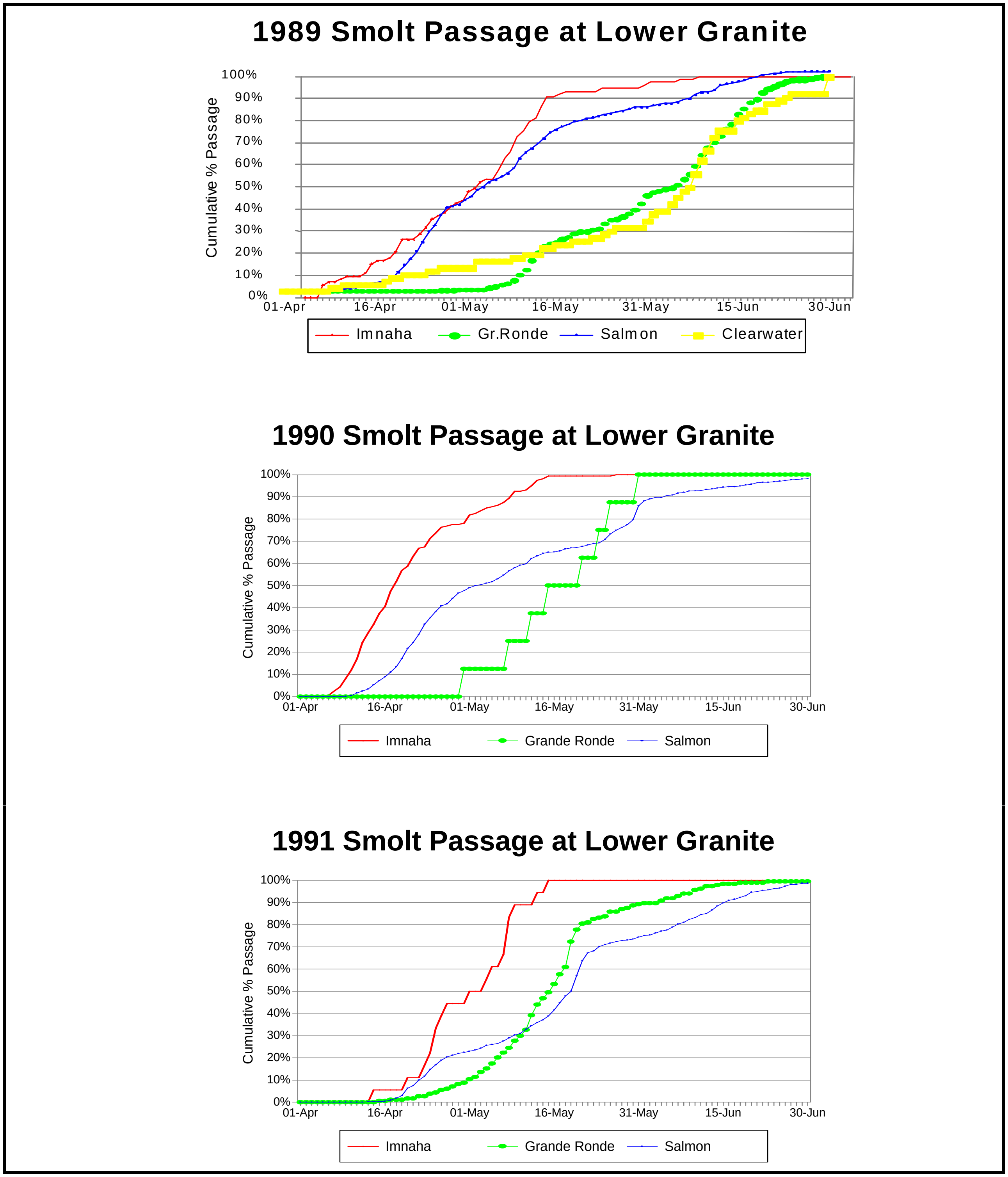
Travel time from the Imnaha River to Lower Granite Dam ranged from 29.2 days for late-March migrants to 7.6 days for fish tagged in early May 1994 (Ashe et al. 1995). In 1995, mean travel time of wild chinook salmon from the Imnaha River to Lower Granite Dam ranged from 15 days for fish tagged in early-April to 8.4 days for fish tagged in late-April (Blenden et al. 1996). Mean travel time of PIT-tagged wild chinook salmon from the Imnaha River ranged from 8 days for the May 11 release group to 26 days for fish tagged and released by March 30, 1996 (Blenden et al. 1997). Late spring migrants travel faster than early spring migrants, and migration speed appears to be associated with flow.

Some studies have documented downstream travel time after reaching the first dam. Sankovich et al. (1997) found that the average travel time of natural Imnaha chinook salmon smolts from Lower Granite Dam to Little Goose Dam was about 5 days. Travel time from Little Goose Dam to Lower Monumental Dam was 6.8 days and from Lower Monumental Dam to McNary Dam travel time was 8.8 days.

5.2.6 Ocean Rearing

Distribution of Imnaha River spring chinook in the Pacific Ocean is unknown. Few spring chinook identifiable as originating from the Snake River Basin are taken during ocean fisheries. Those taken are hatchery chinook identified by coded-wire tags. Consequently, a tool used to understand ocean distribution is not available. However, Mundy and Witty (1998) note that Snake River spring chinook are distributed farther offshore than any other Columbia River stocks except steelhead.

Figure 5-1 Cumulative Frequency of Smolt Passage at Lower Granite Dam 1989-91



Source: Achord et al. 1992, Matthews et al. 1992, Matthews et al. 1990.

5.3 Historical and Current Fisheries Management

The following section discusses harvest management and artificial production of Imnaha spring chinook.

5.3.1 Harvest Management

Salmon originating in the Imnaha River are harvested intentionally and unintentionally under regulations of four national governments, six state governments and twelve tribal governments. These governments coordinate harvest regulations through many organizations and processes (see Table 5-4). As federally-listed endangered species, the taking of the naturally-spawning Imnaha River spring chinook and fall chinook is also regulated by the Section 7 (federal) and Section 10 (non-federal) processes of the Endangered Species Act (P.L. 93-205).

Table 5-4 Organizations and Processes for Harvest Management

Life Cycle Stage	Organizations, Agreements, Processes, or Forums
Adult, Marine	Columbia River Compact, *U.S. v. Oregon*, *U.S. v. Washington*, Columbia River Inter-Tribal Fish Commission, the Northwest Indian Fish Commission, the Pacific Fishery Management Council, the Pacific Salmon Commission, Sections 7 and 10 ESA
Adult/Spawner, Freshwater	Columbia River Compact, *U.S. v. Oregon*, Columbia River Inter-Tribal Fish Commission, Sections 7 and 10 ESA
Egg through Smolt	Sections 7 and 10 ESA
Juvenile, early marine	Columbia River Compact, *U.S. v. Oregon*, Columbia River Inter-Tribal Fish Commission, Sections 7 and 10 ESA
Juvenile, marine	Columbia River Compact, *U.S. v. Oregon*, *U.S. v. Washington*, Columbia River Inter-Tribal Fish Commission, the Northwest Indian Fish Commission, the Pacific Fishery Management Council, the Pacific Salmon Commission, the North Pacific Fishery Management Council, and the North Pacific Anadromous Commission

Regulations downstream of the mouth of the Imnaha River treat Imnaha spring chinook as part of the mixed stock aggregate of upriver spring chinook. Therefore, Imnaha River salmon are only explicitly recognized and protected under regulations when they are harvested upstream of the Imnaha River mouth. The Nez Perce Tribe and the state of Oregon, in consultation with NMFS, manage the harvest of salmon within the Imnaha River watershed.

5.3.1.1 Tribal Harvest Management

Limited information is available to estimate recent tribal harvest of salmon in the Imnaha River, but it is assumed that members of the Nez Perce Tribe fish in the Imnaha when fish are available. Limited information is available because the tribal fisheries program and its creel census data collection and reporting system began in 1981, and no data is available for tribal harvest before that time. In addition, few harvestable returns have occurred in the Imnaha in the past 30 years.

In 1998, the NPT and ODFW cooperatively developed a management agreement for broodstock allocation and harvest of adults by setting adult escapement goals. This agreement is detailed in the ESA Section 10 permit application (ODFW 1998) and is summarized in Table 4-4.

5.3.1.2 State of Oregon Harvest Management

Beginning in the early 1900s, the state of Oregon began to impose harvest restrictions on salmon. In 1916, in regulations applying specifically to the Imnaha watershed, Oregon imposed limits on the daily amount of salmon and steelhead that could be taken (see Table 5-5). Bag limits changed from 50 pounds per day in 1916, to 20 pounds per day in 1925, to the daily limit of two larger salmon, or 10 smaller (jack) salmon until the last fishing season in 1978.

Limitations on the location and season of harvest began in the Imnaha River three decades after daily bag limits were imposed (see Table 5-5). Sometime after 1944, fishing was prohibited in the upper reaches of the watershed where the principal spawning grounds of the spring chinook are located. Between 1944 and 1954, fishing was restricted to areas downstream from Grouse Creek. From 1955 to 1978, fishing was prohibited above the Freezeout Creek Bridge.

Because salmon returns declined in the Imnaha River, sport fishing was closed mid-season for spring chinook in 1974, reopened in 1975, closed again in 1976, opened in 1977 and 1978, and closed again in 1979 (Mundy and Witty 1998). Adult returns have not been able to support a sport fishery since 1978, despite implementation of the LSRCP program in 1986.

In 1950, Oregon implemented a system of punch cards for keeping track of sport harvests (see Table 5-5). Corrected annual salmon sport harvests have ranged from zero in 1974, to 270 in 1960 (see Table 5-6).

5.3.2 Production Management

5.3.2.1 Early Production Efforts

The first artificial production activities in the Imnaha River occurred in the mid-1900s. In 1949, the Oregon Game Commission initiated an Imnaha River spring chinook egg-take with the objective of introducing Imnaha chinook into the Umpqua River System in Southwest Oregon. Salmon were collected on the spawning beds in 1949 and 1950, and in 1951, a weir was constructed at Coverdale to assist in the effort. Between July 24 and August 18, 1951, 152 male and 6 female chinook were collected (Mundy and Witty 1998).

In 1966, 119 adult spring chinook trapped at Hells Canyon Dam were outplanted into the Imnaha (Neeley et al. 1993). These fish would have been from the same population that was used to establish the Rapid River stock that originated from adults trapped at Hells Canyon Dam from 1964 through 1969 (Olsen et al. 1992, Abbot and Ball 1991, and Keifer et al. 1992).

In 1976, Congress authorized hatchery production of Imnaha spring chinook under the Lower Snake River Compensation Plan. In 1984, the first spring chinook juveniles produced under the LSRCP were released into the Imnaha River.

Table 5-5 State of Oregon Fishing Regulations for Imnaha River Salmon

Regulations	Time
SEASONS	Open year-round through 1954 Closed April 10-June 1 1955-61 Closed to salmon June 20-August 31, 1962-63. Closed to salmon June 20-August 31, 1964-74. Closed to salmon June 20-August 31, 1975. Open to salmon May 1-December 31, 1976. Closed to salmon year-round, 1977 Open to salmon May 1-June 30, 1978. Closed to salmon after 1978
UPPER BOUNDARY	Grouse Creek sometime prior to 1944 to 1954. Freezeout Bridge 1955 to 1978 No seasons after 1978
DAILY BAG LIMIT	50 pounds per day 1916-1918 35 pounds per day 1919 to 1924 20 pounds per day 1925 3 per day (no limit on jacks >20 inches) 1944-1946 2 per day (no limit on jacks >20 inches) 1947 2 per day (10 jacks per day) 1948-1978
PUNCH CARDS	1950-1978
Source: Adapted from Mundy and Witty 1998.	

5.3.2.2 LSRCP Program Overview

Adult return goals contained in the LSRCP were based on the Snake River runs between 1959 and 1961. For Snake River spring chinook, the adult return goal is 58,700 fish. The adult return goal for the Imnaha River is 3,210 adults. The LSRCP assumed a smolt-to-adult survival of 0.65 percent for the Imnaha and production of 490,000 smolts was estimated to be sufficient to meet the adult return goal. The Northeast Oregon facilities currently operated for spring chinook under the LSRCP include: Lookingglass Fish Hatchery (which presently houses the Imnaha River and the Grande Ronde spring chinook salmon supplementation programs), Gumboot weir and acclimation facility, LaGrande Fish Health Laboratory, Northeast Oregon Research and Monitoring in LaGrande (ODFW and CTUIR) and the Nez Perce Tribe Research Program in Enterprise. Implementation of the LSRCP Imnaha spring chinook salmon program has been guided by five primary management objectives (see Section 3.1.1).

In 1982, a temporary facility was constructed and operated to collect broodstock on the Imnaha River near Gumboot Creek. In 1989, a permanent facility was constructed at the Gumboot site. Adults were collected, held and spawned at the Gumboot facility from 1982 to

1994, and eggs were transported to Lookingglass Hatchery for incubation and rearing. Beginning in 1995, adults were transported to Lookingglass Hatchery where they were held and spawned. Fish are reared at Lookingglass Hatchery for approximately 14 months to the smolt stage (see Figure 1-1 for recent operations). Smolts are either acclimated at the Gumboot facility prior to release, or released directly to the Imnaha. A comprehensive research, monitoring and evaluation program has been underway since 1984 (Carmichael et al. 1998b) (see Section 4.1.13).

Table 5-6 Sport Harvest of Imnaha River Chinook Salmon, 1953 to 1997

Year	**Estimate**	**Year**	**Estimate**
1953	292	1971	26
1954	29	1972	51
1955	38	1973	114
1956	20	1974	CLOSED 5/16
1957	210	1975	0
1958	224	1976	CLOSED
1959	220	1977	44
1960	270	1978	22
1961	87	1979	CLOSED
1962	38	1980	CLOSED
1963	31	1981	CLOSED
1964	13	1982	CLOSED
1965	32	1983	CLOSED
1966	43	1984	CLOSED
1967	31	1985	CLOSED
1968	116	1986	CLOSED
1969	46	1987	CLOSED
1970	48	TO 1999	CLOSED
Source: Mundy and Witty 1998.			

5.3.2.3 Lower Snake River Compensation Plan Status Review

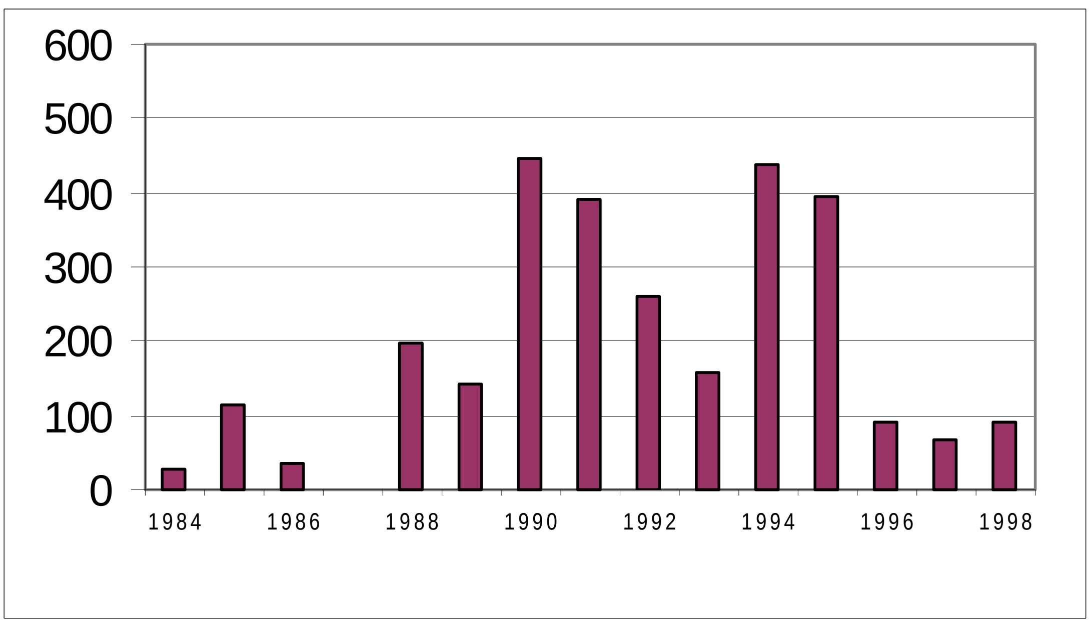
A recent status review conducted for LSRCP hatcheries summarized progress of the program to date. The following information was summarized from a review of the LSRCP Imnaha spring chinook salmon program (Carmichael et al. 1998b).

Wild fish (or fish of natural origin) comprised a majority (82–100 percent) of the Imnaha broodstock until significant numbers of hatchery fish returned to the river (see Table 4-1). From

1989 to the present, the percent of natural origin fish in the hatchery broodstock has ranged from 8-71 percent (see Table 4-2). The percentage of hatchery origin fish released above the weir to spawn naturally was less than 10 percent during the initial years of the program due to the low abundance of hatchery fish and the emphasis on retaining fish for broodstock. Since 1990, hatchery fish have composed from 31-77 percent of fish released above the weir to spawn naturally (Carmichael et al. 1998b).

The smolt production goal of 490,000 fish has not yet been met due to insufficient numbers of broodstock, high pre-spawning mortality, and egg loss (see Figure 5-2). Smolt-to-adult survival has been lower than the expected 0.65 percent for every brood-year (Carmichael et al. 1998b). To date, the program has not been successful in recovering the natural population to historic levels or restoring fisheries. Table 5-7 shows the adult collection and smolt production numbers based on an expected smolt-to-adult survival rate of 0.65 percent. The average survival rate has been 0.13 percent. When the adult returns are based on the average survival rates, only 637 adults can be expected from a release of 490,000 smolts. To produce 3,210 adults, smolt production would have to be increased to 2,500,000 (see Table 5-7).

Figure 5-2 Smolts Released to the Imnaha River under the LSRCP Program (in thousands of fish)



Note: In 1987, Imnaha spring chinook smolts were released into Lookingglass Creek instead of the Imnaha drainage because the fish were infected with erythrocytic inclusion body syndrome (EIBS).

The progeny-to-parent (or recruit-per-spawner) ratio or the number of returning adults that result from a brood-year of spawners is one of the most important performance measures used by the monitoring and evaluation program to assess the effectiveness of the Imnaha spring chinook hatchery program. Progeny-to-parent ratios for the natural spawning population in the Imnaha have been well below replacement (1.0) since 1983 and have been as poor as 0.2 (Carmichael et al. 1998b). In contrast, the hatchery parent-to-progeny ratios have been above replacement for all brood-years except 1990, 1992 and 1994 (Carmichael et al. 1998b). The average progeny-to-parent ratio for hatchery origin fish is near 4.0, while the average for the natural spawning population is less than 0.5 (Carmichael et al. 1998b). Figure 5-3 shows the declining trend in the natural population in comparison with the hatchery-reared population. The declining trend indicates that under present circumstances a natural population will not persist.

Carmichael et al. (1998b) conducted a simulation of what the Imnaha spring chinook populations would be without the hatchery program. Their assessment indicated there are far more fish returning to the basin and contributing to the number of natural spawners with the hatchery program than there would have been without the hatchery (see Appendix A).

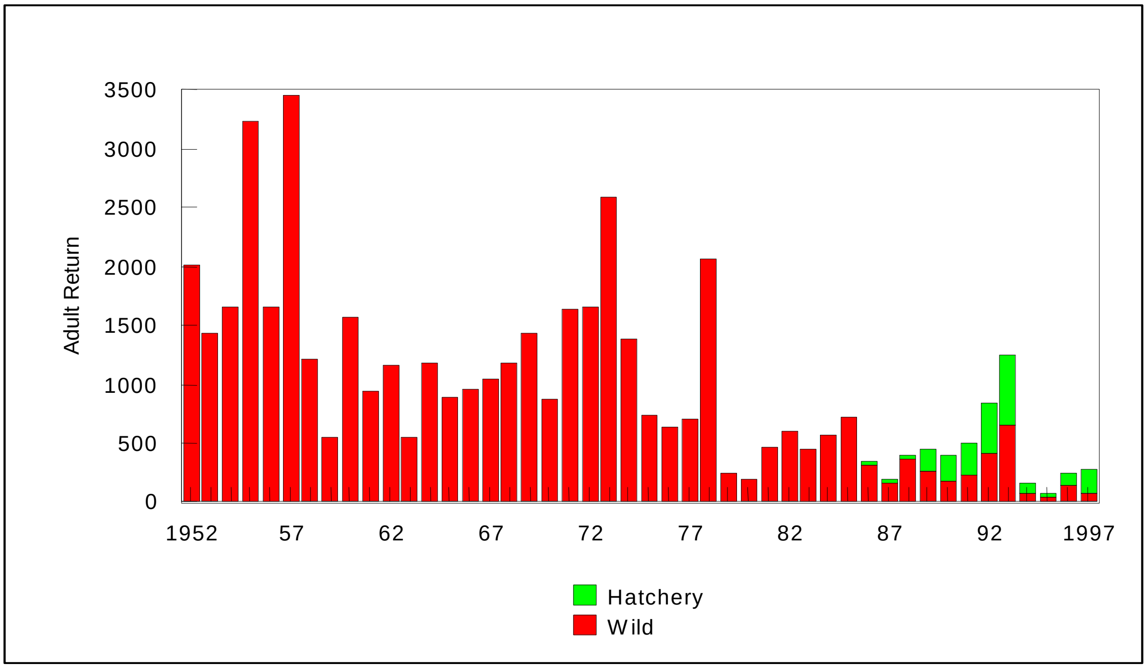
As the number of individuals in a population declines, the probability of the population's extinction or extirpation due to random genetic, demographic, or environmental events increases. Due to the continuing decline of the population and the increased risk of extirpation, co-managers have used an **adaptive management** approach to refocus the management goals and objectives from emphasizing mitigation and hatchery production to emphasizing natural production enhancement. An example of this adaptive management approach to the LSRCP is the sliding scale management plan described in Section 4.1.2.

Table 5-7 Number of Fish Expected at Each Life-history Stage to Produce a Full Program of 490,000 Smolts, as authorized under the LSRCP

	0.65 % Smolt to Adult Return	**0.13 % Smolt to Adult Return**
Number of adults to collect	320	1,650
Adult survival rate to spawn	80%	80%
Number of adults surviving to spawn	256	1,292
Ratio of males to females	1:1	1:1
Number of females	128	646
Fecundity per female	4,500	4,500
Number of eggs to incubate	576,000	2,907,000
Egg to smolt survival	85%	85%
Number of smolts to release	490,000	2,470,950
Smolt to adult survival	0.00655	0.00130
Adults returning to subbasin	3,210	3,210

Note: Numbers are rounded.

Figure 5-3 Adult Return Trends for Natural and Hatchery Reared Spring Chinook



5.4 Description of the Grande Ronde River Subbasin

The Grande Ronde River Subbasin encompasses an area of about 3,950 square miles in the northeast corner of Oregon and a small portion of southeast Washington. The mainstem Grande Ronde River extends 212 miles from its headwaters in the Blue Mountains (elevation 7,700 feet) and the Wallowa Mountains (elevation 10,000 feet) to its confluence with the Snake River in Washington at RM 169 (elevation 820 feet) (ODFW et al. 1990). The Grande Ronde River is located upstream of eight mainstem dams and 493 miles from the mouth of the Columbia River (see Map 1). The subbasin is characterized by two major river valleys, the Wallowa and Grande Ronde, surrounded by rugged mountain ranges. Major tributaries include Joseph Creek, Wenaha River, Lookingglass Creek, Wallowa River, and Catherine Creek (see Map 3).

The U.S. Forest Service manages about 45 percent (1,831 square miles) of the land in the subbasin (ODFW et al. 1990) (see Map 3). Headwaters of the upper Grande Ronde River, Wallowa River and its tributaries and Joseph Creek originate in the Wallowa-Whitman National Forest, and the Wenaha River and Lookingglass Creek originate in the Umatilla National Forest. Portions of the subbasin are designated wilderness areas. The Wenaha/Tucannon Wilderness Area encompasses 177,465 acres and almost the entire Wenaha River drainage (ODFW 1990). The Eagle Cap Wilderness Area is 346,000 acres, and most of the Minam River and upper portions of the Wallowa and Lostine rivers are within its boundaries. Sections of the Grande Ronde, Minam, Wenaha, and Lostine rivers, and Joseph Creek were added to the Wild and Scenic Rivers Act in 1988. The lower portion of the Grande Ronde Subbasin, including the Wenaha River and Wallowa River and its tributaries, is within the area established for sole Nez

Perce occupancy under the Treaty of 1855 (see Map 4). The upper portion of the Grande Ronde Subbasin, including most of Lookingglass Creek, Catherine Creek and the upper Grande Ronde River is within the area established for the Confederated Tribes of the Umatilla Indian Reservation under the Treaty of 1855.

Economically important land-use activities in the basin are irrigated agriculture, dryland farming, livestock grazing, and timber production. Agricultural and grazing lands are throughout the Grande Ronde and Wallowa valleys. Approximately 11 percent of the entire basin is privately cultivated cropland, of which about half is irrigated.

Most residential development is concentrated in or near six towns in the subbasin: La Grande (population 12,340), Union (population 2,090), Elgin (population 1,765), Wallowa (population 810), Enterprise (population 2,075) and Joseph (1,175) (ODFW et al. 1990).

There are 24 native and 19 exotic fish species in the Grande Ronde River. Table 5-8 lists native species and Table 5-9 lists exotic fish species. Exotic species are found predominantly in the lower reaches of the Grande Ronde River.

The Grande Ronde River historically supported large runs of chinook, coho, sockeye and steelhead. Escapement of naturally-produced chinook salmon to the Grande Ronde River exceeded 12,000 in the 1950s. Redd counts indicate that large runs of spring chinook returned until the early 1970s (ODFW et al. 1990). Current escapement levels of natural chinook have been fewer than 1,000 fish (Sims 1994). Spring, fall chinook and steelhead are currently listed as threatened under the ESA. Coho and sockeye salmon have been extirpated from the Grande Ronde Subbasin. Bull trout have also been listed as threatened under ESA.

Historically, spring chinook were widely distributed throughout the basin in at least twenty-one tributaries (Hurato 1993). Presently, the most productive of these are the Wenaha River, Lostine River, Minam River, and Catherine Creek. To date, the Nez Perce Tribe has directed active restoration programs at the Lostine River and agreed with co-managers to monitor populations in the Wenaha and Minam rivers. This master plan details the co-managers efforts focused on restoration of the Lostine River spawning aggregate of Grande Ronde spring chinook salmon.

Table 5-8 Fish Species Originally Occurring in the Grande Ronde River Subbasin

Common name	**Scientific name**
Spring chinook salmon	*Oncorhynchus tshawytscha*
Summer/early fall chinook salmon	*Oncorhynchus tshawytscha*
Fall chinook salmon	*Oncorhynchus tshawytscha*
Summer steelhead	*Oncorhynchus mykiss*
Coho salmon	*Oncorhynchus kisutch*
Sockeye salmon/kokanee	*Oncorhynchus nerka*
Rainbow trout	*Oncorhynchus mykiss*
Redband trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*
Bull trout	*Salvelinus confluentus*
Mountain whitefish	*Prosopium williamsoni*
Pacific lamprey	*Lampetra tridentata*
White sturgeon	*Acispenser transmontanus*
Mountain sucker	*Catostomus platyrhynchus*
Largescale sucker	*Catostomus macrocheilus*
Bridgelip sucker	*Catostomus columbianus*
Chiselmouth	*Acrocheilus alutaceus*
Longnose dace	*Rhinichthys cataractae*
Torrent sculpin	*Cottus rhotheus*
Leopard dace	*Rhinichthys falcatus*
Mottled sculpin	*Cottus bairdi*
Northern pikeminnow	*Ptychocheilus oregonensis*
Peamouth	*Mylocheilus caurinus*
Redside shiner	*Richardsonius balteatus*
Paiute sculpin	*Cottus bildingi*
Shorthead sculpin	*Cottus confusus*
Lampreys	*Lampetra* spp.
Speckled dace	*Rhinichthys osculus*

Source: Coby Menton, NRSCS, SWCD personal communication 1999.

Table 5-9 Fish Species Introduced to the Grande Ronde River Subbasin

Common name	Scientific name
Largemouth bass	*Micropterus salmoides*
Yellow perch	*Perca flavescens*
Sunfish	*Lepomis spp*
Brown bullhead	*Ictalurus nebulosus*
Common carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Smallmouth bass	*Micropterus dolomieu*
White crappie	*Pomoxis annularis*
Brook trout	*Salvelinus fontinalis*
Black bullhead	*Ameiurus melas*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Flathead catfish	*Pylodictis olivaris*
Golden trout	*Oncorhynchus aguabonita*
Lake trout	*Salvelinus namaycush*
Pumpkinseed	*Lepomis gibbosus*
American shad	*Alosa sapidissima*
Tadpole madtom	*Noturus gyrinus*
Yellow bullhead	*Ameiurus natalis*

Source: Coby Menton, NRSCS, SWCD personal communication 1999.

5.5 Lostine River Watershed Description

The Lostine River is a tributary to the Wallowa River located within Wallowa County. The Wallowa River drains approximate 933 square miles, flows 54 miles from its headwaters in the Wallowa Mountains (elevation 8,400 feet) to its confluence with the Grande Ronde River (elevation 2,288 feet). Other major tributaries to the Wallowa River are: Prairie, Spring, Bear, and Hurricane creeks and the Minam River (see Map 5). Historically, spring chinook spawning populations were present in Prairie Creek, Spring Creek, Hurricane Creek, Bear Creek, Minam River and the Little Minam River, Lostine River, and Deer Creek (Big Canyon Creek) (Neeley et al. 1994). Based on redd count data, native spring chinook populations in Spring, Prairie, and Deer creeks are functionally extirpated. As described above, the co-managers have directed restoration efforts through supplementation at spring chinook returning to the Lostine River.

The Lostine is a perennial flowing stream that originates at Minam Lake and Upper Lake in the Eagle Cap Wilderness area of the Wallowa Mountains (elevation 9,673 feet) and flows 25 miles in a northerly direction to its confluence with the Wallowa River (elevation 3,600 feet) (see Map 5). Silver, Lake and Copper creeks are major tributaries. The watershed covers an area of 92 square miles.

Approximately 74 percent of the Lostine River watershed is in the Wallowa-Whitman National Forest. The lower reaches of the watershed are primarily held in private agricultural lands (see Map 5). With the exception of the Eagle Cap Wilderness Area, Forest Service lands are managed for multiple use including timber production, livestock grazing and recreation. Average annual precipitation varies from 14 to 60 inches. The average discharge is approximately 194 $ft.^3/s$ or 140,400 acre ft./year. Maximum discharge for the period of record occurred on June 16, 1974 when discharge reached 2,550 $ft.^3/s$. The minimum discharge occurred on in 1963 when discharge dropped to 10 $ft.^3/s$. Peak discharge typically occurs from April through late June (USGS 1999).

The portion of the Lostine River within the National Forest Boundary has been designated a Wild and Scenic River under the 1988 Omnibus Oregon Wild and Scenic Rivers Act. The upper 5 miles within the Eagle Cap Wilderness was designated Wild; the lower 11 miles running between the Wilderness boundary and the Forest boundary was designated Recreational (Bryson unpublished data). The Oregon chapter of the American Fisheries Society has identified the Lostine River as a biodiversity area because it provides "critical ecological function" as a genetic reserve for bull trout and native rainbow trout (Bryson unpublished data).

5.6 Life History and Population Biology of Chinook Salmon Returning to the Lostine River

The following section on life history is adapted from Neeley et al. (1994), interviews with knowledgeable people, and literature reviews. An overview of Grande Ronde chinook salmon life history is followed by a more detailed description of life history characteristics for the Lostine spawning aggregate.

Historic native runs of chinook salmon in the Grande Ronde Subbasin were continuous with the first fish arriving in early-May, runs peaking in June, July, or later depending on the water year, and the last fish arriving in October (Neeley et al. 1994). Generally, spawning activity occurred from late July through November. Parr produced in upper reaches stayed either in the Grande Ronde or Snake rivers for a period of about one year before they migrated to the ocean. Some males did not migrate but stayed in the natal stream where they matured (Jonasson et al. 1997). Adults would return to the natal stream after one to three (sometimes four) years in the ocean (Neeley et al. 1994).

In-subbasin and out-of-subbasin habitat changes and out-of-subbasin salmon harvest have reduced all salmon populations and extirpated or nearly eliminated certain segments of chinook salmon populations (Mobrand and Lestelle 1997). Chinook that may have once spawned from late-September through October have probably been extirpated, and chinook populations that spawn in November have been reduced to a remnant population.

5.6.1 Adult Migration

Grande Ronde spring chinook enter the Columbia River March through June (Neeley et al. 1994) and they pass through the lower Snake River primarily during April through mid-July (Thompson et al. 1958 and Bjornn et al. 1992). Spring chinook migrate quickly through lower Snake River reservoirs requiring an average of 1.4 days to pass each reservoir (Bjornn et al. 1992). Fish moving up the Snake River take another 1.9 days to reach the Grande Ronde River. The rate of migration slows as fish approach their natal stream (Bjornn et al. 1992).

Historically, good water flows accommodated adult migration year-round in the Lostine River, Hurricane and Bear creeks. Beginning in the early 1900s, water diversions for irrigation, coupled with low flows, dewatered lower reaches of the Lostine River and Bear Creek and a mid-section of Hurricane Creek from mid-to-late July through September (see Section 6.4.2.2). Adult chinook salmon could not enter these dry sections in most years and Neeley et al. (1994) suspect that a major component of the historic run of salmon was eliminated in these three streams with the development of the irrigation system. The operation of a hatchery program and the associated dam (located at RM 50) on the Wallowa River downstream of Minam from 1903 through 1913 also contributed to elimination of the original population from Wallowa River tributaries (see Section 5.8.2.1).

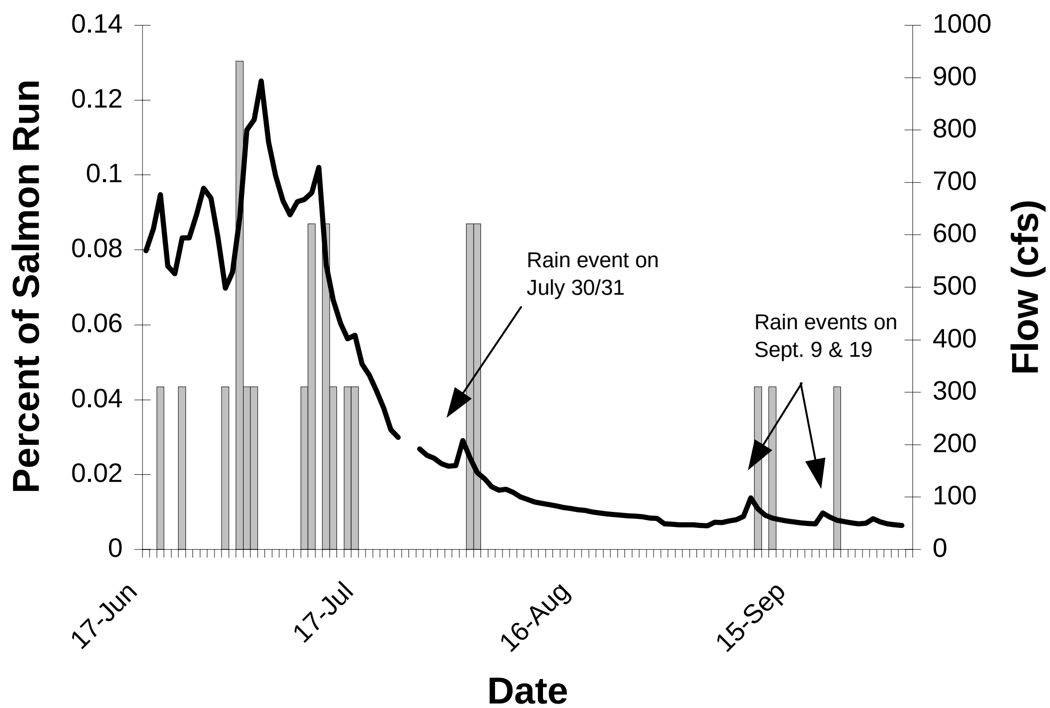
Presently, water conditions are generally good for spring chinook entry into the Lostine River, Hurricane Creek, and Bear Creek from late May through mid- July. Most chinook enter these streams in June and early-July (Neeley et al. 1994). Under natural conditions, chinook could enter natal streams over a more extended period of time.

In 1997 and 1998, the NPT fished an adult weir trap at RM 0.9 in the Lostine River to collect baseline data on spring chinook migration timing and select broodstock for supplementation. In 1997, high water prevented installation of the trap until mid-July and resulted in missing the early portion of the run (Ashe et al. in prep.). The first fish was captured on July 18 and the last fish was captured on September 22 (see Table 5-10). In 1998, the trap and weir were installed June 17 and the first fish was captured June 19. The last fish was captured September 21 (Harbeck 1998). Despite the earlier installation date, data collected during spawning ground surveys indicated that chinook still passed prior to trap installation (Harbeck October 1998). Migration of chinook was interrupted from late July through September when irrigation withdrawals dewatered sections of the stream. During that period, fish migrated only when rain events caused freshets in the descending hydrograph (see Figure 5-4).

Table 5-10 Summary of Capture at Adult Trap on the Lostine River

Year	1997	1998
Date of first capture	July 18	June 19
Date of last capture	September 22	September 21
Total males	14	11
Total females	13	12
Total	**27**	**23**
Source: Jim Harbeck October 1998.		

Figure 5-4 Migration Timing of Lostine River Spring/summer Chinook Salmon Compared to River Flows in 1998



Source: USGS data from Krieger Bridge; Harbeck 2000 in prep.

5.6.2 Adult Holding

Most chinook salmon hold in the Lostine River from the O.C. Ranch (also known as Strathern or Krieger Ranch) at RM 10 to an area below the Six-Mile Bridge RM 13 (see Map 5). Recent housing construction and channelization in the upper part of this section has reduced chinook holding and spawning habitat. Property owners of the O.C. Ranch have restricted public access to salmon holding areas, which may be the reason adult salmon are holding in this area. Chinook salmon have also been observed holding in the lower reaches of the Lostine River near available spawning habitat (Harbeck 1998).

5.6.3 Spawning

5.6.3.1 Timing

Neeley et al. (1994) suspect that historically, chinook returning to the Lostine River spawned as early as the last week of July and as late as mid-October. Currently, however, spring chinook typically spawn in the Lostine River from mid-August through September, maybe into October.

5.6.3.2 Distribution

The majority of spring chinook spawning in the Lostine River occurs between RM 13 and RM 10 (see Map 5). Spawning escapement in the Lostine River above the Pole Bridge has been very low in recent years. This may be partially due to a naturally-caused debris barrier that is believed to have blocked chinook passage upstream of the Pole Bridge for two or three years. In addition, campgrounds constructed by the U.S. Forest Service in this area were located next to chinook salmon holding waters. Some biologists suspect activities of people and their pets in the campgrounds next to and in the salmon holding waters discourages use of these areas by chinook salmon (Neeley et al. 1994). Recently, some of these campgrounds have been relocated away from the river (see Section 6.2.2.4). Chinook salmon have also been observed holding and spawning in the lower reaches of the Lostine River (below RM 1.5) where spawning habitat is available (Harbeck 1998 and Bryson April 2000). Late-run spring chinook have historically spawned in this area (Thompson and Haas 1960).

5.6.3.3 Age Composition

Length and age at maturity data collected during spawning ground surveys in the Grande Ronde Subbasin indicate that, generally, spring chinook return at ages 3 through 6 (Neeley et al. 1994). Four-year-old fish are the dominant age class especially in Lookingglass and Catherine creeks. Lostine and Minam river fish, while also age-four dominant, have a higher age 5 frequency than other evaluated streams. From 1961 through 1975, pooled age distributions showed that 5-year chinook comprised more than one third of the run in the Lostine River (Oregon State Game Commission and ODFW, Wallowa District Annual Reports, 1964 to present). Adults collected at the Lostine River weir facility in 1997 and 1998 were predominantly age 5 according to length frequency (see Table 5-11) (Ashe et al., in prep., Harbeck et al., in prep.).

Table 5-11 Summary Characteristics of Lostine River Spring Chinook Salmon Sampled at the Lostine River Weir in 1997 and 1998

Trait	**1997**	**1998**
Number of fish captured	27	23
Females	13	12
Males	14	11
Origin (marks)	25 natural (none) 2 hatchery (ad-clip)	23 natural (none) 0 hatchery
Age composition (percent in parentheses)	Age-3: 0 Age-4: 9 (33%) Age-5: 18 (67%)	Age-3: 1 (4%) Age-4: 6 (26%) Age-5: 16 (70%)
Age composition of females	Age-4: 2 Age 5: 11	Age-4: 4 Age 5: 8
Age composition of males	Age-3: 0 Age-4: 7 Age-5 7	Age-3: 1 Age-4: 1 Age-5 9
Mean length-at-age	Age-4: 749 mm Age-5: 824 mm	Age-4: 753 mm Age-5: 883 mm
Minimum length-at-age	Age-4: 704 mm Age-5: 800 mm	Age-4: 690 mm Age-5: 810 mm
Maximum length-at-age	Age-4: 793 mm Age-5: 852 mm	Age-4: 790 mm Age-5: 1020 mm
Source: Ashe et al., in prep. and Harbeck et al., in prep.		

5.6.4 Egg Incubation

Egg incubation occurs in gravel spawning areas beginning at the time eggs are deposited during August and early-September through swim-up. Fry swim-up occurs in the Lostine River from March through early-June with peak emergence in April and May (Neeley et al. 1994).

5.6.5 Juvenile Rearing

After emergence, in March to early-June, rearing conditions can be challenging. Water temperatures during the early period of emergence seldom exceed 40 degrees F, stream flows could vary from seasonal lows to highs, and available food would always be in short supply (Neeley et al. 1994). Fry seek slack water conditions near the bank, side channels, or backwater areas. Distribution of fry is unknown, but high water conditions tend to distribute fry downstream of the natal area. Information on juvenile rearing in the Lostine River and other Grande Ronde tributaries is currently being collected by the ODFW through the Early Life History study (see Table 1-1).

Based on data collected from rotary screen live-box traps on diversion canals, Lostine River chinook exhibit a strong pre-smolt out-migration characteristic (Neeley et al. 1994). Late-summer/fall parr appear to drift downstream into reaches of the Wallowa and perhaps into the lower Grande Ronde and possibly the Snake River by December or January. Some fish entering the Wallowa River show characteristics of moving upstream into the lower reaches of smaller, cooler tributaries in early-July through August. The percentage of salmon parr remaining in the natal stream probably varies from year to year depending on water conditions and displacement (Burck 1993). Jonasson et al. (1997) operated a rotary screw trap at RM 2 on the Lostine River and found that 42 percent of the total migrant population of juvenile chinook salmon outmigrated from the Lostine River during the fall, 10 percent during the winter, and 48 percent during the spring.

The distribution and abundance of spring chinook juveniles during fall, winter, and early spring is largely unknown in the Grande Ronde Subbasin. Burck (1993) made an attempt to establish distribution patterns of fish he marked in Lookingglass Creek. He suspected that Lookingglass chinook over-winter in the roadless, canyon section of the Grande Ronde River below Rondowa. Burck (1993) used seines and explosives to sample fish during late summer and fall months to confirm this hypothesis, however, he was unsuccessful in catching marked chinook. Despite Burck’s lack of definitive findings, the lower Grande Ronde River may be an important parr rearing habitat area (Neeley et al. 1994).

5.6.6 Smolt Migration

Spring chinook smolts collected at diversion screen bypasses and inclined plane traps by the Oregon Game Commission in 1965-67 were marked with hot brands and released to determine rate and timing of migration of juvenile salmonids in the Snake River. Neeley et al. (1994) used these data to depict migration habits of Grande Ronde Subbasin naturally produced smolts. In both 1966 and 1967, timing of out-migrating smolts from the Grande Ronde River Subbasin was generally a month later than the Salmon River, Imnaha River and Eagle Creek (Powder River System) fish. The median date for most Grande Ronde River smolts to arrive at Ice Harbor Dam was May to early-June, whereas the median arrival time for smolts from the Salmon River was late-April (Park and Bentley 1968).

However, studies from 1989 through 1991 based on detections of PIT-tagged spring chinook at Lower Granite Dam reported that Grande Ronde smolts outmigrated at approximately the same time as many Salmon River stocks, but later than the Imnaha stock (Matthews et al. 1990, Matthews et al. 1992, Achord et al. 1992). There did not appear to be a major distinction between Lower Granite passage times for the Grande Ronde and Imnaha populations in 1993 (Neeley et al. 1994). However, fish from these later studies may have some degree of hatchery parentage and may not be representative of truly indigenous stock.

Lengths of out-migrant Grande Ronde chinook captured for the 1966-67 study ranged from 80 to 120 mm (Neeley et al. 1994). Jonasson et al. (1997) reported that lengths of out-migrating smolts from the Lostine River ranged from 74 mm to 145 mm. Mean length of out-migrants was 77.7 mm for juveniles migrating in the summer, 98.3 mm for juveniles migrating in the fall, 91.9 mm for juveniles migrating in the winter and 102.2 mm for juveniles migrating in the spring.

5.6.7 Ocean Rearing

Distribution of Grande Ronde Subbasin spring chinook in the Pacific Ocean is unknown, although as mentioned for other Snake Basin fish (see Section 5.2.6), they appear to travel far offshore. Few spring chinook identifiable as originating from the Snake River Basin are taken during ocean fisheries. Those taken are hatchery chinook identified by coded wire tags (Mundy and Witty 1998).

5.7 Historic and Current Status

Natural escapement declines of the Lostine River spawning aggregate of spring chinook have paralleled those of other Grande Ronde River tributaries. Redd count totals for the Lostine River have plummeted from an estimated 893 in 1957 to 16 in 1994, 11 in 1995, 27 in 1996, 49 in 1997, and 35 in 1998. The declining trend is shown in Figure 5-5, which compares redd counts within the established index area (RM 10 to RM 13). The highest count was in 1957 when 157 redds were counted within the index area. Redd counts since 1994 have been extremely low. In 1995, only six redds were counted within the index area. Recent escapement estimates to the Lostine River, based on recent redd counts, are 50 adults in 1994, 34 in 1995, 84 in 1996, 152 in 1997, and 109 in 1998.

Based on the data presented above, the co-managers have determined that the Lostine River spawning aggregate of Grande Ronde River spring chinook is at short-term risk of extirpation.

5.8 Historical and Current Fisheries Management

The following section discusses artificial production and harvest management of spring chinook in the Grande Ronde River.

5.8.1 Harvest Management

The large-scale harvest management strategies for Grande Ronde spring chinook salmon is identical to that described for Imnaha chinook salmon (see Section 5.3.1).

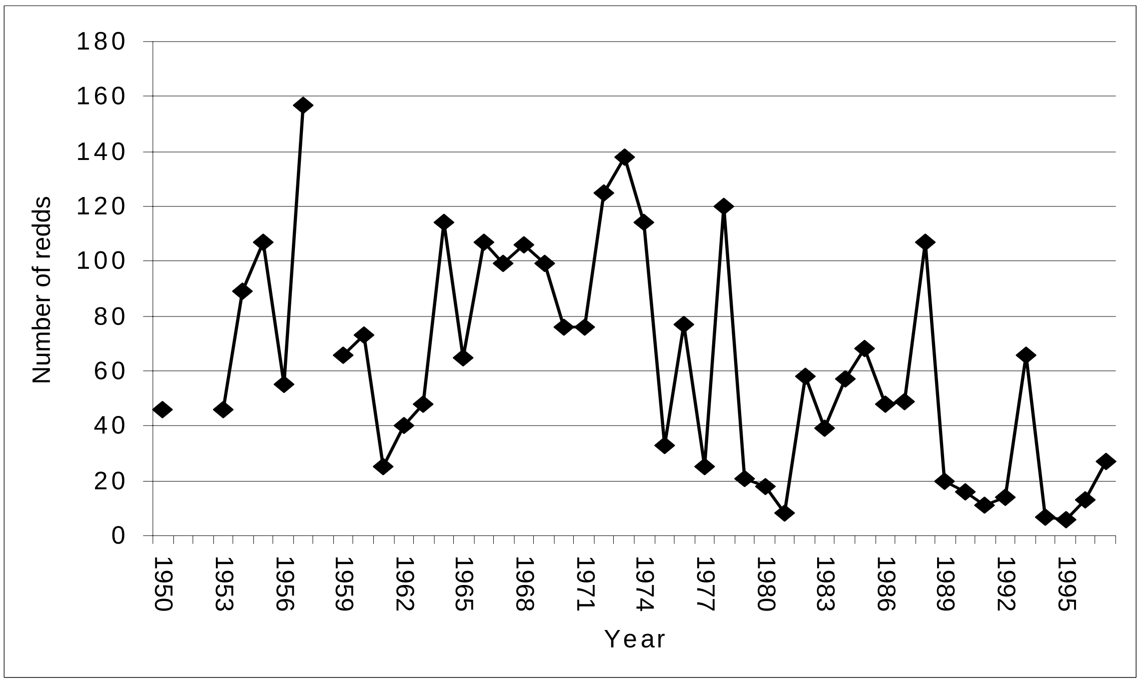
5.8.1.1 Tribal Harvest Management

As with the Imnaha spring chinook salmon (see Section 5.3.1), there is little information to describe tribal harvest in the Lostine River. In Lookingglass Creek during 1992 and 1993, tribal members harvested 173 and 110 Rapid River (non-native) stock chinook returning to Lookingglass Hatchery.

5.8.1.2 State of Oregon Harvest Management

Beginning in the early 1900s, the state of Oregon began to impose harvest restrictions on salmon harvested from the Grande Ronde River, and in the 1950s, began to record sport harvest. Table 5-12 shows harvest estimates for the Grande Ronde River. Individual harvest data is not available for the Lostine River.

Figure 5-5. Redd Counts within the Index Area from 1950 to 1997



Source: Tranquilli December 1998.

Note: Data reported prior to 1964 (when index area was established) were obtained from Tranquilli (ODFW) who reconstructed index area counts by reviewing old field notes and survey reports.

Table 5-12 Estimated Spring Chinook Harvest from Angler Punch-card Estimates in the Grande Ronde River and Tributaries, 1959-1977

Year	Washington	Oregon	Total
1959	NA[a]	503	503
1960	NA	552	552
1961	NA	221	221
1963	NA	762	762
1963	NA	345	345
1964	2	444	446
1965	7	361	368
1966	9	1,175	1,184
1967	23	489	512
1968	0	437	432
1969	7	645	652
1970	18	237	255
1971	2	129	131
1972	0	122	122
1973	6	257	263
1974	0	Closed	0
1975	0	Closed	0
1976	0	Closed	Closed
1977	Closed	Closed	Closed

Source: ODFW et al 1990.

[a] Data not available.

5.8.2 Production Management

5.8.2.1 Early Production Efforts

Artificial production of spring chinook in the Grande Ronde River began in 1901 when a weir was constructed across the mouth of the Wenaha River and the Grande Ronde River upstream of the confluence with the Wenaha River (Neeley et al. 1994). In 1903, the hatchery program moved to the Wallowa River about 1.5 miles below the confluence of the Minam River where it operated until 1913 (Neeley et al. 1994). In 1904, the Wallowa River Hatchery Dam was built just above the hatchery. The dam was partially destroyed in 1913 with the closing of the hatchery but remained a partial barrier to passage until it was completely destroyed in 1924 (Cramer 1998). Based on the hatchery operation descriptions and a photograph of Wallowa River Hatchery Dam, Neeley et al. (1994) believe that all salmon (chinook, coho, and sockeye) were blocked from reaching their spawning grounds in the Wallowa and its tributaries above the dam from at least 1904 through 1912. Therefore, all original salmon populations of the Wallowa and its tributaries above the dam were extirpated during this period.

5.8.2.2 Lower Snake River Compensation Plan Overview

In 1980, the first release of spring chinook under the LSRCP were made into the Grande Ronde River. For the LSRCP, Oregon's mitigation goal to areas above Lower Granite Dam includes 5,820 spring chinook from the Grande Ronde system (ODFW et al. 1990). The LSRCP assumed a smolt-to-adult survival of 0.65 percent for the Grande Ronde and therefore production of 900,000 smolts (the original Design Memorandum lists 898,000 smolts) was estimated to be sufficient to meet the adult return goal. The Northeast Oregon facilities currently operated for spring chinook under the LSRCP include: Lookingglass Hatchery on Lookingglass Creek and the ODFW LaGrande Fish Health Laboratory. Other programs held at Lookingglass Hatchery are explained in detail in Montgomery Watson (1999a).

Original plans for releases involved direct stream releases at Wildcat Creek (50,000), upper Wallowa tributaries (75,000), upper Wallowa River (50,000), upper Grande Ronde River (98,000), Catherine Creek (100,000) and acclimated releases at Big Canyon Creek (125,000) and Lookingglass Creek (400,000) (ODFW 1979).

5.8.2.3 Lower Snake River Compensation Plan Status Review

A recent status review was conducted for LSRCP hatcheries that summarized progress of the program to date. The following information was summarized from a review of the LSRCP Grande Ronde spring chinook salmon program (Carmichael et al. 1998a).

At the initiation of the LSRCP program in the late 1970s, population numbers of spring chinook in the Grande Ronde Subbasin were considered insufficient to develop an adequate broodstock program. Therefore, ODFW decided that importing hatchery stock from outside the basin was the only way to meet smolt production goals (Carmichael et al. 1998a).

Rapid River stock was originally chosen for broodstock development, and in 1980, smolts from Rapid River Hatchery (Idaho) were released into Lookingglass Creek (see Table 5-13). Use of Rapid River stock was discontinued from 1981-1984 however, due to disease concerns and lack of egg availability.

Carson stock (from the mid-Columbia River) was adopted as an interim broodstock source and releases were made into Lookingglass and Catherine creeks, and in later years into the upper Grande Ronde River and Deer Creek. The last year of Carson juvenile releases was 1991 (1989 brood-year) into Lookingglass Creek (Neeley et al. 1994).

Rapid River stock was reintroduced in Lookingglass Creek in 1987 (1985 brood-year). In 1987, Imnaha spring chinook smolts were released into Lookingglass Creek instead of the Imnaha drainage because the fish were infected with erythrocytic inclusion body syndrome

(EIBS). In 1990 (1988 brood-year), Rapid River releases were made into Catherine and Deer creeks, and Wallowa and upper Grande Ronde rivers in addition to Lookingglass Creek. Since 1991, releases of Rapid River stock have been confined to Lookingglass Creek; the program was terminated in 1998.

Beginning in 1994, adults returning from these releases were trapped and removed at Lower Granite Dam. The Nez Perce Tribe has been using these adults for supplementation efforts in the Clearwater and Salmon River Subbasins.

Table 5-13 History of Spring Chinook Salmon Broodstock Sources Used at Lookingglass Hatchery for the Grande Ronde River Subbasin

Brood Year	Source
1978	Rapid River
1980-1984	Carson/Willamette Hatchery
1985-1987	Carson/Lookingglass Hatchery/Idaho
1988	Rapid River/Idaho
1989	Carson/Lookingglass Hatchery Rapid River/Idaho
1990-1997	Rapid River/Lookingglass Hatchery
Source: Carmichael et al. 1998a.	

Outplants of spring chinook in the Wallowa River included adults from 1987 to 1990 and smolts in 1990 (1988 brood-year) (see Table 5-14). No releases were made directly into the Lostine River.

Table 5-14 Hatchery Releases of Spring Chinook into the Wallowa River by Stock, Brood year and Life Stage

Stock	Brood Year	Life Stage	Number
Lookingglass (Rapid River/Carson)	1987	Adult	394
Lookingglass (Rapid River/Carson)	1988	Adult	568
Lookingglass (Rapid River/Carson)	1989	Adult	88
Lookingglass (Rapid River/Carson)	1990	Adult	75
Rapid River	1988	Smolt	26,445
Source: Summarized from Neeley et al. 1994.			

The spring chinook program for the Grande Ronde Subbasin was never managed as designed in the original Design Memorandum program (Montgomery Watson 1999a). Most modifications were designed to improve smolt-to-adult survival (change in smolt size) and accommodate monitoring and evaluation studies (presmolt releases in the fall, smolt size comparisons). Fish were mainly released at Lookingglass Hatchery to secure broodstock and to reduce ecological interaction.

Low smolt-to-adult survival rates (well below the target 0.65 percent - Carmichael et al. 1998a) have resulted in insufficient numbers of returning adults to reestablish tribal or recreational fisheries. All sub-smolt release strategies showed poor survival, and the only successful release strategy was the yearling smolt release in the spring. Lookingglass Hatchery fish also strayed into the Lostine, Minam and Wenaha Rivers at high rates, and in some years, represented a large proportion of the natural spawners (Carmichael et al. 1998a, Neeley et al. 1994) (see Table 5-15).

Table 5-15 Percent of Hatchery-origin Carcasses Sampled in Grande Ronde River Spawning Areas by Site and Year

(Number of carcasses in parentheses)

Area	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1986-92 Pooled**
Minam	50% (14)	4% (5)	38% (8)	0% (7)	46% (13)	39% (13)	88% (41)	**58% (101)**
Wenaha	0% (2)	91% (23)	73% (40)	33% (3)	78% (9)	67% (15)	91 %(46)	**80% (138)**
Lostine	25% (12)	32% (25)	46% (44)	56% (16)	40% (10)	35% (20)	71% (24)	**45% (151)**
Hurricane		80% (10)	100% (8)	33% (9)	67% (3)	50% (4)	100% (2)	**69%(36)**
Bear	0% (2)			0% (1)	0% (1)	0% (1)	0% (3)	**0% (8)**
Prairie			67% (6)					**67%(6)**
Wallowa			100% (9)					**100%(9)**

Note: This analysis was performed using discriminate analysis of scale patterns that may be biased toward identifying scales of hatchery fish.

Source: Adapted from Neeley et al. 1994.

5.8.2.4 Refocus from Mitigation to Conservation

In 1995, co-managers made a decision to use native stock and shift the focus of the program from mitigation to conservation. This decision was a result of a number of factors including: increased emphasis on natural production and native stock recovery; consultations and requirements resulting from listing of Grande Ronde chinook populations as endangered; a lack of success in using non-local stocks for supplementing Grande Ronde chinook populations; preferred strategies for use of artificial propagation identified in the NMFS draft recovery plan; and recommendations of an Independent Scientific Panel (Currens et al. 1996), which was convened under the *U.S. v. Oregon* dispute resolution process. The program implemented is one of the first developed using an integrated, dual component approach (captive and conventional broodstock) to prevent extinction of anadromous salmonid species in the Columbia River Basin. This program is known as the Grande Ronde Endemic Spring Chinook Salmon Supplementation Program.

5.8.2.5 Grande Ronde Endemic Spring Chinook Salmon Supplementation Program

The GRESP was implemented as an emergency conservation measure to assist in preventing extinction and providing the potential for rebuilding of listed natural chinook salmon populations. Short-term objectives of the program are:

- Prevent extinction of spring chinook in three Grande Ronde tributaries,
- Provide a future basis to reverse the decline in stock abundance, and
- Ensure a high probability of population persistence.

The GRESP proposes to increase the survival of spring chinook salmon in the Grande Ronde River by increasing egg-to-smolt survival through hatchery incubation and rearing (80 percent survival as compared to 12 percent survival for natural origin fish). Co-managers targeted spawning aggregates of spring chinook in three tributaries, the Lostine and upper Grande Ronde rivers and Catherine Creek for active supplementation under the GRESP. The production goal for each tributary is currently 250,000 smolts to be made up of with two complimentary components: conventional and captive broodstock production.

The conventional broodstock component consists of the “traditional” adult-to-juvenile production program of collecting adults for gametes, mating, incubation and rearing of offspring until they are released as smolts. Collection of adult spring chinook occurs in the three tributaries listed above; adults selected for broodstock are currently transported to Lookingglass Hatchery where they are spawned. Currently, the gametes collected are transported to Oxbow and Irrigon hatcheries, where they are incubated and reared to the early rearing stage (approximately 200 fish/lb.) Fish are then transported back to Lookingglass Hatchery, where they are reared until just prior to the smolt stage, then transported back to their natal stream, acclimated for several weeks and released (see Figure 1-1).

The captive broodstock component consists of a juvenile-to-juvenile production program where juvenile chinook are collected from their natal streams, reared to adult in captivity, spawned, and their offspring are incubated, reared to smolt stage and released. Currently juveniles collected from the three tributaries are transported to Lookingglass Hatchery where they are reared to the smolt stage. They are then transported to either Bonneville Hatchery or Manchester Marine Laboratory for rearing to adult in freshwater (BH) or saltwater (MML) (see Figure 1-1). Upon reaching maturity, adults are spawned at Bonneville Hatchery. The original plan was to have resultant gametes incubated and reared at Lookingglass Hatchery, however, due to limited pathogen-free water and space these eggs are currently being shipped to Irrigon and Oxbow hatcheries for incubation and early rearing. When fish are approximately 200 fish/lb., they are transported back to Lookingglass Hatchery for rearing to smolt. Smolts produced are released in the natal stream of their parents following several weeks of acclimation.

Co-managers have attempted to design this program to use conventional and captive brood production to increase numbers of natural spawners at low levels of abundance and produce more of a balance between natural and hatchery production at higher levels of natural spawner abundance. The current target goal for the Lostine River is a minimum of 250 adults, below which demographic risk is of greater concern than potential genetic impacts from hatchery rearing. The program is designed to scale down the captive broodstock component as numbers of conventional and natural adults increase and shift captive smolt production to conventional production.

The conventional component of the GRESP was initiated on the Lostine River in 1997 with the collection of adult fish using a portable weir (see Section 4.2.2). A total of 27 adults were trapped and seven of these were retained for brood. Of these seven fish, four females and two males were spawned (one female died in captivity). Milt collected from two males released above the weir was also used to spawn, resulting in the spawning of a total of eight fish. A total of 12,080 eyed eggs were produced from the spawn (Ashe et al. 1998 in prep.). In 1998, one male and one female were retained for the conventional program. However, due to high mortality of spring chinook adults being held at Lookingglass Hatchery and escalating disease concerns in the juvenile populations at Lookingglass Hatchery, broodstock collection on the Lostine River was terminated for BY98 and the two previously collected adults were returned to the Lostine River to spawn naturally.

In March 1999, approximately 12,000 smolts resulting from the conventional BY97 spawn were transported to the juvenile acclimation and release facility on the Lostine River (see Section 3.4.2.1). These fish were released in April 1999.

The Lostine River captive broodstock component was implemented in 1995 with the first collection of juvenile spring chinook from the 1994 **cohort**. Approximately 500 juveniles have been collected every year since 1995 (see Table 5-16).

Table 5-16 Summary of Juveniles Collected for Captive Broodstock from the Lostine River

Collection Year	Cohort	Lostine
1995	1994	499
1996	1995	481
1997	1996	500
1998	1997	501

The first spawn of Lostine captive broodstock chinook occurred during the 1998 fall season. Production was approximately 30,000 smolts, which will be acclimated and released from the Lostine acclimation facility in spring 2000.

Chapter 6 Limiting Factors

In this chapter:

- Limiting Factors

Salmon experience human-caused mortality throughout their life cycle. Timber harvest, grazing, irrigation, road construction, dam construction, harvest, residential development, and all other activities requiring water use, or degradation of water quality, result in taking of salmon at various freshwater life history stages (Mundy 1996). The dredging and filling of the estuary, and mixed stock and mixed species harvest in the ocean can result in a take of salmon during their estuary and ocean life history stages. A synopsis of limiting factors in this chapter organizes impacts into four major categories (harvest, habitat, hydrosystem, and hatcheries). These factors have impacted spring chinook originating from the Imnaha and Grande Ronde rivers to the point where the populations are at demographic risk of extirpation.

The most recent data analysis by the Cumulative Risk Initiative (CRI) for Snake River spring/summer chinook salmon reveals that the condition of this ESU may be worse than was previously thought. It is now even less likely that breaching the four Lower Snake River dams alone would mitigate imminent risks faced by Snake River spring/summer chinook salmon. Additionally, there are no data to indicate that improvements in any of the other major categories could, by themselves, mitigate the **extinction risks** faced by the Snake river spring/summer chinook ESU (NMFS, in review).

6.1 Harvest

6.1.1 Ocean Harvest

Ocean harvest rates on upriver spring chinook are believed to have always been low, and the rate has been further reduced since the 1980s when restrictive ocean seasons and catch quotas were adopted (TAC 1997). The Columbia River Fish Management Plan was based on the premise that the ocean harvest of upriver-destined spring chinook south of the southwesterly projection of the United States-Canada boundary between British Columbia and Washington is minimal. This is supported by coded-wire tag recoveries, which indicate that relatively small numbers of Snake River spring chinook are landed in ocean sport and commercial fisheries (Mundy and Witty 1998). Imnaha and Grande Ronde spring chinook salmon have been landed from commercial and sport ocean fisheries in California and Washington based on CWT recoveries. However, the number of these fish captured in ocean fisheries is very small (Mundy and Witty 1998). Based on CWT and genetic stock identification (GSI) data, upriver spring chinook are impacted by ocean fisheries at a lower rate than any other Columbia River chinook race (TAC 1997). TAC concluded that the ocean harvest rate is probably less than 2 percent.

6.1.2 Columbia River Mainstem Harvest

6.1.2.1 Hydrosystem

Although the eight mainstem hydropower dams on the Snake and Columbia rivers are not normally associated with harvesting fish, they are responsible for a large portion of the adult mortality. NMFS (2000) estimates that interdam loss accounts for 50 percent of the mortality of returning natural origin Snake River spring chinook salmon. This “harvest” rate is used in determining the number of spring chinook salmon that will be allowed to be harvested incidentally in the mainstem tribal and sport fisheries (<10 percent). Impacts associated with the hydrosystem are discussed in more detail in Section 6.1.3.

6.1.2.2 Fisheries

Salmon destined for the Snake River Basin are not managed as individual stocks until they reach the mouth of the Snake River. Columbia River fisheries recognize and manage all Snake River Basin tributary runs as an aggregate. For example, under the recently completed biological assessment (CRITFC 1999) and biological opinion (NMFS 2000) discussing Columbia River fisheries, escapement objectives for Snake River Subbasin spring chinook were identified only for the aggregate of populations originating above Lower Granite Dam and not for populations of individual watersheds such as the Imnaha River. Run sizes and composition for the various Snake River Basin tributaries are discussed in a separate biological assessment.

Since 1994, tribal and non-tribal commercial fisheries targeting upriver spring chinook occurred only in 1977, although incidental catch does occur in winter fishery targeting sturgeon and steelhead (February 1 – March 21). Since 1993, incidental catch of upriver spring chinook salmon in these fisheries has averaged 11 salmon annually (CRITFC 1999). Incidental harvest of upriver spring chinook occurring in non-Indian lower river sport and commercial fisheries (Youngs Bay, Oregon and Deep River, Washington) were limited by the CRFMP to a combined rate of 4.1 percent and in no event was the harvest rate to exceed 5.0 percent. The 4.1 percent upriver chinook harvest limitation allowed mainstem harvest opportunities for lower river stocks that are timed somewhat earlier than upriver stocks in most years. From 1978-1996, the combined incidental harvest of upriver spring chinook in lower river fisheries averaged 2.4 percent of the upriver run; the 5 percent rate was exceeded twice, in 1988 (6.9 percent) and 1990 (5.4 percent) (TAC 1997).

Tribal and non-tribal commercial fisheries targeting upriver summer chinook salmon have been closed since 1965. Incidental harvest of summer chinook salmon was allowed to occur during shad and sockeye seasons until 1974 (ODFW and Washington Department of Fish and Wildlife 1989).

As described in the CRFMP, the Columbia River treaty tribes’ Ceremonial and Subsistence (C&S) harvest of adult upriver spring chinook salmon would not exceed 5.0 percent on runs of 25,000 to 50,000 fish, and would not exceed 7.0 percent on runs of 50,000 (TAC 1997). Since 1974, Treaty Indian commercial fisheries targeting spring chinook occurred only in 1977. From 1978-96, the total harvest averaged 5.9 percent of the upriver run (TAC 1997). The tribes enacted regulations closing all or portions of the spring C&S fishery in 1989 and from 1994-

1996. The *U.S. v. Oregon* Technical Advisory Committee (TAC) reported that, with the exception of 1997, the recent five-year (1994-98) average harvest rates for these fisheries have been 5.6 percent of spring chinook salmon (TAC 1998).

6.1.3 Harvest in the Imnaha River And Grande Ronde River Subbasins

Because so few fish return to these subbasins, harvest within either subbasin is not considered a limiting factor. Tribal harvest is not significant. Sport harvest of spring chinook has been prohibited in the Imnaha River since 1979 and in the Grande Ronde River since 1973 (see Sections 5.3.1 and 5.8.1).

With the limited ocean and inriver fisheries, upriver stocks were expected to show signs of rebuilding. However, even hatchery returns, which increased in the 1980s, are showing declines.

6.2 Hatcheries

Considerable concern has been expressed among the scientific community that hatchery fish negatively impact natural spawning populations due to adverse effects from genetic introgression, disease transmission, and competitive interactions. Most directly, the presence of hatchery fish in mixed-stock fisheries has led to harvest rates that result in overfishing of natural populations. The history of artificial propagation in the Columbia Basin and associated impacts are discussed in detail by Brannon et al. (1999). PATH (Plan for Analyzing and Testing Hypotheses) scientists have noted that the potential for negative interaction between naturally-produced fish and hatchery-reared fish during mainstem smolt migration is likely greater for listed Snake River stocks than for downstream stocks because of increased contact between fish during barging and dam passage (Mamorek et al. 1996).

In the last ten years, a considerable amount of effort has been directed at reviewing artificial production in the Columbia River Basin and developing recommendations and guidelines for technical and policy reform of hatcheries (NPPC 1999, IHOT 1995). NMFS has completed consultations covering all hatchery production in the Columbia Basin (NMFS 1999). As a result, hatchery management practices have been substantially revised (NMFS 2000). For example, many non-indigenous stocks are no longer used for broodstock, but are being transitioned to native stocks, rearing densities are being reduced, and size-at-release and release locations have been adjusted to decrease competitive interactions with natural populations.

In the *1999 Biological Opinion on Artificial Propagation in the Columbia River Basin*, NMFS (1999) concluded that artificial propagation programs in the Columbia River Basin as described by the action agencies are not likely to jeopardize the continued existence of listed Snake River spring/summer chinook salmon. In addition, PATH scientists have preliminarily concluded that, relative to the hydrosystem, artificial propagation of spring/summer chinook has not significantly contributed to declines in natural populations of spring/summer chinook in upstream areas (Mamorek et al. 1996).

Although uncertainties remain about the effectiveness of supplementation programs, those uncertainties have to be weighed against the risk of not taking any remedial action. NMFS (2000) determined it is reasonable to expect that the listed ESUs will benefit over time from improvements in artificial propagation and that carefully designed intervention programs will improve the future prospects for survival and recovery.

6.3 Mainstem Snake and Columbia River Hydrosystem/Habitat

Hydroelectric dams and reservoirs on the lower Snake and Columbia rivers are considered a primary factor in the decline of Snake River anadromous fish runs over the last 30 years (CBFWA 1991, NMFS 1995, ISG 1996). Wild spring chinook escapement trends in northeastern Oregon streams from 1952-1996 depicts relatively stable escapements from the mid-1950s to the early 1970s, then a sharp decline occurred soon after the completion of four additional mainstem dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite). During 1952-96, the aggregate of northeastern Oregon spring chinook habitat has not undergone any dramatic changes that account for, or coincide with, Snake River stock declines observed in the late 1970s (TAC 1997).

The system of hydropower dams on the Columbia and Snake rivers (known as the Federal Columbia River Power System or FCRPS) has greatly diminished the diversity of habitat once characteristic of this watershed. The dams severed the continuum of habitat, leaving very little riverine habitat left in the mainstem and isolating other types of habitat. Dams also altered flooding and draining patterns, which further reduced available habitat types and food webs in those habitats. Slack water reservoirs increase water temperatures, pollutant levels, travel time for migrating salmonids, and predator populations, and decrease habitat complexity. Two key consequences of this loss of habitat diversity have been a reduction in the biodiversity of native salmon stocks and the proliferation of non-native species (ISG 1996).

Direct mortality due to the hydroelectric system and associated operations is recognized as one of the most significant sources of mortality for anadromous fishes (Iwamoto et al. 1994, Mundy et al. 1994, ODFW et al. 1990, Quinn and Adams 1996, Raymond 1979). NMFS (2000) estimates that interdam loss accounts for 50 percent of the mortality of returning natural origin Snake River spring chinook salmon and 22 percent for summer chinook salmon. An estimated 15 percent adult mortality per dam was estimated by Chaney and Perry (1976), which would total 73 percent mortality for adults migrating above eight dams.

A recent evaluation of 25 years of juvenile survival studies found that an estimated 13-14 percent of emigrating smolts are lost at each lower Snake and Columbia River dam (Bickford and Skalski 2000). Additionally, mortality may be greater for wild smolts, may accumulate as additional dams are encountered, and may vary considerably by year and river section. NMFS (2000) believes that improvements in the hydrosystem (i.e., passage improvements at the dams) are increasing survival of migrating juveniles. For Snake River spring/summer chinook smolts migrating in river (not transported), the estimated survival through the hydrosystem is now 40-60 percent, compared to 20-40 percent in the 1970s (NMFS 2000). However, delayed mortality is believed to occur in the estuary and ocean as a result of cumulative effects of the hydroelectric system (Mundy et al. 1994, Mamorek et al. 1996).

Neither the current transport system nor present in-river migration conditions will provide recovery of Snake River spring/summer or fall chinook (BRWG 1994, NMFS 1995, STFA 1995a, STFA 1995b, ISG 1996). Improvements to the transportation system are also not likely to provide the survival rates necessary to recover Snake River spring/summer chinook (Mundy et al. 1994, Mamorek et al. 1996). The analysis of the survival and productivity of Snake River and lower Columbia River chinook stocks indicates Snake River spring/summer chinook survival goals can be achieved if a portion of the mainstem migration corridor is restored to a more natural or normative condition (Mamorek et al. 1996).

Critical decisions with respect to the future configuration and operation of the FCRPS and its impacts to the recovery of listed salmon stocks are due to be made in 2000 (see Table 1-3).

6.4 Habitat

6.4.1 Ocean/Estuary

Many events and actions in the Pacific Ocean and the Columbia River estuary may be having an adverse effect on the survival of salmon. Filling and dredging, and water quality impacts from large cities, such as Portland, Oregon may have decreased the ability of the estuary to support salmon smolts as they make the transition to salt water. An estimated 65 percent of tidal swamps and marshes in the Columbia River estuary have been lost due to diking and filling (NMFS in review).

A shift in ocean conditions over the past two decades, exacerbated by El Nino events, have impacted Columbia Basin salmon returns (NMFS 2000). Oceanic climate **regime shifts** and their effect on Pacific Northwest salmon populations are discussed at length by Anderson (1997). Studies detailing the cyclic changes in ocean conditions have been emerging since the early 1990s. Recent studies indicate the warm and cool regimes appear to persist over about two decades, therefore, it is reasonable to expect that ocean conditions are cyclic and will eventually improve (Anderson 1997). There is increasing evidence that a regime shift to favorable ocean conditions for Columbia River salmon has now occurred although confidence in that conclusion will come only after the associated weather patterns have been observed for several years (NMFS 2000).

Another factor affecting salmon is the concentration of predators in the estuary and ocean. Seals and sea lions have been targeted for over a century for preying on Columbia River salmon (Reed 1888) and more recently bird populations in the lower Columbia River have been identified as effective predators of salmon smolts. The world’s largest colony of Caspian terns and the two largest colonies of double-crested cormorants on the west coast of North America have recently become established in the Columbia estuary (NMFS 2000). Efforts are currently underway to relocate the bird populations and it is reasonable to expect these efforts will eventually reduce the bird predation (NMFS 2000).

6.4.2 Freshwater

This section on freshwater habitat contains a more extensive discussion than the other sections in this chapter for several reasons. The Imnaha and Grande Ronde River Subbasins are within the area that the Nez Perce Tribe has co-management jurisdiction over and the Tribe has been actively involved in on-the-ground habitat improvements in these areas. Freshwater habitat has been identified by the CRI as important in recovering Snake River spring/summer chinook and is an area that is more manageable than habitat for other life stages (i.e., ocean).

6.4.2.1 Imnaha River Subbasin

Approximately 75 percent of the watershed is under public ownership. Most of the Imnaha Subbasin is within the boundaries of the Hells Canyon National Recreational Area and was included in the Oregon Wild and Scenic Omnibus Bill. The area above Indian Crossing is within the boundaries of the Eagle Cap Wilderness (see Map 2).

Moderate levels of logging, road building, mining, farming, irrigation, ranching, recreation, and channelization have affected the Imnaha River Subbasin. Most of the habitat in the subbasin has remained unaltered since the mid-1950s (Carmichael and Boyce 1986b). Currently, spawning and rearing habitat is extremely underseeded, however, as escapement levels increase, rearing habitat would become more limiting.

Logging

Timber harvest along the mainstem of the Imnaha River has never been an extensive activity on national forest land. The area below RM 29.4 (Freezeout Creek) is classified as grassland. Timber exists along the riparian zone and in stringers along the ridges, and some timber removal has occurred in these stringers. From Freezeout Creek to the forest boundary, private land is forested and has seen a more extensive and intensive harvest history. Timber harvest has been more extensive on private and national forest land in the tributaries, such as Big Sheep and Little Sheep creeks.

Roads

Roads have historically been one of the leading causes of erosion and subsequent sedimentation in streams. There are three major roads in the subbasin. The Imnaha Highway (Highway 350) runs from the town of Joseph to the town of Imnaha. This is a state highway, is paved, and for most of its length runs along Little Sheep Creek as a draw bottom road. The main Imnaha River road runs from Cow Creek to Indian Crossing. From Cow Creek to Fence Creek the road is maintained by the U.S. Forest Service, is a native surface road, and sits high above the river for most of its length. Wallowa County maintains the road from Fence Creek to the downstream end of the Imnaha Rivers Woods community. The U.S. Forest Service maintains the road from the Imnaha River Woods to Indian Crossing, which is where the road ends. These road sections are gravel-surfaced and run along the Imnaha River. They are classified as draw bottom roads, but generally have a sufficient riparian buffer width to reduce channelization effects and sediment inputs.

The Wallowa Mountain Loop Road (Forest Service 39 road) is maintained by the county and the Forest Service on private and federal ownerships, respectively. This road leaves the Imnaha Highway approximately 8 miles from Joseph, runs up Little Sheep Creek to Salt Creek Summit and then descends to the Imnaha River along Gumboot Creek. The road is paved and is a draw bottom road for most of its length to this point. The road continues up the Imnaha for 2 miles and then goes up the Dry Creek drainage before entering Baker County on the way to Halfway, Oregon. A private native surface draw bottom road runs up Big Sheep Creek for approximately 11 miles. Other private and Forest Service native surface roads exist in the subbasin. The overall open and closed road density for the subbasin is less than 1.5 miles per square mile.

Mining

Mining for gold, copper, silver, and cinnabar occurred at various locations in the watershed but the operations were all small and short-lived. Some hobby mining still occurs.

Farming

Farming begin in the mid to late 1800s with settlement of the watershed by non-Indians. Crops have included hay, vegetables, and fruit from orchards. The major effects of these activities on in-stream habitat have been associated with channelization to protect cropland and infrastructure (homes, barns, etc.), sediment inputs, and irrigation withdrawals. Irrigation withdrawals on the Imnaha River mainstem are not significant, however, there is a 120 cfs water right on Big Sheep Creek, Little Sheep Creek, and all of the streams and seeps in-between that is transported to the Wallowa Valley for irrigation via the Wallowa Valley Improvement Canal.

Ranching

Settlers brought in large herds of sheep in the late 1800s and their effect can still be observed around seeps, springs, and some stream segments where the native fescue plant communities were removed. Sheep and cattle grazing pressure has been significantly reduced since the early 1900s and the last sheep allotment became vacant in 1998. Some feed lot operations are active along the river and creek bottoms.

Recreation

The Wilderness designation, Wild and Scenic designation, and the Hells Canyon National Recreation Area designation draw a variety of users to the Imnaha Subbasin. The major forms of recreation are sport fishing, sightseeing, bird watching, back country recreation, and snow sports, such as snowmobiling and cross country skiing. The rafting season is short. A number of developed campgrounds are available in the national forest. Most roads on the national forest are not plowed in the winter.

6.4.2.2. Habitat Conditions in the Imnaha River Mainstem in Relation to Salmon Life History Stage

This section describes limiting habitat factors and the impact to each life history stage for chinook salmon. Habitat ratings of excellent, good, fair, and poor are also given for each life history stage.

Adult Passage

There are no known passage barriers for the upstream migration of spring chinook although the high gradient reach above the Blue Hole may limit passage in some years. However, warm water temperatures during the summer were identified as a potential concern by Wallowa County and Nez Perce Tribe (1993) and Huntington (1993), and the lower portion of the Imnaha River is listed on the Oregon Department of Environmental Quality's 303d list for summer temperatures. Mobrand and Lestelle (1997) indicated a slight increase in temperatures from historic levels in the lower river corridor (below Freezeout Creek, RM 29.4) during August and September. Increased temperatures may increase the stress on migrating fish but will not stop their migration. Table 6-1 shows seven-day moving maximum stream temperatures for three areas of the Imnaha River.

Early season migration is rated as excellent and late season migration conditions are rated as fair to good.

Table 6-1 Seven-day Moving Maximum Stream Temperatures (^{0}F) in the Imnaha River

Site	Year	May	June	July	Aug	Sept	Oct
Lower Imnaha Watershed							
Imnaha @ Marr Ranch @ RM 14.3	1991	55	69	n/a	67	71	55
Upper Imnaha Watershed							
Imnaha @ 9 Point Creek	1993	n/a	n/a	57	62	60	55
	1994	n/a	n/a	71	72	64	58
	1996	n/a	n/a	60	62	61	55
Imnaha @ Indian Crossing	1994	n/a	n/a	63	63	56	n/a
	1995	n/a	n/a	54	56	54	47
	1996	n/a	n/a	56	57	55	49
	1997	n/a	n/a	n/a	56	55	50
Source: USFS 1998.							

Spawning and Incubation

Mobrand and Lestelle (1997) documented that the greatest reduction in the quantity of key habitat for spawning and egg incubation stages is due to losses in gravels of a size suitable for spring chinook spawning. Causes of the loss are mainly due to the removal of in-channel structure and some bank hardening (Mobrand and Lestelle 1997). The loss of in-channel structure can be attributed to the in-stream wood removal practices of the 1960s and 1970s and the Forest Service's practice in the 1980s of removing trees from the river as a "safety issue" for campers. In the late 1980s, the District Biologist for ODFW worked out an agreement with the

USFS to pull five trees per year (including root wads) for five years into the Imnaha River. These were bug-killed Englemann Spruce and they were cabled in place. Englemann Spruce continued to fall into the river and by the mid 1990s the Imnaha had gone from a wood deficient stream to a stream approaching sufficiency upstream from the national forest boundary, with gravel bars beginning to form behind log jams.

Sedimentation in this reach has also been identified as a minor concern (Wallowa County and NPT 1993). Sedimentation is attributed to a mass wasting event in the North Fork and from a forest fire in the Eagle Cap Wilderness Area.

Spawning and incubation conditions are rated as good to excellent.

Colonization and Summer Rearing

Fry colonization generally occurs close to the point of emergence and, to be successful, requires complex fringe habitat to provide hiding cover. This fringe habitat can consist of large size substrate, undercut banks, and woody debris.

Mobrand and Lestelle (1997) reported that the capability for supporting spring chinook productivity (survival) has been reduced for fry colonization and summer rearing life stages. Slightly elevated water temperatures, a small loss in habitat diversity, increased sediment, and increased channel instability are the main causes of the reduction in survival conditions (Mobrand and Lestelle 1997, Wallowa County/NPT 1993, and Huntington 1993). However, these are not considered major limiting factors on fish production.

Colonization and summer rearing is rated as good to excellent.

Fall Redistribution and Overwintering

Fall redistribution occurs when temperatures begin dropping. Gaumer (1968) reported that juvenile migration was extensive in October and November in the lower river. Movement in the upper Imnaha was also extensive in October and November, and in the lower river continued well into December (Cleary 1998 in prep., 1999, in prep.). Both Cleary (1998, in prep., 1999, in prep.) and Gaumer (1968) concluded that a portion of Imnaha fish overwinter in the Snake River. Winter temperatures and harsh conditions may reduce survival in the upper watershed.

Fall redistribution and overwintering conditions are good to excellent in the lower Imnaha and fair to good in the upper Imnaha (temperature related).

Smolt Migration

There are no known conditions that would limit smolt migration, although late migrating wild smolts would experience somewhat elevated temperatures in the lower Inmaha.

Smolt outmigrations conditions are rated as excellent in the early part of the migration and good in the latter part of the migration.

6.4.2.3 Habitat Conditions in the Big Sheep Creek in relation to Salmon Life History Stage

Adult Passage

Chinook salmon migrate 33 miles upstream from the mouth. The only known physical passage barrier is increased gradient at RM 33, although high summer temperatures and reduced flows may limit passage in August and September. Summer temperatures, flows and sediment loads were noted as issues by Wallowa County and NPT (1993), Huntington (1993), and Mobrand and Lestelle (1997). Big Sheep Creek is also listed on ODEQ's 303d list (ODEQ 1998) for temperature and habitat modification from the mouth to Owl Creek (RM 27.7). The USFS Section 7 Biological Assessment (USFS 1994) lists sediment, temperatures, pools, and flows as potential limiting factors. They rated these factors as fair within chinook habitat. Table 6-2 shows seven-day moving maximum stream temperatures just upstream of the confluence with Little Sheep Creek in 1999. Table 6-3 contains data collected near the mouth of Big Sheep Creek (RM 0.5) during 1965-1966. Both sets of data indicate summer water temperature problems in the lower reaches of Big Sheep Creek. However, data collected in the 1960s does indicate that minimum monthly temperatures during June, July, and August may provide windows of opportunity for migration during these months.

Early season migration conditions are rated as excellent and late season migration conditions are rated as fair to poor (based on temperatures and possible flow concerns).

Table 6-2 Maximum Seven-day Moving Average Stream Temperatures (^{0}F) in Big Sheep Creek by Month

Site	**Year**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
Just above the confluence with Little Sheep Creek (RM 3.3)	1999	N/A	N/A	72.84	73.01	64.76	55.61
Source: Wallowa Soil and Water Conservation District, unpublished.							

<u>Spawning and Incubation</u>

Spawning ground surveys are conducted from Coyote Creek to the 39 Road bridge (RM 20.4 to RM 33.4), a distance of 13 miles, but the major concentration occurs from Echo Canyon to the bridge (RM 29.4 to RM 33.4), a distance of 4 miles. Water temperatures in the lower spawning reach, channel stability, flows, and sediment delivery are all listed as issues by Wallowa County/NPT (1993), Huntington (1993), and Mobrand and Lestelle (1997). Fine sediment delivery increased after the 1989 Canal Fire. The USFS (1994) concluded that existing conditions for salmon spawning and incubation were fair. They determined that sediment, large wood, pools, peak stream flows, temperature, and bank stability were not limiting production at present population levels. Low summer flows, temperature, and shade/canopy cover may limit chinook production.

Spawning and incubation conditions are rated as fair to excellent in the upper watershed above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek.

Table 6-3 Maximum and Minimum Temperature and Flow Data near the Mouth of Big Sheep Creek (RM 0.5), 1965 – 1966

Month/Yr.	**Temperature (^{0}F)**		**Stream flows (cfs)**	
	Maximum	**Minimum**	**Maximum**	**Minimum**
8/65	77	47	N/A	N/A
9/65	68	40	N/A	N/A
10/65	64	41	48	38
11/65	52	39	48	38
12/65	41	32	28	28
1/66	39	32	48	28
2/66	44	32	28	28
3/66	54	32	262	38
4/66	59	34	302	232
5/66	66	39	292	212
6/66	74	42	250	87
7/66	76	51	83	35
8/66	77	53	42	19
Source: Gaumer 1968.				

Colonization and Summer Rearing

Mobrand and Lestelle (1997) reported that the capability for supporting spring chinook productivity (survival) has been reduced for fry colonization and summer rearing life stages. They listed habitat diversity and temperature as issues from the mouth to RM 24 and predators, competitors, flow, and sediment load from the mouth to RM 36. The U.S. Forest Service listed water temperatures as possibly limiting rearing habitat (USFS 1994). Blowdown from the bug killed Englemann Spruce and the Canal Fire has increased large wood in the stream, thereby increasing habitat complexity and the number of pools.

Colonization and summer rearing conditions are rated as good to excellent above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek.

<u>Fall Redistribution and Overwintering</u>

Blowdown of bug and fire killed trees has increased the complexity of habitat structure within the spawning reach, although some of the lower reach has been more impacted by land use practices and the Big Sheep Creek Road. The extent of overwintering is unknown, but earlier data indicate that a large portion of fish migration occurs during the fall (Gaumer 1968).

Fall redistribution and overwintering conditions are fair to excellent from the 39 Road bridge to the mouth.

Smolt Migration

Peak spring movement occurs in March and April similar to the timing of emigration in the mainstem Imnaha River (Gaumer 1968). There are no known conditions that would limit smolt migration, although late migrating smolts would experience somewhat elevated temperatures in lower Big Sheep Creek and the lower Inmaha River.

Smolt outmigration conditions are rated as excellent in the early part of the migration and good in the latter part of the migration.

6.4.2.4 Habitat Conditions in Lick Creek in Relation to Salmon Life History Stage

Adult Passage

Chinook salmon migrate at least 4.3 miles upstream from the mouth. The only known physical passage barrier is reduced flows in the braided channel above RM 4.3. Neither Huntington (1993) nor Mobrand and Lestelle (1997) list information on Lick Creek. Lick Creek is not listed on ODEQ’s 303d list (ODEQ 1998) for chinook, but is listed for summer temperatures from the mouth to RM 5 for bull trout. Hiding cover in the first mile is excellent due to blowdown from bug killed Engelmann Spruce and trees killed by the Canal Fire. Scour pools are abundant. The only area of concern is the meadow below the Lick Creek Guard Station where the only cover is provided by undercut banks. Table 6.4 shows maximum and minimum stream temperatures just above the confluence with Big Sheep Creek.

Adult migration conditions are rated as excellent.

Table 6-4 Temperature Data Collected at the Mouth of Lick Creek, 1992

Month	Temperatures ^{0}F	
	Maximum	Minimum
May	58	42
June	69	40
July	65	48
August	68	40
September	57	37

Source: USFS 1992.

Spawning and Incubation

Spawning ground surveys are conducted from the mouth to 0.3 miles above the 39 Road, a distance of 4.3 miles, but the major concentration occurs in the upper 2.3 miles. Following the Hankin and Reeves habitat survey in 1991, the USFS (1991) concluded that "fish reproduction in Lick Creek does not appear to be hampered by **cobble** embeddedness or the availability of appropriately sized spawning substrate." Channel stability in the meadow below the Lick Creek Guard Station is a concern because chinook spawn in this area. Sloughing banks are frequent, with the associated sediment input.

Spawning and incubation conditions are rated as good to excellent.

Colonization and Summer Rearing

Adequate fringe habitat is available except in the meadow below the Lick Creek Guard Station. As chinook populations increase, this area may be a concern. Juveniles would have to move from the redd area to find suitable cover.

Rearing habitat is not limiting. Blowdown of bug killed Englemann Spruce and the Canal Fire has increased large wood, thereby increasing habitat complexity and the number of pools. The USFS (1991) concluded in their habitat report that "Most limitation to the anadromous fish population is very likely due to out-of-system migration problems."

Colonization and summer rearing conditions are rated as good to excellent.

Fall Redistribution and Overwintering

No data exists relating to fall migration or overwinter rearing. It is expected that the Lick Creek chinook would exhibit similar migration and overwintering characteristics as the fish in rearing in Big Sheep Creek. The USFS (1991) concluded in their habitat report that "Additionally, the inherent low water temperatures of Lick Creek cause low growth rates for approximately 10 months of the year." An unknown percent of Lick Creek fish overwinter in Big Sheep Creek and the Imnaha River.

Fall redistribution and overwintering conditions are fair to excellent in Lick Creek.

Smolt Migration

No known conditions would limit smolt migration, although late migrating smolts would experience somewhat elevated temperatures in lower Big Sheep Creek and the lower Inmaha.

Smolt outmigration conditions are rated as excellent in the early part of the migration and good in the latter part of the migration.

6.4.2.5 Lostine River Watershed

Greater than 75 percent of the watershed is under public ownership, 74 percent of which is national forest. All of the Lostine watershed on U. S. Forest land is included in the Eagle Cap Wilderness except for a narrow band along the river running from the Forest boundary to the East Fork (see Map 5). The Lostine River was also included in the Oregon Wild and Scenic Omnibus Bill, however, the designation only included U.S. Forest managed lands.

Logging

Logging, road building, mining, ranching, farming, and channelization have affected the Lostine River watershed. Carmichael and Boyce (1986a) estimated that the adult and smolt production capacity in the Lostine River has been reduced 20 percent since the late 1950s due to habitat modifications. Currently, spawning and rearing habitat is extremely underseeded, however, as escapement levels increase, rearing habitat will become more limiting.

Timber Harvest

Timber harvest has never been an extensive activity on national forest land. Approximately 50 percent of private land is forested and has seen a more extensive and intensive harvest history.

Roads

Much of the main Lostine River road is classified as a draw bottom road but generally has a sufficient riparian buffer width to reduce channelization effects and sediment inputs. The overall open and closed road density for the watershed is 1.21 miles per square mile.

Mining

Mining for gold, copper, molybdenum, and tungsten occurred in the southwestern portion of the watershed but none of the prospects have been active since the 1930s and were never extensive. In-stream gravel mining was discontinued in 1998.

Ranching

Settlers brought in large herds of sheep in the late 1800s and their effect can still be observed around seeps, springs, and some stream segments where the native fescue plant communities were removed. Sheep and cattle grazing pressure has been significantly reduced since the early 1900s and the only allotment left on national forest land has been vacant since 1990.

Farming

Farming begin in the mid-to late-1800s with settlement of the watershed by non-Indians. Crops and products have included wheat, hay, hogs, dairies, and seed potatoes. The major effects of these activities on instream habitat have been associated with channelization to protect cropland and infrastructure (homes, barns, etc.), sediment inputs, and irrigation withdrawals.

Recreation

The Wilderness designation and the Wild and Scenic designation draw a variety of users to the Lostine River. The major forms of recreation are sport fishing, sightseeing, bird watching, back country recreation, and snow sports, such as snowmobiling and cross country skiing. A number of developed campgrounds are available in the national forest. Most roads on the national forest are not plowed in the winter.

6.4.2.6 Habitat Conditions in the Lostine River in Relation to Salmon Life History Stage

Adult Passage

Irrigation diversions, when coupled with normal low flows, produce conditions in the lower river that are not conducive to a portion of the adult upstream migration. There are two areas within this reach that experience low to extreme low flows from mid-July to the end of the irrigation season (September 30). The area from the Clearwater Diversion (see Figure 6-1 and

Table 6-5) to the mouth frequently experiences low flows (see Tables 6-6 and 6-7). These low flows exacerbate water temperature problems and make upstream migration difficult for adults. Harbeck (1998) found that low flows in 1998 prevented upstream movement of salmon after mid-July, and that salmon moved upstream only when a rain event caused a small freshet (see Figure 5-4). The area from the Miles Ditch to the Poley Allen Ditch (Figure 6-1) is nearly de-watered during the same time period (Tables 6-6 and 6-7), preventing the upstream migration of late running adults. The instream Flow Incremental Methodology (IFIM) study predicted that flows below 40 cfs would block the upstream migration of chinook through this lower reach (R2 Resource Consultants 1998). The same IFIM study noted, however, that natural low flows can be as low as 26 cfs through this reach during August and September. Channel modifications for flood control have widened the river channel thereby increasing the flows needed to provide adult passage. The Sheep Ridge diversion structure (Figure 6-1) is not presently a problem because flows lower in the system block adult passage. If flows are improved, however, this structure will need to be modified.

The Lostine River from the mouth to the Westside Ditch is listed for flow, habitat modification, and sedimentation on ODEQ’s 303d list (ODEQ 1998). From the mouth to RM 10, irrigation withdrawals, low flows, summer water temperatures, nutrient loading, lack of woody debris, and excess fine sediments are identified as high priorities by the Wallowa County/NPT (1993). This is consistent with findings of Mobrand and Lestelle (1997), which identified habitat diversity, summer water temperatures, water withdrawals, and low flows in the lower ten miles of the river as changes from the template condition that could affect adult survival.

Bonneville Power Administration has contracted with Harza Engineering to conduct an analysis of the flow issues and to develop a plan, working with the local landowners, to improve flows in the Lostine River. After the 1996 flood, pool habitat has improved significantly below the Highway 82 bridge. Landowners are allowing the Lostine River some freedom of movement and large scour pools have developed in relation to downed cottonwoods.

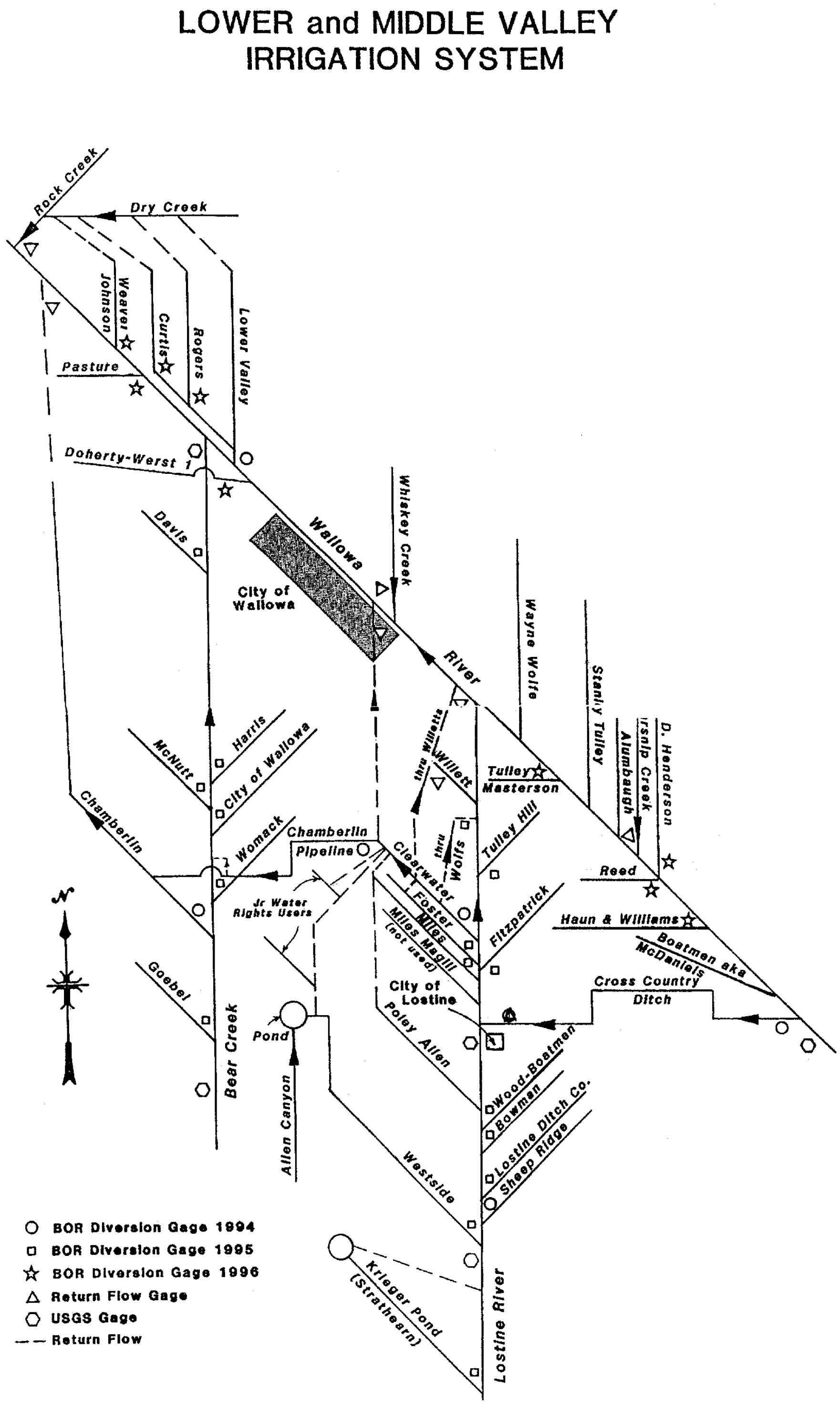
Early season migration conditions are rated as excellent and late season migration conditions are rated as poor to fair.

Spawning and Incubation

The major concentration of spawning occurs from RM 10 to RM 13 but ranges from RM 1 to RM 22.5. No problems are listed from RM 10 to RM 22.5 although gravel quarrying was allowed until recently at RM 11. Late run fish are forced to spawn in the lower four miles due to lack of flows with gravel concentrations occurring mainly at RM 1. Gravel quarrying was allowed in the lower ten miles of the river but has been discontinued. Fine sediments may be a problem for incubation below the Cross Country Canal (see Figure 6-1). A complicating factor in the lower portion of this reach is that Wallowa River water is transported by the Cross Country Canal to the Lostine River just above the Highway 82 bridge. The Clearwater Ditch then removes most of the added water just below the Highway 82 bridge. The Wallowa River generally carries a large sediment and nutrient load.

Spawning and incubation conditions are rated as good to excellent in the area from RM 10 to RM 22.5 and fair to poor from the mouth to RM 10.

Figure 6-1 Map of Irrigation Withdrawals from the Wallowa Valley Irrigation System including the Lostine River



Source: Neeley et al. 1994.

Table 6-5 Lostine River Ditches (see Figure 6-1)

Diversion Screen Number	Diversion Name
214	Strathearn Pond Ditch
8	Westside Ditch
17	Sheep Ridge Ditch
7	Lostine Ditch company Ditch
2	Bowman Ditch
1	Wood Boatman Ditch
47	Poley Allen Ditch
28	Miles Magill Ditch
27	Miles Ditch
50	Fitzpatrick Ditch
49	Fowler Ditch
32	Clearwater Ditch
36	Tulley Hill Ditch
40	Gary Willet Ditch

Colonization and Summer Rearing

Mobrand and Lestelle (1997) reported that the capability for supporting spring chinook productivity (survival) has been reduced for fry colonization and summer rearing life stages. Elevated water temperatures, a loss in habitat diversity, increased sediment, irrigation return flows, nutrients, and increased channel instability are the main causes of the reduction in survival conditions (Mobrand and Lestelle 1997, Wallowa County 1993, and Huntington 1993, Bryson 1995). These are not considered to be major problems above RM 10 except in localized areas of rip rapped banks but could substantially reduce colonization and summer rearing success in the lower ten miles. In addition, the sharp decline in returning adults has likely impacted available nutrients and probably reduced aquatic invertebrate productivity and, therefore, capacity for summer rearing.

Colonization and summer rearing conditions are rated as good to excellent from RM 10 to RM 22.5 and fair to poor in the lower ten miles.

Table 6-6 Average Flow Data at Three Gauge Sites on the Lostine River, 1995-1999

Values are in cubic feet per second (cfs)

Year/ Location	**Month**				
	May	**June**	**July**	**August**	**September**
1995					
RM 10.0	415	836	611	116	53.1
RM 5.4	N/A	N/A	N/A	62.5	16.7
RM 1.3	N/A	894	535	32.0	23.1
1996					
RM 10.0	423	878	617	128	61.6
RM 5.4	313	693	478	75.7	23.0
RM 1.3	484	839	507	66.3	31.3
1997					
RM 10.0	669	1053	538	123	62.6
RM 5.4	533	1000	523	84.1	37.3
RM 1.3	586	887	461	64.2	80.9
1998					
RM 10.0	516	622	427	74.8	54.7
RM 5.4	494	597	363	32.7	26.8
RM 1.3	467	518	282	42.4	39.3
1999					
RM 10.0	390	927	519	144	53.7
RM 5.4	392	911	784	149	18.0
RM 1.3	318	805	426	107	31.1
Data from: USGS Water Resource Data, Oregon, Water Years 1995 – 1998 and USGS 1999 data.					

Table 6-7 Minimum Flows at Three Gauge Sites on the Lostine River, 1995-1999

Values are in cubic feet per second (cfs)

Year/ Location	Month				
	May	June	July	August	September
1995					
RM 10.0	132	426	190	65	47
RM 5.4	N/A	N/A	N/A	29	11
RM 1.3	N/A	425	67	7.4	11
1996					
RM 10.0	158	449	280	78	50
RM 5.4	156	284	170	40	14
RM 1.3	132	283	160	57	9.6
1997					
RM 10.0	215	591	255	65	52
RM 5.4	218	490	200	33	26
RM 1.3	259	444	141	15	36
1998					
RM 1.0	291	460	148	45	43
RM 5.4	212	408	59	8.0	7.6
RM 1.3	250	388	18	11	8.7
1999					
RM 10.0	147	416	270	79	44
RM 5.4	107	400	350	33	9.5
RM 1.3	99	350	187	53	17
Data from: USGS Water Resource Data, Oregon, Water Years 1995 – 1998 and USGS 1999 data.					

Fall Redistribution and Overwintering

Mobrand and Lestelle (1997) listed habitat diversity throughout the range of salmon distribution and winter temperatures above RM 13 as possible limiting factors. Side channels are minimal on private land due to channelization to protect infrastructure from flood damage. There are, however, some off-stream ponds that have been improved for overwinter habitat. Habitat diversity and cover have improved significantly below the Highway 82 bridge. It is expected that movements in the Lostine River would be similar to what is found in the Imnaha River with some of the juveniles overwintering in the Wallowa River.

Fall redistribution and overwintering conditions are rated as fair to good.

Smolt Migration

Smolt emigration is similar in timing to the Imnaha River (Jonasson et al. 1997). There are no known conditions that would limit smolt migration, although late migrating smolts would experience somewhat elevated temperatures in the lower Lostine.

Smolt outmigration conditions are rated as excellent in the early part of the migration and good in the latter part of the migration.

6.4.2.7 Habitat Studies, Assessments and Planning Efforts

In 1992, the Wallowa County Court and the NPT established a public ad hoc committee to develop an assessment of habitat conditions within the county as they related to chinook. The result of this 18-month effort was the Wallowa County and Nez Perce Tribe Salmon Habitat Recovery Plan (Wallowa County and NPT 1993). The plan identified and analyzed water quantity and quality problems, stream structure, substrate, and habitat requirements. Problems were identified and solutions were recommended for each watershed within Wallowa County known to have chinook.

Under the framework of the County/Tribe Plan individual watershed action plans or Comprehensive Resource Management Plans were to be developed for individual watersheds that would include site-specific analysis, project development, and implementation. The Salmon Plan was also incorporated into the Wallowa County Land Use Plan. In addition, a Memorandum of Understanding was developed between Wallowa County, the Nez Perce Tribe and the U.S. Forest Service that stated the Salmon Plan would be implemented on Forest Service lands within Wallowa County (Resolution 95-014 of the Wallowa County Court).

In April 1992, the Grande Ronde Basin was accepted by the Northwest Power Planning Council as a Model Watershed project in Oregon. The area covered by the Model Watershed project included the Imnaha Subbasin and all tributaries in Wallowa County that drain directly into the Snake River, a total combined area of 5,265 square miles. The Salmon Plan was incorporated into the Grande Ronde Model Watershed Operations-Action Plan. The Grande Ronde Model Watershed Program (GRMWP) is funded by BPA through the FWP. The purpose of the GRMWP is to provide coordination for the many local, state, tribal, and federal habitat improvement activities occurring in Wallowa and Union counties as well as a funding avenue for new projects. More information on the GRWMP can be found in GRMWP (1994) and the FY 2000 funding proposal.

Efforts to improve habitat conditions in the Imnaha and Lostine rivers are being conducted through and by many entities (Table 6-8).

Table 6-8 Entities Involved in Habitat Improvements in the Imnaha and Grande Ronde Rivers

Wallowa County Court	Nez Perce Tribe
Wallowa-Whitman National Forest	Wallowa Public Works
Wallowa Soil and Water Conservation District	Oregon Department of Fish and Wildlife
Wallowa County Extension Service	Oregon Department of Forestry
Natural Resource Conservation Service	Bureau of Reclamation
Bonneville Power Administration	Oregon Watershed Enhancement Board
Wallowa Resources	Private Foundations
Bureau of Land Management	Private Land Owners

Studies and assessments focused on both watersheds:

- The USFS and ODFW conducted stream surveys using Hankin and Reeves protocols in 1991-1993 (unpublished data).
- Stream and Riparian Conditions in the Grande Ronde Basin (Huntington, 1993). This study was contracted by the Grande Ronde Model Watershed Program in preparation for developing their Operation/Action Plan.
- The Application of the Ecosystem Diagnosis and Treatment Method to the Grande Ronde Model Watershed Project (Mobrand and Lestelle 1997).
- DEQ's 1994/1996 303d List of **Water Quality Limited** Waterbodies (ODEQ 1996).
- Annual Monitoring and Evaluation Reports for the Forest Plan (USFS).

Lostine River

- Flow study. All irrigation diversions are gauged, with the irrigators cooperation and the long term USGS gauge was reestablished along with the installation of two additional mainstem gauges (see Figure 6-1). This effort was initially funded by the Bureau of Reclamation (USBR), but is now funded cooperatively by the Oregon Watershed Enhancement Board, BPA, and the irrigators.
- Lostine River Instream Flow Study (R2 Resource 1997). BPA and USBR contracted with R2 Resource Consultants to conduct an instream flow study using the Instream Flow Incremental Methodology.
- Lostine River Assessment (Bryson 1995c, unpublished).
- Lostine River Section 7 Watershed, Assessment of Ongoing Activities – Final Report (USFS 1994)

Imnaha River

- Upper Imnaha River and Lower Imnaha River Watershed Analysis (USFS 1998).
- Biological Evaluation, ESA Section 7 Consultation (BLM 1993)

Planning efforts focused on both watersheds:

- Eagle Cap Wilderness Plan (completed).
- Wallowa-Whitman National Forest Land and Resource Management Plan (USFS 1990)
- The Wallowa County/Nez Perce Tribe Salmon Habitat Recovery Plan (Wallowa County 1992).
- Grande Ronde Model Watershed Program Operations/Action Plan (GRMWP 1994)
- Senate Bill 1010 Plan (initiated in December 1999 – ongoing). The Senate Bill 1010 planning effort is being led by the Oregon Department of Agriculture and will address non-point source pollution coming from the agricultural practices.
- Total Maximum Daily Load (TMDL) Plan (the planning effort will be initiated in Wallowa County in the summer of 2000). The TMDL planning effort, led by the Oregon Department of Environmental Quality, will cover point source pollution.

Lostine River

- Lostine River Wild and Scenic River Management Plan (USFS 1993).
- Grande Ronde River Subbasin Salmon and Steelhead Production Plan (NPPC 1990)
- Comprehensive Salmon Passage Improvement Plan (ongoing). BPA has contracted with Harza Engineering Company to develop a comprehensive plan to improve passage for adult spring chinook. The plan is to be completed by the fall of 2000.

Imnaha River

- Hells Canyon National Recreational Area Final Environmental Impact Statement and Comprehensive Management Plan (USFS 1981). This plan is in the process of being revised.
- Imnaha River Wild and Scenic River Management Plan (USFS 1993). This plan was developed by the U.S. Forest Service and a local public ad hoc committee.
- Imnaha River Subbasin Salmon and Steelhead Production Plan (NPPC 1990)

Big and Little Sheep creeks, tributaries to the Imnaha River

- Big Sheep Creek Habitat Assessment (Bryson 1998)
- Comprehensive Resource Management Plan for Big Sheep Creek (NRCS 1995)
- Comprehensive Resource Management Plan for Little Sheep Creek (NRCS 1996)

6.4.2.8 Habitat Improvement Projects

Habitat improvement projects that have been implemented in the Imnaha and Lostine rivers since 1992 are listed in Tables 6-9 and 6-10. There have also been other projects accomplished by private landowners using private funds that are not listed in Tables 6-9 and 6-10.

Habitat improvement projects fall into several general categories and are all expected to improve fish and wildlife habitat while providing some benefit to the landowner. Landowner cost share is a part of all of these projects

Road projects generally fall into these categories: improving drainage, improving the road surface, moving roads out of draw bottoms or highly unstable locations and closing or obliterating the old road, or closing roads during certain seasons such as during the spring thaw.

Livestock projects generally fall into the categories of: riparian exclusion or pasture fencing, development of off-stream water, cross fencing to improve distribution, development of grazing plans (required for all fencing projects), and moving feeding operations off of streams and ditches.

Irrigation projects are designed to improve distribution and use efficiencies or to improve fish passage. Passage projects in the Lostine River have replaced annual push-up dams that frequently had inadequate fish passage with permanent structures with built- in fish passage. Many farms have converted from flood irrigation to sprinkler irrigation. Water delivery improvements have involved lining ditches or piping the water. All of the water delivery and water application projects are expected to result in additional water being left instream.

Habitat projects occur from the riparian zone to the uplands. These projects can involve grassland and timberland improvement, riparian planting, instream structure improvement (e.g., large woody debris placement), bank stability projects that involve bio-engineering solutions whenever practicable, and moving campgrounds, trails, or parking facilities away from rivers and streams where resource damage is apparent.

A coordinated monitoring program is being developed in Wallowa County to monitor the results of these projects on a watershed and subbasin level. The results from this monitoring program, coupled with project specific monitoring required for each project, will provide the data needed to practice adaptive management. Not all projects work as designed and better techniques are constantly being developed.

Table 6-9 Habitat Improvement Projects in the Imnaha River Subbasin

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
Aspen by Hart Butte Lookout Riparian Enhancement	Wetland/riparian exclosure	Wetland in Needham Creek subwatershed	USFS	USFS	$1250
Big Sheep Creek Riparian Enhancement	Streambank rock structures and riparian/upland exclosure fencing	Big Sheep Creek at confluence with Little Sheep	OWHP	GWEB	$5,500
Big Sheep Creek Riparian Enhancement	Riparian planting	Big Sheep Creek & small portion of Lick Creek	USFS	USFS	$12,000
Big Sheep Creek Riparian Fence	Riparian exclosure fencing and planting	Lower Big Sheep Creek above Confluence with Little Sheep Creek	NRCS/SWCD	NRCS OWHP Private landowners	$4,950 $3,350 $1,750 $10,050
Big Sheep Riparian Fence- Buhler	Riparian exclosure fence	Lower end of Big Sheep Creek, RM 4-6	NRCS/SWCD	GWEB Private landowners	$11,000 $5,840 $16,840
Big Sheep Riparian Fence and Revegetation – Suarez	Riparian pasture fencing	Big Sheep Creek	SWCD	OWHP Private landowners	$3,274 $6,756 $10,029
Big Sheep Riparian Pasture Fencing & Trough Replacement	Riparian pasture fencing	Big Sheep Creek	SWCD	OWHP Private landowners	$21,186 $8,946 $30,132
Divide Riparian Pasture Fencing	Riparian pasture fencing w/cattleguard	Big Sheep Creek, RM 26-36, Lick Creek, RM 0-4	USFS	OWHP Permittee USFS	$8,000 $1,550 $12,190 $21,740
Gumboot Creek In-Stream Rehabilitation	Rehabilitate stream habitat altered in 1997 flood, instream placement of large woody debris, boulders, log weirs & floodplain restoration	Gumboot Creek	USFS	USFS	$32,900
Imnaha Riparian Fence-	Riparian exclosure fence	Imnaha River	NRCS/SWCD	FCS Private landowners	$14,821 $4,940 $19,761
Imnaha River Riparian Enhancement	Large woody material	Imnaha River	USFS	USFS	$8,000
Lightning Creek Road – Phase I	Relocate road out of creek bottom and construct stream crossing fords along Lightning Creek	Lightning Creek Road	NPT	NPT ODFW Private landowners	$2,000 $55 $2,060 $4,115
Little Sheep Creek-	Streambank rip rap, log/barb	Little Sheep Creek	NRCS/SWCD	FSA	$10,000

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
Streambank Stabilization	vegetative planting, rock weirs			Private landowners	$25,125 435,125
Little Sheep Creek Fence-	Riparian exclusion fence	Little Sheep Creek	NRCS/SWCD	FSA Private landowners	$1,048 $492 $1,540
Little Sheep Creek Fencing	Riparian exclosure fencing and planting	Little Sheep Creek near junction of Imnaha Hwy & Wallowa Loop Rd	SWCD	OWHP Private landowners	$3,425 $2,119 $5,544
Marr Flat/ Big Sheep Riparian Pasture Fencing	Riparian pasture fencing	Big Sheep Creek, RM 26-34 and Lick Creek RM 0-1	USFS	OWHP Permittee USFS	$8,000 $3,500 $3,500 $15,000
Road Canyon Headwaters	spring/ pond/ gully exclosure fence	Road Canyon	USFS	USFS	$1,000
Skookum Creek Large Woody Debris Placement	Instream placement of large woody debris	Skookum Creek	USFS	USFS	$2,535
Upper Imnaha Fish & Recreation Enhancement	Campground riparian plantings interpretive signs, road closures	Upper Imnaha River, RM 58.5-64.5, Coverdale CG & dispersed campsite	USFS	Miscellaneous USFS	$12,000 $38,200 $50,200
Upper Imnaha Fisheries & Recreation Enhancement	Campground riparian planting interpretive signs, road/trail closures	Upper Imnaha River, RM 59-66, Evergreen Campground Coverdale CG & 065 Campsite dispersed	USFS	BPA Miscellaneous USFS	$10,500 $5,000 $12,300 $27,800
Upper Imnaha Recreation & Fish Enhancement	Campground riparian planting and road closures	Imnaha River at Indian Crossing, Evergreen and Coverdale Campgrounds	USFS	USFS Volunteers	$22,500 $5,000 $27,500
Whiskey Riparian Corridor Fencing and Trough Replacement	Riparian corridor exclosure fence & trough improvements	Big Sheep Creek, RM 17-20.5	USFS	OWHP Private landowners USFS	$26,470 $5,613 $1,500 $33,583

Table 6-10 Habitat Improvement Projects in the Lostine River Watershed

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
Carmen Ranch Gated Pipe Demonstration	Flood irrigation improvements	Near Lostine River mouth	NRCS/SWCD	USBR FSA GWHP Private Landowner(s)	$40,025 $9,360 $14,397 $9,360 $73,141
Clearwater Ditch Diversion Structure	Construct permanent diversion structure	Lostine River mile 3.5	NRCS/SWCD	USBR BPA OWHP Private Landowner(s)	$1,500 $46,000 $48,900 $16,250 $112,650
Clearwater Ditch Fence	Ditch exclusion fence	Clearwater Ditch	NRCS/SWCD	FSA Private Landowner(s)	$6,782 $2,261 $9,043
Clearwater Ditch Fencing	Ditch livestock exclosure fencing	Spring Branch Clearwater Ditch	NRCS/SWCD	FSA Private Landowner(s)	$2,499 $2,615 $5,114
Clearwater Ditch Improvement	Ditch fencing & improvements livestock water developments Feedlot relocation, cross fencing	Clearwater Ditch & Lostine River, 2 miles east of Wallowa	NRCS/SWCD	USBR FSA OWHP Private Landowner(s)	$41,320 $3,500 $16,385 $31,516 $92,721
Clearwater Ditch Improvement	Relocate feedlot, livestock water developments, ditch Exclosure fencing	Spring Branch flowing into Clearwater Ditch	NRCS/SWCD	USBR FSA GWEB Private Landowner(s)	$6,000 $7,000 $10,150 $20,740 $43,890
Clearwater Ditch Lining	Ditch Lining	Clearwater Ditch	USBR	USBR Private Landowner(s)	$8,900 $5,109 $14,009
Grande Ronde Fish Presence Survey	Fish survey, data analysis and map production	Streams in Grande Ronde River Basin	ODFW	ODF	$25,000

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
				ODFW OWHP	$25,000 $40,300 $90,300
Grande Ronde Vegetative Inventory	GIS database of vegetative cover and stand conditions, fuel hazard inventory & analysis	Grande Ronde River Basin	ODF	ODF OWHP	$16,250 $168,800 $185,050
Lostine riparian fencing	Riparian exclosure fencing	Lostine River, RM 6.5 – 7	NRCS/SWCD	OWHP Private Landowner(s)	$6,116 $8,116 $14,232
Lostine Riparian Fencing	Riparian exclosure fencing	Lostine River	SWCD	OWHP Private Landowner(s)	$2,213 $1,181 $3,394
Lostine River Campgrounds	Altered or moved 19 campsites and closed 2.25 miles of road	Lostine River Campground, from Williamson CG site to Two Pan CG site	USFS	OWHP USFS	$2,660 $4,579 $7,239
Lostine River Irrigation Improvements	Install gated pipe irrigation system	Lostine River	USBR	USBR Private Landowner(s)	$3,245 $3,245 $6,490
Lostine River Irrigation Improvements	Install gate pipe irrigation from Clearwater Ditch to replace diversion from Lostine River	Clearwater Ditch	USBR	USBR FSA Private Landowner(s)	$5,400 $6,600 $2,700 $14,700
Lostine River Livestock Water & Irrigation Improvements	Install well , pipe to troughs, convert from flood to sprinkler irrigation	Lostine River	NRCS/SWCD	FSA Private Landowner(s)	$19,080 $6,360 $25,440
Lostine River Riparian Fence & Feedlot/ Irrigation Improvements	Riparian exclosure fence conversion to gated pipe feedlot improvements	Lostine River	NRCS/SWCD/ ODFW	USBR FSA ODFW Private Landowner(s)	$2,307 $16,883 $460 $8,395 $28,045
Lostine Wild & Scenic River Restoration	Campground improvements recreation livestock watering	Lostine River Campground	USFS	BPA USFS	$16,254 $26,800

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
	development, limit vehicle & livestock access				$43,054
Miles Ditch Diversion	Permanent diversion structure	Lostine River near Cross Country Canal Confluence	NRCS/SWCD	USBR BPA Private Landowner(s)	$40,795 $51,623 $6,929 $99,347
Poley Allen Ditch	Permanent diversion structure	Lostine River near South Fork Ready Mix Plant	NRCS/SWCD	USBR BPA Private Landowner(s)	$38,359 $49,403 $6,211 $93,973
Sheep Ridge Ditch Fencing	Ditch exclusion fencing & planting	Lostine River watershed, Sheep Ridge Ditch	NRCS/ SWCD	OWHP Private Landowner(s)	$5,270 $1,331 $6,601
Tulley-Hill Diversion Structure	Permanent diversion dam with fish ladder/ weir	Lostine R ~RM 1.7	USBR	USBR BPA ODFW Private Landowner(s)	$121,537 $80,934 $18,000 $20,000 $240,471
Wallowa Co. Soil Survey Digitizing	Digital maps of soil survey	Wallowa County	NRCS/ SWCD	BCC NRCS OWHP SWCD	$2,228 $410 $23,000 $100 $25,738
Wallowa High School Water Quality Monitoring	Water quality monitoring, education	Lostine River, Wallowa River, Bear Crk	WAHS	OWHP Wallowa High School	$4,361 $7,650 $12,011
Water Quality Monitoring for The Grande Ronde Basin	Compile & analyze monitoring data, conduct instream monitoring. Coordinate monitoring activities in Basin	Grande Ronde Basin	NRCS/SWCD	BCC USBR BPA GWEB NFWF NRCS ODA OSUE OWHP SWCD	$7,000 $48,000 $20,500 $66,650 $2,000 $6,000 $800 $500 $1,600 $1,600

Project Name	Project Description	Location	Project Lead	Project Funding	Cost
				USFS	$10,000
					$164,560
Water Quality Monitoring for the Grande Ronde River Basin	Compile & analyze monitoring data expand number of monitoring locations, train & educate public about water quality monitoring	Grande Ronde Basin	NRCS/SWCD	USBR	$24,000
				GWEB	$36,284
				NFWF	$13,000
				NRCS	$3,000
				ODA	$2,000
				OSUE	$1,200
				OWHP	$4,315
				SWCD	$4,000
					$87,799
Westside Ditch Lining/Fence & Livestock Water	Ditch lining & livestock exclosure fence livestock water development	Westside Ditch	USBR/NRCS/ SWCD	USBR	$22,750
				FSA	$3,835
				Private Landowner(s)	$6,168
					$32,583

6.5 Demographic Risk

All of the factors discussed above have contributed to what is currently the greatest short-term risk to Imnaha and Grande Ronde River spring chinook populations – which is the demographic risk of extinction. In conservation biology, demographic risk is defined as the risk of extinction due to factors that contribute to population growth and decline. These factors include birth and death rates as well as immigration and emigration rates. Smaller populations have higher risks of extinction because chance plays a greater role in determining individual survival and breeding success. Based on the declining trend and the extremely low abundance of adult spawners, co-managers have determined that the Imnaha and Grande Ronde River spring chinook spawning aggregates are at risk of extirpation.

Chapter 7 References

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Chapter 8 Glossary and Acronyms

Acronyms

APR	Artificial Production Review
BA	Biological Assessment
BCC	Boise Cascade Corporation
BH	Bonneville Hatchery
BIA	Bureau of Indian Affairs, U.S. Department of Interior
BKD	Bacterial Kidney Disease
BLM	Bureau of Land Management, U.S. Department of Interior
BMP	Best Management Practices
BO	Biological Opinion
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
BRWG	Biological Requirements Work Group
BY	Brood Year
C&S	Ceremonial and Subsistence
CBFWA	Columbia Basin Fish and Wildlife Authority
cfs	1000 cubic feet per second
CREP	Conservation Reserve Enhancement Program
CRI	Cumulative Risk Initiative
CRFMP	Columbia River Fish Management Plan
COE	Corps of Engineers
CRITFC	Columbia River Inter-Tribal Fish Commission
CWT	Coded-Wire Tag
ECWA	Eagle Cap Wilderness Area
EIBS	Erythrocytic inclusion body syndrome
ELISA	Enzyme-linked immunosorbent assay
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FI	Flow Index
FOTG	Fish Operations Technical Group
FSA	Farm Services Administration
Ft^3	Cubic feet
FWP	Columbia River Basin Fish and Wildlife Program
Gpm	Gallons per minute
GSI	Genetic stock identification
GWEB	Governors Watershed Enhancement Board
HCP	Habitat Conservation Plan
HGMP	Hatchery Genetic Management Plan
H/N	Hatchery:Natural fish ratio
ICBEMP	Interior Columbia Basin Ecosystem Management Program
IHOT	Integrated Hatchery Operations Team
ISAB	Independent Scientific Advisory Board

ISG	Independent Scientific Group (formerly Scientific Review Group)
ISRP	Independent Science Review Panel
Km	kilometer
LSRCP	Lower Snake River Compensation Plan
LSRFS	Lower Snake River Feasibility Study
MML	Manchester Marine Laboratory
M&E	Monitoring and Evaluation
NATURES	Natural Rearing Enhancement System
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Service
NPPC	Northwest Power Planning Council
NPT	Nez Perce Tribe
NRC	National Research Council
NRCS	Natural Resources Conservation Service
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OSUE	Oregon State University Extension Office
OWHP	Oregon Watershed Health Program
PAC	Production Advisory Committee
PATH	Plan for Analyzing and Testing Hypotheses
PFMC	Pacific Fisheries Management Council
PIT	Passive Induced Transponder
PNNL	Pacific Northwest National Laboratory
PST	Pacific Salmon Treaty
Rkm	River kilometer
RM	River Mile
SAR	Smolt-to-Adult Return
SRBA	Snake River Basin Adjudication
STFA	State and Tribal Fisheries Agencies Analytical Team
SWCD	Soil and Water Conservation District
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TUs	Temperature units
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFS	U.S. Forest Service
USFWS	United States Fish and Wildlife Service
VSP	Viable Salmonid Population

Technical Terms

Adaptive Management - Feedback based on knowledge or data generated by monitoring and evaluation actions, of the effects or results of an implemented action. The information and data are purposefully collected and used improve future management plans and actions.

Alevin - The developmental life stage of young salmonids and trout that are between the egg and fry stage. The alevin has not absorbed its yolk sac and has not emerged from the spawning gravels.

Anadromous Fish - Fish that hatch and rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.

Artificial Production - Spawning, incubating, hatching or rearing fish in a hatchery or other facility constructed for fish production.

Artificial Production Review (APR) - The Northwest Power Planning document that recommends how to use of fish hatcheries in the Columbia River Basin.

Artificial propagation - Any assistance provided by man in the reproduction of Pacific salmon. This assistance includes, but is not limited to, spawning and rearing in hatcheries, stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Broodstock, captive breeding - Adult fish maintained in captivity, used to propagate the subsequent generation of hatchery fish.

Broodstock, wild - Adult fish harvested from indigenous populations used to propagate the subsequent generation of hatchery fish.

Buttoned-up - Once the yolk sac has been absorbed to the point that only a fingernail width slit, generally less than 5 mm, is present. At this stage of development, fish are able to begin feeding. In a hatchery setting this is generally termed as “swim-up fry” or “feeding fry” and is associated with the initiation of the early rearing stage.

Captive-breeding program - A form of artificial propagation involving the collection of individuals (or gametes) from a natural population and the rearing of these individuals to maturity in captivity. For listed species, a captive broodstock is considered part of the evolutionarily significant unit (ESU) from which it is taken.

Carrying Capacity - The maximum number and type of species which a particular habitat or environment can support without detrimental effects.

Cobble (nests) - Substrate particles that range from 2 to 10 inches in diameter at its largest ordinate.

Cohort - Individuals all resulting from the same birth-pulse, and thus all of the same age.

Compliance (monitoring) - Adhering to the protocols of a monitoring and evaluation plan.

Conservation hatchery program - A program that uses artificial propagation to recover Pacific salmon by maintaining the listed species’ genetic and ecological integrity.

Cryopreserved – Preservation by freezing, typically using liquid nitrogen. Semen that has been cryopreserved can be thawed and utilized for fertilization.

Demographic risk of extinction – Risk of extinction due to factors that contribute to population growth and decline. These factors include birth, death, immigration and emigration rates. Smaller populations have higher risks of extinction because chance plays a greater role in determining individual survival and breeding success.

Diel - Changes of environmental conditions throughout the period of a day. For instance, water temperature in open, natural systems tends to have a warming trend in the afternoon caused by the effects of surrounding air temperature produced by the sun.

Domestication - The intentional or unintentional process by which wild plant and animals adapted to cultivation, is tamed, or loses its ability to survive in the wild.

Egg Incubation - Egg development of the embryo, influenced by temperature and other environmental factors.

Electrophoresis - A biochemical technique that deciphers protein phenotypes. A method of identifying allozyme variants identified because they migrate a given amount on an electrophoretic gel. The information extracted is a phenotypic class and may be genetically heterogeneous.

Emergence - The process during which fry leave their gravel spawning nest and enter the water column.

Endangered (ESA) - A species of plant or animal in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA) - An act passed by Congress in 1973 intended to protect species and subspecies of plants and animals that are of "aesthetic, ecological, educational, historical, recreational and scientific value." It may also protect the listed species' "critical habitat", the geographic area occupied by or essential to the species. The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) share authority to list endangered species, determine critical habitat and develop recovery plans for listed species.

Endemic (species) - Native to or limited to a specific region.

Enzyme - Any of various organic substances that are produced in cells and cause changes in other substances by catalytic actions.

Escapement - The number of salmon and steelhead that return to a specified measuring location after all natural mortality and harvest have occurred. Spawning escapement consist of those fish that survive to spawn.

ESU (evolutionary significant unit) - A salmon population or group of populations that are substantially reproductively isolated from other conspecific population units, and contributes substantially to ecological/genetic diversity of the biological species as a whole.

Extinction risk - A component to modeling scenarios involving stocks becoming extinct.

Extirpate - To destroy or remove completely, as a species from a particular area, region, or habitat.

Fecundity - The total number of eggs produced by a female fish.

Fry (emergence) - The first free-swimming life stage of a salmonid.

Fyke - A long bag net kept open by hoops.

Gametes – Sexual cells: eggs and sperm.

Genetic Diversity - The array of genetic traits that exists within a population, due to a large number of slightly dissimilar ancestors, which enables it to adapt to changing conditions.

Genetic Fitness - The relative reproductive success of a population (genotype) as measured by fecundity, survival, and other life history parameters.

Genetic Interactions - Outbreeding between genetically differentiated populations. Straying of genetically divergent hatchery produced salmon into a native population.

Genetic Variability - Differences in the frequency of genes and traits among individual organisms within a population.

Green Eggs - Eggs after removal from the female and prior to fertilization with sperm.

Hatchery Genetic Management Plan (HGMP) - A document detailing the continued operation of an artificial propagation program.

Integrated recovery - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as “supplementation”.

Life stage - An organism’s period of development to adulthood.

Listed fish, species - Species determined to be threatened (any species in danger of becoming endangered in the foreseeable future) or endangered (a species in danger of extinction throughout all or a significant portion of it’s range) as allowed under the ESA.

Locus/loci - The site of a gene on a chromosome; or, sometimes, the gene and its alleles. Colloquially, the terms locus and gene are used interchangeably.

Mainstem- The principle channel of a drainage system into which other smaller streams or rivers flow.

Mitigate - make less severe or more bearable.

Multi-Species Framework Project – a collaborative project of the Northwest Power Planning Council, the Columbia River Basin’s Indian Tribes and the United State Government to create a handful of scientifically based, agreed upon alternatives for determining how best to achieve fish and wildlife recovery in the Columbia River Basin.

Natal (stream or watershed) - Stream or watershed of birth.

Natural fish - A fish that is produced by parents spawning in a stream or lake bed, as opposed to a controlled environment such as a hatchery.

Naturally spawning fish/populations - Populations of fish that have completed their entire life cycle in the natural environment without human intervention.

Nutrient cycling - Circulation or exchange of elements such as nitrogen and carbon between nonliving and living portions of the environment.

Opercle – A bony flap-like protective gill covering.

Outbreeding - The interbreeding of distantly related or unrelated individuals.

Pacific Salmon Treaty (PST) - A long-term and comprehensive management plan, negotiated between the United States and Canada, that would govern salmon fisheries in Southeast Alaska, British Columbia, and the Pacific Northwest.

Parr – Juvenile salmonids develop bar-shaped marks on their sides called parr marks between becoming fry and smolting.

Passive integrated transponder (PIT) tagging - Passive Integrated Transponder tags are used for identifying individual salmon for monitoring and research purposes. This miniaturized tag consists of an integrated microchip that is programmed to include specific fish information. The tag is inserted into the body cavity of the fish and decoded at selected monitoring sites.

Plan for Analyzing and Testing Hypotheses (PATH) - The PATH process is a multi-agency/multi-participant effort to allow a wide community of scientists and managers to analyze hypotheses for salmon decline and examine the outcome of different management options, including drawdown and transportation.

Population(s) - A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.

Progeny - Offspring.

Rear - To feed and grow in a natural or artificial environment.

Recovery - Defined as the point at which a listed species has improved to such an extent that it no longer requires the protection of the ESA.

Recovery goal - The reestablishment of a threatened or endangered species to a self-sustaining level in its natural ecosystem (i.e., to the point where the protective measures of the Endangered Species Act are no longer necessary).

Redd - A nest of fish eggs covered with gravel.

Regime shift – A shift in oceanic conditions affecting water temperatures, currents, and weather. A change from a cool/wet regime to a warm/dry regime.

Restoration – Reestablishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics (NRC).

Riparian (zones) - Those terrestrial areas where the vegetation complex and microclimate conditions are products of the combined presence and influence of perennial and /or intermittent water, associated with high water tables, and soils that exhibit some wetness characteristics (FEMAT).

Run (fish) - A group of fish of the same species that migrate together up a stream to spawn, usually associated with the seasons, e.g., fall, spring, summer, and winter runs. Members of a run interbreed, and may be genetically distinguishable from other individuals of the same species.

Salmonids - Fish of the family Salmonidae, that includes salmon and steelhead.

Shocking- Act of mechanically agitating eggs, which ruptures the perivitelline membrane and turns infertile eggs white. A common fish culture practice that occurs during the eyed-egg stage of development.

Smolt - Refers to the salmonid or trout developmental life stage between parr and adult, when the juvenile is at least one year old and has adapted to the marine environment.

Spawn - The act of reproduction of fishes. The mixing of the sperm of a male fish and the eggs of a female fish.

Stock - A specific population of fish. When referring to salmon, a specific population of fish spawning in a particular stream during a particular season.

Subbasin – A watershed area defined by 4th –field USGS hydrologic unit code; the size averages 200,000 hectares.

Substrate - The composition of a streambed, including mineral and organic materials.

Supplementation - Artificial propagation intended to reestablish a natural population or increase its abundance.

Take (legal/illegal) - Under the Endangered Species Act, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect an animal, or to attempt to engage in any such conduct.

Temperature Units- A method of monitoring egg and fish development based upon the effect of cumulative water temperature. This method assigns a value of one “unit” for each degree above 32 degrees Fahrenheit in average daily water temperature. For example, if the average daily water temperature was 52 degrees Fahrenheit then 52-32=20 temperature units.

Threatened (ESA) - A genetic population that is at risk of becoming endangered in the foreseeable future.

Tribal fishing rights - The guaranteed right for Native Americans to fish in their usual and accustomed places. The right was established in a series of treaties dating from the mid-1850s and it applies to a number of tribes and their various harvesting practices (i.e., commercial and ceremonial and subsistence).

Trust obligations/responsibility - Governmental obligations to the tribes under the treaties of 1855.

Water quality limited - A water body that does not meet the federally approved state water quality standard establish under the provision of the Clean Water Act.

Watershed - A watershed area defined by 5th –field USGS hydrologic unit code; the size ranges between 20 to 40,000 hectares.

Wild fish - See “natural fish.”

Appendix A
Section 10 Permit Applications

Appendix B
Hatchery Genetic Management Plan Template

Hatchery and Genetic Management Plan Template

The Hatchery and Genetic Management Plan (HGMP) was developed by the National Marine Fisheries Service (NMFS) for the primary purpose of providing a single, comprehensive source of information regarding anadromous salmonid hatchery programs. The NMFS will use this information in its Endangered Species Act (ESA) processes to assess impacts on listed anadromous fish and issue section 10 permits or compliance with the 4(d) rules. In addition, the HGMP template provides a comprehensive source of information for use in regional fish production and management planning by federal, state, and tribal managers.

Due to the importance of this template in determining ESA compliance and future planning and management, the information requested in the HGMP template has been incorporated into the master plan document. This appendix identifies where to look in the master plan to find the information requested by the HGMP.

Section 1 General Program Description

1.1 Name of hatchery program

Northeast Oregon Hatchery Project – Spring Chinook Salmon Master Plan

1.2 Species and population under propagation and ESA status

Snake River spring chinook salmon (*Oncorhynchus tshawytscha*) from the Imnaha and Lostine rivers listed as threatened under the Endangered Species Act – see Table 1-3.

1.3 Responsible organization and individuals

Nez Perce Tribe

Silas Whitman, Manager, Department of Fisheries Resource Management

P.O. Box 365

Lapwai, ID 83540

(208) 843-7320, ext. 5

1.4 Funding source, staffing level, and annual hatchery program operational costs

See Table 1-3 for funding sources and Sections 3.4.1.2 and 3.4.2.2 for estimated operating costs. Staffing levels have not yet been determined for the proposed facilities.

1.5 Location of hatchery and associated facilities

See Chapter 3 – Proposed Alternative and Other Alternatives

1.6 Type of program

Integrated Recovery

1.7 Purpose (Goal) of program

See section 3.1.2.

1.8 Justification for the program

See Chapters 1 – Introduction and 2 – Need for the Project

1.9 List of program Performance Standards

See Appendix D – Conceptual Framework Monitoring and Evaluation Plan

1.10 List of program Performance Indicators

See Appendix D – Conceptual Framework Monitoring and Evaluation Plan

1.11 Expected size of program

See Chapter 4 – Production of the Currently Permitted Program

1.12 Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels.

See Chapter 4 – Production of the Currently Permitted Program and Chapter 5 – Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon

1.13 Date program started (years in operation), or is expected to start.

Timeline for construction of new facilities under the proposed alternative will be subjected the NPPC's 3-Step Review Process schedule. For historic information on the production program See Chapter 5 - Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon

1.14 Expected duration of program.

See Section 3.1.

1.15 Watersheds targeted by program.

See Chapter 1 - Introduction

1.16 Indicate alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.

See Chapter 3 – Proposed Alternative and Other Alternatives and Chapter 6 – Limiting Factors.

Section 2 Program Effects on ESA-Listed Salmonid Populations

2.1 List all ESA permits or authorizations in hand for the hatchery program.

See Table 1-3.

2.2 Provide descriptions, status, and projected take actions and levels for ESA-listed natural populations in the target area.

See Chapter 4 – Production of the Currently Permitted Program.

2.2.1 Description of ESA-listed salmonid population(s) affected by the program.

- **Identify the ESA-listed population(s) that will be directly affected by the program.**

  See Chapter 5 - Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon and Section 10 Permit applications in Appendix A.

- **Identify the ESA-listed population(s) that may be incidentally affected by the program.**

See Chapter 5 - Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon and Section 7 consultations (NMFS 1998b, NMFS 1999, and USFWS 1998).

2.2.2 Status of ESA-listed salmonid population(s) affected by the program.

- **Describe the status of the listed natural population(s) relative to "critical" and "viable" population thresholds.**

Critical – see Section 2.1.1.

- **Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for the listed population. Indicate the source of these data.**

See Section 2.1.1 and Carmichael et al. 1998a,b, and Appendix A.

- **Provide the most recent 12 year (e.g. 1988-present) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.**

See Section 2.1.1 and Chapter 5 - Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon.

- **Provide the most recent 12 year (e.g. 1988-present) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.**

See Table 4-1 and 4-2 for the Imnaha and Table 5-15 for the Lostine.

2.2.3 Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to take of listed fish in the target area, and provide estimated annual levels of take.

- **Describe hatchery activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take.**
- **Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish.**

- **Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting form the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).**
- **Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.**

The information requested in the bullets above can be found in Chapter 4 – Production of the Currently Permitted Program or in the Section 10 Permit applications in Appendix A.

Section 3 Relationship to Program of Other Management Objectives

3.1 Describe alignment of the hatchery program with any ESU-wide hatchery plan, or other regionally accepted policies. Explain any proposed deviations from the plan or policies.

See Table 1-3.

3.2 List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which the program operations.

See Table 1-3 and Section 3.4.3.

3.3 Relationship to harvest objectives.

3.3.1 Describe fisheries benefiting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years (1988-99), if applicable.

See Sections 2.1.3.2 (Imnaha), 2.1.4.1 (Lostine), 4.1.2 (Imnaha), 4.2.2 (Lostine), 5.5.1 (Imnaha), 5.8.1 (Lostine), and 6.1.

3.4 Relationship to habitat protection and recovery strategies.

See Chapter 6 – Limiting Factors.

3.5 Ecological interactions

See Section 10 Permit applications in Appendix A and Section 7 consultations (NMFS 1998b, NMFS 1999, and USFWS 1998).

Section 4 Water Source

4.1 Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

4.2 Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge.

These issues will be addressed at the proposed facilities during Step 2 of the 3-Step Process, facility design and NEPA.

Section 5 Facilities

5.1 Broodstock collection facilities.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

5.2 Fish transportation equipment (description of pen, tank truck, or container used).

See Section 10 Permit applications in Appendix A.

5.3 Broodstock holding and spawning facilities.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

5.4 Incubation facilities.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

5.5 Rearing facilities.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

5.6 Acclimation/release facilities.

See Sections 3.4.1 (Imnaha) and 3.4.2 (Lostine).

5.7 Describe operational difficulties or disasters that led to significant fish mortality.

Not applicable.

5.8 Indicate available back-up systems, and risk aversion measures that will be applied, that minimize the likelihood for the take of listed natural fish that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.

These issues will be addressed at the proposed facilities during Step 2 of the 3-Step Process, facility design and NEPA. For the ongoing program see Section 10 Permit applications in Appendix A.

Section 6 Broodstock Origin and Identity

6.1 Source.

See Sections 4.1.1 (Imnaha) and 4.2.1 (Lostine).

6.2 Supporting information

6.2.1 History.

6.2.2 Annual size.

6.2.3 Past and proposed level of natural fish in broodstock.

6.2.4 Genetic or ecological differences.

6.2.5 Reasons for choosing.

The information requested in the subsections of 6.2 above can be found in Chapter 4 – Production of the Currently Permitted Program and in Chapter 5 - Life History and Management Background of the Imnaha and Grande Ronde Spring Chinook Salmon.

6.3 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish that may occur as a result of broodstock selection practices.

See sections 4.1.2 (Imnaha) and 4.2.1 (Lostine).

Section 7 Broodstock Collection

7.1 Life history stage to be collected (adults, eggs, or juveniles).

See Sections 4.1.1 (Imnaha), 4.2.1 (Lostine) and 4.2.9 (Lostine).

7.2 Collection or sampling design.

See Sections 4.1.1 (Imnaha), 4.2.1 (Lostine) and 4.2.9 (Lostine).

7.3 Identity.

See Sections 10 Permit applications in Appendix A.

7.4 Proposed number to be collected.

7.4.1 Program goal (assuming 1:1 sex ratio for adults)

See Sections 4.1.2 (Imnaha), 4.2.2 (Lostine) and 4.2.9 (Lostine).

7.4.2 Broodstock collection levels for the last twelve years (e.g. 1988-99), or for most recent years available

See Sections 4.1.1 (Imnaha) and 5.8.2.5 (Lostine).

7.5 Disposition of hatchery–origin fish collected in surplus of broodstock needs.

See Sections 4.1.2 (Imnaha) and 4.2.2 (Lostine).

7.6 Fish transportation and holding methods.

See Section 10 Permit applications in Appendix A.

7.7 Describe fish health maintenance and sanitation procedures applied.

See Sections 4.1.10 (Imnaha) and 4.2.10 (Lostine).

7.8 Disposition of carcasses.

See Sections 4.2.4.4 (Imnaha) and 4.2.4.4 (Lostine).

7.9 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

See Sections 4.1.2 (Imnaha) and 4.2.2 (Lostine).

Section 8 Mating

8.1 Selection method.

See Sections 4.1.4 (Imnaha) and 4.2.4 (Lostine).

8.2 Males.

See Sections 4.1.4 (Imnaha) and 4.2.4 (Lostine).

8.3 Fertilization.

See Sections 4.1.4.2 (Imnaha) and 4.2.4.2 (Lostine).

8.4 Cryopreserved gametes.

See Sections 4.1.4.3 (Imnaha) and 4.2.4.3 (Lostine).

8.5 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

See the spawning matrix in Appendix G.

Section 9 Incubation and Rearing

9.1 Incubation.

9.1.1 Number of eggs taken and survival rates to eye-up and/or ponding.

See Section 4.1.5 and Table 4-6 (Imnaha) and Section 4.2.5 and Table 4-12 (Lostine).

9.1.2 Cause for, and disposition of surplus egg takes.

See Section 4.2.9.5 (Lostine captive broodstock).

9.1.3 Loading densities applied during incubation.

See Sections 4.1.5 (Imnaha) and 4.2.5 (Lostine).

9.1.4 Incubation conditions, (see Section 4.__).

See Sections 4.1.5 (Imnaha) and 4.2.5 (Lostine) and Table 4-7.

9.1.5 Ponding.

See Sections 4.1.6 (Imnaha) and 4.2.6 (Lostine).

9.1.6 Fish health maintenance and monitoring.

See Sections 4.1.10 (Imnaha) and 4.2.10 (Lostine).

9.1.7 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.

See Sections 4.1.5 (Imnaha) and 4.2.5 (Lostine) and Table 4-7.

9.2 Rearing

9.2.1 Survival rates (average program performance) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.

This information is not applicable for the proposed facilities in this master plan.

9.2.2 Density and loading criteria (goals and actual levels).

See Sections 4.1.6 (Imnaha), 4.1.7 (Imnaha), 4.2.6 (Lostine), 4.2.7 (Lostine) and Table 4-7).

9.2.3 Fish rearing conditions.

See Sections 4.1.6 (Imnaha), 4.1.7 (Imnaha), 4.2.6 (Lostine), 4.2.7 (Lostine) and Table 4-7).

9.2.4 Indicate biweekly or monthly fish growth information (average program performance), including length, weight, and condition factor data collected during rearing, if applicable.

This information is not applicable for the proposed facilities in this master plan.

9.2.5 Indicate monthly fish growth rate and energy reserve data (average program performance), if applicable.

This information is not applicable for the proposed facilities in this master plan.

9.2.6 Indicate food type used, daily application schedule, feeding rate range, and estimates of total food conversion efficiency during rearing.

This information is not applicable for the proposed facilities in this master plan.

9.2.7 Fish health monitoring, disease treatment, and sanitation procedures.

See Sections 4.1.10 (Imnaha) and 4.2.10 (Lostine).

9.2.8 Smolt development indices, if applicable.

This information is not applicable for the proposed facilities in this master plan.

9.2.9 Indicate use of “natural” rearing methods as applied in the program.

See Table 4-7.

9.2.10 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation – question on example in HGMP template.

See Sections 4.1.6 – 4.1.9 (Imnaha) and 4.2.6 – 4.2.7 (Lostine).

Section 10 Release

10.1 Proposed fish release levels.

See Table 4-5 (Imnaha) and Table 4-11 (Lostine).

10.2 Specific location(s) of proposed release(s).

See Sections 4.1.8 (Imnaha) and 4.2.8 (Lostine).

10.3 Actual numbers and sizes of fish released by age class through the program.

See Sections 5.3.2.3 (Imnaha) and 5.8.2.5 (Lostine).

10.4 Actual dates of release and description of release protocols.

See Sections 5.3.2.3 (Imnaha) and 5.8.2.5 (Lostine).

10.5 Fish transportation procedures, if applicable.

See Section 10 Permit applications in Appendix A.

10.6 Acclimation procedures.

See Sections 4.1.8 (Imnaha) and 4.2.8 (Lostine).

10.7 Marks applied, and proportions of the total hatchery population marked, to identify hatchery adults.

See Section 10 Permit applications in Appendix A.

10.8 Disposition plans for fish identified at the time of release as surplus to programmed or approved levels.

See Sections 4.1.12 (Imnaha) and 4.2.11 (Lostine).

10.9 Fish health certification procedures applied prerelease.

See Sections 4.1.10 (Imnaha) and 4.2.10 (Lostine).

10.10 Emergency release procedures in response to flooding or water system failure.

These procedures will be developed for the proposed facilities in Step 2 of the 3-Step Process, facility design and NEPA. For the ongoing program see Section 10 Permit applications in Appendix A.

10.11 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases.

See Sections 4.1.12 (Imnaha) and 4.2.11 (Lostine) and Section 10 Permit applications in Appendix A.

Section 11 Monitoring and Evaluation of Performance Indicators

11.1 Monitoring and evaluation of "Performance Indicators" presented in Section 1.10

11.1.1 Describe plans and methods proposed to collect data necessary to respond to each "Performance Indicator" identified for the program.

11.1.2 Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

11.1.3 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities.

See the Conceptual Framework Monitoring and Evaluation Plan in Appendix D. Specific details on data collection and analysis will be developed during Step 2 and 3 of the NPPC 3-Step Review Process.

Appendix C
Independent Scientific Review Panel and Artificial Production Review Requirements

ANSWERS TO ATTACHMENT 1:

Program Language Regarding Master Planning Requirements

This information is also contained in Section 1.4 of the master plan document (see box).

Question 1: Project goals.

Response: See Section 3.1.

Question 2: Objectives.

Response: See Section 3.1

Question 3: Factors limiting production of the target species.

Response: See Chapter 6

Question 4: Expected project benefits (e.g., gene conservation, preservation of biological diversity, fishery enhancement and/or new information).

Response: See Section 1.2. See also Section 10 permit applications (BIA 1998, ODFW 1996, ODFW 1998b in Appendix A).

Question 5: Alternatives for resolving the resource problem.

Response: See Section 3.3.

Question 6: Rationale for the proposed project.

Response: See Chapters 2 and 3.

Question 7: How the proposed production project will maintain or sustain increases in production.

Response: See Sections 4.1.12 and 4.2.11.

Question 8: The historical and current status of anadromous and resident fish in the subbasin.

Response: See Section 2.1.1 and Chapter 5.

Question 9: The current (and planned) management of anadromous and resident fish in the subbasin.

Response: See Chapters 4, 5, and 6.

Question 10: Consistency of proposed project with Council policies, National Marine Fisheries Service recovery plans, other fishery management plans, watershed plans and activities.

Response: See Table 1-1, and Table 1-3 and Chapter 6.

Question 11: Potential impact of other recovery activities on project outcome.

Response: See Table 1-3 and Chapter 6.

Question 12: Production objectives, methods and strategies.

Response: See Chapter 4.

Question 13: Broodstock selection and acquisition strategies.

Response: See Chapter 4.

Question 14: Rationale for the number and life-history stage of the fish to be stocked, particularly as they relate to the carrying capacity of the target stream and potential impact on other species.

Response: See Sections 4.1.12 and 4.2.11.

Question 15: Production profiles and release strategies.

Response: See Chapter 4.

Question 16: Production policies and procedures.

Response: See Chapter 4.

Question 17: Production management structure and process.

Response: Section 3.4.3.

Question 18: Related harvest plans.

Response: See Sections 4.1.1 and 4.2.1.

Question 19: Constraints and uncertainties, including genetic and ecological risk assessments and cumulative impacts.

Response: See Support documents, Neeley et al. 1993 and Neeley et al. 1994, Section 10 Permit applications in Appendix A, LSRCP Biological Assessment (USFWS 1998), NMFS Biological Opinion (NMFS 2000), and conceptual framework for monitoring and evaluation plan in Appendix D.

Question 20: Monitoring and evaluation plans, including a genetics monitoring program.

Response: See Sections 4.1.13 and 4.2.12 and Appendix D.

Question 21: Conceptual design of the proposed production and monitoring facilities, including an assessment of the availability and utility of existing facilities.

Response: See Chapter 3.

Question 22: Cost estimates for various components, such as fish culture, facility design and construction, monitoring and evaluation, and operation and maintenance.

Response: See Sections 3.4.1.2 and 3.4.2.2.

ANSWERS TO ATTACHMENT 2:

Questions Identified in the September 1997 Council Policy Document for FY98 Project Funding

Question 1: Has the project been the subject of appropriate independent scientific review in the past? If so, how has the project responded to the results of independent review?

Response: See Sections 4.1 and 4.2.

Question 2: Have Project sponsors demonstrated adequately at earlier stages that the project is consistent with the Council's policies on artificial/natural production in Section 7 (the specific concern of the Panel)? If not, can these points be demonstrated now?

Response: See responses to Attachment 5, Table 1-3, and Chapters 3 and 4.

Question 3: Is the final design of the project consistent with any master plan and preliminary design?

Response: This question is not applicable. This master plan submittal is to fulfill Step 1 (conceptual planning). Final design will not occur until after the master plan document is approved, and preliminary design and NEPA phase is completed and approved.

Question 4: If not, do the changes raise any underlying scientific questions for further review?

Response: Not applicable.

Question 5: Has information about the project or its purposes changed in such a way to raise new scientific concerns?

Response: No new information about the project or its purposes has developed to raise new scientific concerns.

Question 6: Has the underlying science or the way it is understood changed so as to raise new scientific issues?

Response: No.

Question 7: How technically appropriate are the monitoring and evaluation elements of the project?

Response: Ongoing monitoring and evaluation activities are described in Sections 4.1.13 and 4.2.12. Technical details of these activities are contained in Lower Snake River Compensation Plan annual statements of work (Carmichael et al. 2000). These activities are also described in ESA Section 10 Permit applications (BIA 1998, ODFW 1996, ODFW 1998b) contained in Appendix A. The conceptual framework for the monitoring and evaluation program for the proposed alternative can be found in Appendix D.

Question 8: Are there ways to obtain the same production benefits with facilities that are lower in cost or less permanent, should monitoring and evaluation later indicate that the effort be abandoned?

Response: Chapter 3 summarizes the potential to utilize other facilities to accomplish this program. The preferred alternative is the only alternative capable of providing facilities that meet the production criteria established by co-managers for these ESA listed populations. This program is being managed under the adaptive management philosophy, with extensive monitoring and evaluation. As M&E results indicate a need for program and facility changes, we will be making adjustments to the program.

ANSWERS TO ATTACHMENT 3:

Program Language Identified by the ISRP

Measure 7.0D: Comprehensive environmental analysis assessing the impacts on naturally produced salmon of hatchery produced anadromous fish.

> ***Question:*** Measure 7.0D of the Council's 1994 Fish and Wildlife Program calls for a comprehensive environmental analysis assessing the impacts on naturally produced salmon of hatchery produced anadromous fish. The primary question we would like to have addressed is, does the environmental assessment adequately deal with the question of interactions of hatchery-produced salmonids and naturally spawning salmonids and steelhead in the Columbia River Basin? If so, how? If not, what are the potential or posited interactions and impacts?
>
> ***Response:*** The environmental assessment for the proposed alternative will be developed during Step 2. However, environmental assessments and biological assessments have been completed for the Currently Permitted Program (see Table 1-3).

Measure 7.1A: Evaluation of carrying capacity and limiting factors that influence salmon survival.

> ***Question:*** Measure 7.1A of the Council's 1994 Fish and Wildlife Program calls for a basin-wide study on the ecology, carrying capacity, and limiting factors that influence salmon survival.

A. The primary question we would like to have addressed with regard to this measure is how does the project intend to address the issue of carrying capacity within the watershed(s) into which fish will be placed?

B. Do these fish originate from the most appropriate native stock?

C. Specifically, how will the artificial production which is proposed, impact natural production?

D. What are the impacts on mainstem and ocean harvest? How are these impacts addressed?

Response:

A. See Sections 4.1.12 and 4.2.11.

B. See Sections 4.1.1.1 and 4.2.1.2.

C. We anticipate the proposed program will enhance natural production as described in Section 1.2.

D. See Chapter 6. We believe there will be little or no impact to mainstem and ocean fisheries because spring chinook are not harvested at any significant level, presently. Adults produced from this program could contribute to harvest in the future.

Measure 7.1C: Collection of population status, life history and other data on wild and naturally spawning populations of salmon and steelhead.

Question: Measure 7.1C calls for the collection of population status, life history and other data on wild and naturally spawning populations of salmon and steelhead.

A. The primary question we would like to have addressed with regard to this measure, especially with regard to listed species is, what biological baseline information on naturally spawning populations of salmon and steelhead have been collected, and what high priority populations and "provisional population units" have been identified?

B. Does this baseline information include a profile on the genetic and morphological characteristics of wild and naturally spawning populations?

C. What characteristics are to be maintained by management actions?

D. What are the limiting factors for wild and naturally spawning populations?

E. What is the natural carrying capacity for the identified populations?

F. What monitoring of identified populations of salmon and steelhead is identified as part of the project?

G. Are these efforts being coordinated with NMFS? If so, how?

Response:

A-B. See Chapter 5. Also natural escapement, life history, genetic, and production baseline information can be found in (Waples, *et al.*, 1995, Keefe, *et al.,* 1995, Jonasson, *et al.,* 1996, Grande Ronde Subbasin Plan, GRA, 1994).

C. See Chapter 4. Also refer to Captive Broodstock Section 10 permit application, Mod Permit 1011, ODFW FY99 Captive Brood BPA proposal, and NPT FY99 BPA Proposal.

D. Limiting factors are discussed in Chapter 6. More information can be found in the Imnaha Subbasin Plan, the Grande Ronde Subbasin Plan, Tribal Recovery Plan, Captive Broodstock application, Mod Section 1011, *U.S. v. Oregon* Spring Chinook Production Plan, and Grande Ronde EDT.

E. See Sections 4.1.12 and 4.2.11.

F. Ongoing monitoring and evaluation activities are described in Sections 4.1.13 and 4.2.12. The conceptual framework for the monitoring and evaluation plan for the proposed alternative is in Appendix D.

G. The production program described in this master plan is for spring chinook salmon listed as threatened under the Endangered Species Act. Activities involving artificial propagation and monitoring and evaluation are described in ESA Section 10 permits.

Measure 7.1F: Systemwide and cumulative impacts of existing and proposed artificial production projects on the ecology, genetics and other important characteristics of the Columbia River Basin anadromous and resident fish.

> ***Question:*** Measure 7.1F calls for a study to address the system wide and cumulative impacts of existing and proposed artificial production activities on the ecology, genetics and other important characteristics of Columbia River Basin anadromous and resident fish. This study is to be coordinated with the genetic impact assessment of Columbia River Basin hatcheries called for in measure 7.2A.2 of the Council's program.

A. How does the projects environmental assessment address the direct, indirect and cumulative effects of the proposed production activities on anadromous and resident fish?

B. Have those effects commonly associated with cumulative hatchery releases -- density dependent, competition, predation, disease transmission and genetic effects on other fish in the mainstem and oceanic environments been addressed? If so how?

C. Have the genetic effects of the project on fish within and outside the Columbia River Basin been specifically addressed?

Response:

A. Not applicable. An environmental assessment of the proposed alternative will be developed during Step 2 of the 3-Step process.

B. The affects of fish releases from the production has been evaluated through the development of Section 10 Permit applications (see Appendix A). An assessment of effects associated with cumulative hatchery releases are contained in the LSRCP Biological Assessment (USFWS 1998).

C. Regarding genetic effects, see response to questions under Measure 7.1A. Based on our previous experience with supplementation in the Imnaha Basin and the plan to acclimate all smolts prior to release, we do not expect out-of-basin straying to be a significant problem.

Attachment 5: Policies of the Artificial Production Review, Report and Recommendations (Document 99-15)

1. The manner of use and the value of artificial production must be considered in the context of the environment in which it will be used.

Response: See Chapter 2

2. Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate benefits and address scientific uncertainties.

Response: See Appendix D for the monitoring and evaluation conceptual framework.

3. Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.

Response: See Chapter 6.

4. A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.

Response: See Chapter 2

5. Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.

Response: See Chapters 4 and 5.

6. The entities authorizing or managing a artificial production facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.

Response: See Chapter 3.

7. Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives and strategies at the subbasin and province levels.

Response: See Table 1-3 and Chapter 6.

8. Appropriate risk management needs to be maintained in using the tool of artificial propagation.

Response: See Chapter 4 for discussions on genetic risk management, See Chapter 3 for discussion about facility backup planning, and see Appendix D for conceptual framework of the monitoring and evaluation plan.

9. Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of artificially produced populations, harvest rates and practices must be dictated by the requirements to sustain naturally spawning populations.

Response: See Chapter 4.

10. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.

Response: See Table 1-3 and Chapter 2.

Appendix D
Conceptual Monitoring and Evaluation Plan

Northeast Oregon Hatchery Spring/Summer Chinook Salmon Conceptual Monitoring and Evaluation Plan

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SUMMARY

This conceptual plan describes a monitoring and evaluation approach that will help co-managers determine whether they were successful in preserving and recovering chinook salmon in the Imnaha and Lostine rivers. Program success will be gauged primarily by changes in abundance and distribution of the supplemented chinook salmon spawning aggregates. Information gathering strategies are proposed to monitor and evaluate the results of the Northeast Oregon Hatchery (NEOH) supplementation program specific to the Imnaha and Lostine rivers so that operations can be adaptively managed to optimize hatchery and natural production and minimize ecological impacts. The conceptual monitoring and evaluation plan provides a framework that will guide development of a detailed monitoring and evaluation plan.

The plan is grouped according to three categories: Stock Status, Biological Interactions and the Natural Environment. Stock Status refers to both the hatchery and wild components. This category comprises genetic, life history and population viability subcategories. Monitoring and evaluation activities associated with these subcategories will be directed at detecting genetic and life history differences between wild and hatchery fish and changes in population abundance over time. Biological processes that affect stock status will be investigated under the Ecological Interactions category. This category involves both intraspecific and interspecific interactions which includes competition, reproduction and disease transmission between wild and hatchery chinook populations and other species of fish. The third category of interest is the natural environment. Abiotic factors capable of influencing or limiting production, abundance and survival of wild and hatchery fish are considered. Streamflow, water temperature and quality and habitat carrying capacity have the potential to affect stock status and program success in the Imnaha and Lostine rivers.

INTRODUCTION

Monitoring and evaluation are integral to managing the risk associated with supplementation. Therefore, it is imperative that supplementation programs are accompanied by thorough monitoring and evaluation plans. The results of this monitoring and evaluation (M&E) process will be conveyed to managers for proper and informed decision making thus leading to effective adaptive management.

The Northeast Oregon Hatchery (NEOH) conceptual plan provides the framework for future monitoring and evaluation activities that will occur in the Imnaha and Lostine rivers. The conceptual character of the plan specifies the scope, goals, and objectives that will help describe the status of chinook salmon in these rivers and determine the performance and effects of the NEOH supplementation program. The document recognizes the existence of ongoing research as well as other monitoring and evaluation programs. Continued discussions with fisheries co-managers during the development of the M&E action plan and will focus on critical areas that are lacking or that could be improved in the current program. An “action” plan will then address specific program activities by coordinating ongoing evaluation and developing additional M&E activities to be conducted with long-term monitoring and small-scale experiments.

The conceptual plan is organized into three components. The first component is an outline of the policy process that governs supplementation associated with the Northwest Power Planning Council’s Fish and Wildlife Program. The second poses management concerns pertaining to uncertainty and the goals and objectives required to address uncertainty. The final component details the conceptual approach required to adaptively manage the NEOH salmon supplementation program.

BACKGROUND

Policy Process

The *Columbia River Basin Fish and Wildlife Program* (NPPC 1994) includes many procedural mandates in the implementation of coordinated salmon production and habitat projects. One of those requirements directed at fishery managers is to develop Master Plans. Section 7.4B.1 of the Fish and Wildlife Program provides a suggested list of elements that each Master Plan should contain. Included with that list is “monitoring and evaluation plans, including a genetics monitoring program”. This provides the genesis for the development of this conceptual monitoring and evaluation plan.

Other documents also provide guidance in developing monitoring and evaluation plans for supplementation projects (*Table 1*). These documents are intended to give direction for regional evaluation and monitoring efforts. In the following paragraphs summarize each document with respect to monitoring and evaluating of the NEOH supplementation project.

Table 1. List of documents that provide technical and process guidance in the development of monitoring and evaluation plans for supplementation projects in the Columbia River Basin.

-Regional Assessment of Supplementation Project	1992
-National Fish Hatchery Review Panel	1994
-Integrated Hatchery Operation Team	1995
-Columbia River Basin Fish and Wildlife Program	1995
-The National Research Council Review	1996
-The Council's Independent Scientific Group	1996
-Review of Artificial Production of Anadromous and Resident Fish in the Columbia River Basin	1999
-Strawfish Policy	1999
-Artificial Production Policy Statement Columbia Basin Hatcheries: A Program Transition	1999
-Multi-Species Framework – Conceptual Foundation of the Framework Process	1999

The NPPC policy framework is based on several important regional studies and reports from throughout the 1990s, as well as guidance from regional workshops, Council staff, and consultants. Primary among these sources is the *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* report. The document is a thorough review and reformulation of production policy prepared in 1994-95 by the Integrated Hatchery Operations Team (IHOT), as part of the Council's Fish and Wildlife Program. In addition to the IHOT Report, the following sources also contributed significantly to their policy framework proposal:

- *Regional Assessment of Supplementation Project* (RASP), an evaluation of supplementation theories, policies and practices also developed under the Council's Fish and Wildlife Program and funded by the Bonneville Power Administration (1992).
- Recent scientific reviews focused wholly or partly on artificial production in the basin by the National Fish Hatchery Review Panel (1994), the National Research Council (1996), and the Council's Independent Scientific Group (1996).
- Draft Review of Salmonid Artificial Production in the Columbia River Basin by the ISAB's Scientific Review Team (SRT) for the Artificial Production Review (1998).
- Workshop on Artificial Production in the Columbia River Basin sponsored by the Northwest Power Planning Council, January 19-20, 1999 in Portland, Oregon, and the *Strawfish Policy* statement produced by Council staff for the Workshop.

As indicated by the congressional request for Council recommendations on production policy, there remains a need to integrate the findings, conclusions, strategies, and recommendations of these reviews and reports into a coherent set of regional policies for artificial production. Some of the reviews and reports, such as the IHOT report, emphasize reform at the operational level and point out the need for broader, ecosystem scale coordination and planning. Other initiatives, such as the ISG's *Return to the River* or the SRT's review of artificial production, emphasize broad-scale principles and policies to protect wild populations without a clear translation to operations of individual hatcheries

Two documents in particular, give very good background information and summarize the process and technical issues regarding artificial production in the Columbia River Basin. The first document entitled, *Review of Artificial Production of Anadromous and Resident Fish in the Columbia River Basin* by Brannon et al. (1999) provides technical guidelines. The second is a 1999 NPPC document entitled: *Artificial Production Policy Statement Columbia Basin Hatcheries: A Program in Transition*. This statement summarized the evolution of policy and processes that have been a part of the NPPC Fish and Wildlife Program.

The *Artificial Production Policy Statement Columbia Basin Hatcheries: A Program in Transition*, attempts to integrate "bottom up" and "top down" approaches, reconciles various policy recommendations, and incorporates the need for subbasin plan development into a regional policy statement for production. In addition to forming the basis for the Council's recommendations to Congress, their policy statement serves several additional purposes including:

- to update and revise the policies, goals, and performance standards contained in the IHOT Report and provide guidance for upcoming hatchery performance evaluations;
- to provide guidance to subbasin planning efforts, by helping to determine and evaluate the role artificial production could play in particular areas, as regional authorities attempt to meet mitigation obligations, treaty obligations, the requirements of the Endangered Species Act (ESA), and other legal obligations;
- as a central component of the *Regional Multi-Species Framework*, which is designed to provide a set of scientifically supportable alternatives for the future of the Columbia River, especially as it relates to management of fish and wildlife resources;
- to help guide the Council and the fish and wildlife agencies and tribes as the Council amends its Fish and Wildlife Program, and as the Council conducts the funding reviews and provides funding recommendations for the use of the Bonneville fish and wildlife budget for production and watershed activities; and,
- to inform Congress and the relevant agencies on how to fund and implement reform in those artificial production facilities that are not part of the Bonneville budget.

Brannon et al. (1999) reviews the artificial production history of the Columbia River Basin, integrates it’s relationship with additional ongoing processes such as the Multi-species Framework, and provides us with 20 guidelines to be followed regarding artificial production. The following guidelines (16-20) pertain to research and monitoring.

> ***“E. Guidelines on Research and Monitoring***
> Good management is the key to successful integration of hatcheries into a functioning and dynamic ecosystem. Research to improve artificial production, the extent of its application, and its limitations is basic to the effective management of hatcheries in the basin. In this regard, monitoring is also a critical element in the management process. Knowing what is successful and what must change is impossible without appropriate monitoring programs.

Guideline 16. An in-hatchery fish monitoring program needs to be developed on performance of juveniles under culture, including genetic assessment to ascertain if breeding protocol is maintaining wild stock genotypic characteristics.

Rationale: The NPPC needs to design a scientifically valid monitoring program for the basin hatcheries. Special attention should be paid to the collection of valid data that applies to routine assessment of juvenile performance in the hatchery incubation and rearing phase, up to the point of release. Genetic monitoring of the stock inventory would include descriptive evaluation at first feeding and at release time to assess if hatchery propagation is altering genotypes from that of the wild population.

Guideline 17. A hatchery fish monitoring program needs to be developed on performance from release to return, including information on survival success, interception distribution, behavior, and genotypic changes experienced from selection between release and return.

Rationale: The NPPC needs to design a scientifically valid monitoring program for hatchery fish performance after release from the culture facilities. In addition to return success, attention should be paid to relative interception distribution (tag analysis) of hatchery fish to compare performance parameters with native fish. Special attention should also be given to descriptive genetic assessment at time of return to determine if genotypes surviving are representative of genotypes released, and compatible with the native stock. With the advent of the PIT tag system, opportunities to gather more specific information exists. Significant insights can be gained on straying, migratory route and timing that are key to honing hatchery programs.

Guideline 18. A study is required to determine cost of monitoring hatchery performance and sources of funding.

Rationale: A study should be undertaken to consider how much monitoring programs will cost and what reallocation of effort in the production programs would be required to fund adequate monitoring efforts where additional funds cannot be secured.

Guideline 19. Regular performance audits of artificial production objectives should be undertaken, and where they are not successful, research should be initiated to resolve the problem.

Rationale: Routine audits of hatchery production objectives should be established (for example, every five years) to determine if they are achieving their objectives. In those cases where programs or hatcheries are not showing any production benefit, they should be re-prioritized to research-only until the problems can be resolved. In some cases, research may disclose that the objectives are not attainable. In those situations, emphasis can then be redirected, programs changed, or discontinued.

Guideline 20. The NPPC should appoint an independent peer review panel to develop a basinwide artificial production program plan to meet the ecological framework goals for hatchery management of anadromous and resident species.

Rationale: With the development of the broad ecological framework in the basin placing emphasis on hatchery management in the arena of conservation fisheries and ecosystem function, it will be necessary for practitioners and fisheries scientists to work together in developing the appropriate hatchery program plans to achieve the ecosystem goal. Problems that have prevented hatcheries from achieving their goals, or insights on what may be impossible to achieve in the ecosystem approach at the hatchery level, cannot be ascertained without major contribution from hatchery managers experienced in the system. Also, the inherent conflict between the concept of ecosystem management and the concept of management for harvest mitigation has to be resolved within the ecosystem framework. Those resolutions, and the development of the hatchery program plan addressing specific actions needed to achieve the goal, are essential elements early in the planning process. The responsibility will require appointment of an independent peer review panel that can give careful and appropriate consideration, through solicitation of agency, tribal and public interests, to past management experiences."

The report concludes with the following advice.

> "Given the new management emphasis on wild stocks, special consideration must be given to the possibility that some of the maladaptive traits developed by hatchery fish in hatcheries could be expressed even more deleteriously when those fish attempt to spawn naturally (in a supplementation program) or when they interact genetically (as strays) with natural spawning populations, or as they interact with natural stocks ecologically throughout the post-release portion of the life cycle. While these possible risks are in some sense the most alarming, they are also the most poorly documented, and the quantitative strength of the underlying forces are not well understood. Therefore, a large research and monitoring effort needs to be directed at these questions of genetic and ecological effects of hatchery produced fish on naturally spawning fish. The results of these studies are needed to lay to rest some of the fears about worst-case scenarios, and they are also needed to teach us how to modify hatchery management to achieve the most positive kinds of interactions with wild stocks."

Thus, the NEOH conceptual M&E program is intended to be consistent with the guidelines expressed in the *Review of Artificial Production of Anadromous and Resident Fish in the Columbia River Basin* and with the *Artificial Production Policy Statement Columbia Basin Hatcheries: A Program in Transition* as well as with the other pertinent documents reviewed above.

MANAGEMENT CONCERNS

Uncertainty

One of the most important steps in defining a monitoring and evaluation program is to consider uncertainty. Critical uncertainties are consequential because they often serve as a pretext for inappropriate management actions. Uncertainty is a function not only of unpredictability and ecosystem randomness but also of our state of knowledge and scientific understanding. Therefore, monitoring and evaluation have long been recognized as necessary components of natural resource management. Monitoring and evaluation activities are intended to address project uncertainty and to provide feedback to managers (Steward 1996, Multi-Species Framework 1999). This feedback consists of collecting information describing distribution, condition, status, and trends of biological and environmental variables of interest. Management then has current data on a continuous basis in which to properly evaluate program effectiveness.

A successful supplementation program depends, in part, on identifying the appropriate management questions to consider relative to the critical uncertainties and the supplementation goal. The following management questions recognize the existence of ongoing M&E programs in the Imnaha and Lostine rivers and were developed through co-management meetings and review of monitoring and evaluation literature. These management questions relate directly to performance of the supplementation program. Additional issues of ecosystem status/function are raised in the conceptual design section.

- What is the current status of the naturally produced chinook salmon in the Imnaha and Lostine rivers?

- Do the NEOH releases of spring-summer chinook salmon achieve the desired level of adult returns?

- Do the naturally produced and hatchery reared components continue to make up one indistinguishable population segment?

- To what extent will rearing and acclimation of chinook salmon in Imnaha and Lostine river water enhance smolt-to-adult survival?

- To what extent will smolt release methods and strategies (size, time, location) affect reestablishment success?

- Can hatchery strategies be improved to achieve program goals.

- Is it feasible to improve the current adult and juvenile trapping? Do alternative approaches to current sampling provide benefits?

- Does the NEOH program alter intra- and inter-species specific abundance and behavior?

- Does fish health vary among naturally produced and hatchery reared components of the populations?

- Can adult chinook salmon returns to the Imnaha and Lostine rivers be accurately predicted?

- Can management tools such as harvest regulations be used to optimize NEOH operation?

It should be recognized that management questions and the resulting implementation of monitoring and evaluation plans to some extent depend on the abundance level of the population of interest. At very low abundance, management objectives consist of preventing extinction. At such low abundance levels, some sampling could impact survival of the population and therefore, should not be conducted. At the other extreme, once restoration efforts have decreased the risk of demographic extinction, greater efforts can be put into studies that provide data to “fine tune” production strategies. The co-managers will determine the level of monitoring and evaluation conducted at various abundance levels, and may vary between the Imnaha and Lostine rivers.

Monitoring and Evaluation Goals and Objectives

Monitoring and Evaluation Goal

The **goal** of the monitoring and evaluation program is to monitor and evaluate the results of the NEOH supplementation program so that operations can be adaptively managed to optimize hatchery and natural production, and minimize ecological impacts.

Moreover, other long range Nez Perce Tribe research goals include the following:

- To provide science-based recommendations for management and policy consideration.
- To demonstrate when the hatchery production program meets its recovery, restoration and mitigation goals (see Section 3.1.1).
- To assist in the re-establishment of tribal and recreational fisheries.

Monitoring and Evaluation Objectives

After establishing management goals, managers should choose objectives that will define progress towards achievement of those goals and provide a measurable definition of successful management (Krueger and Decker 1993). The following objectives were formulated to meet the above goal, management needs and to address program uncertainty. Associated performance criteria required to address each objective are listed.

Objective 1. Determine if the performance of the hatchery product is meeting program goals/expectations.

- Abundance
- Survival
- Distribution
- Genetic Profile
- Life History

Objective 2. Determine the status and performance of natural production in the Imnaha and Lostine river subbasins.

- Abundance
- Distribution
- Habitat Use
- Genetic Profile
- Life History
- Environmental Conditions

Objective 3. Estimate ecological and genetic impacts to other fish populations (i.e. interactions).

- Genetic Introgression
- Competition
- Predation
- Disease

Objective 4. Determine how the harvest of chinook salmon can be optimized for tribal and non-tribal anglers within Nez Perce Treaty lands.

- Abundance
- Distribution
- Run Prediction

Objective 5. Effectively communicate monitoring and evaluation program approach and findings to resource managers (i.e., adaptive management implementation).

- Data Management
- Result Reporting
- Activity Coordination

CONCEPTUAL DESIGN

Approaches to monitoring benefits and impacts for supplementation programs are thoroughly discussed by Steward (1996). The conceptual design for the NEOH Monitoring and Evaluation program follows the framework established by Steward (1996) and is organized by categories and subcategories related to supplementation interests. The three primary categories of interests are *Stock Status*, *Ecological Interactions* and *Natural Environment* (Table 2). Performance variables across several subcategories address the monitoring and evaluation goal and objectives.

Table 2. Monitoring and evaluation information needs organized by category and subcategory.

Category	Subcategory
Stock Status	Genetic Resources
	Life History Types
	Population Viability
Ecological Interactions	Intraspecific
	Interspecific
Natural Environment	Production Potential (Limiting Factors)
	Biological Community

Stock Status

Monitoring and evaluation of the Imnaha and Lostine river spring chinook salmon stock status is concerned principally with the characteristics and performance of hatchery and natural populations. Stock status is both a descriptive and operational term that encompasses genetic resources, life history types, and population viability.

Genetic Resources

The purpose of these supplementation projects is to increase natural production. Therefore, efforts are made at all life stages to minimize selective pressures that could promote genetic differences between the hatchery and wild components of the Imnaha and Lostine river chinook runs. Supplementation is defined as the restoration or augmentation of natural production via hatchery production while conserving genetic resources (Kapuscinski et al. 1993). For supplementation to succeed, the hatchery product must be sufficiently adapted to the natural environment to survive, it should be genetically compatible with the naturally produced segment, and it should be managed to conserve or enhance genetic variability. It follows, then, that project monitoring and evaluation of genetics resources should focus on whether genetic similitude exists between hatchery and wild populations and whether genetic variability is sufficient to maintain adaptability. Thus, three performance criteria - genetic adaptedness, genetic relatedness, and genetic variability are assigned high priority in this plan.

Genetic Adaptedness - Monitoring activities will be designed to establish baseline stock profiles and characterize genetic profiles over time for the Imnaha and Lostine chinook population segments. Maintaining the phenotypic integrity of a stock is a primary goal to maintain adaptedness. Traits that presumably have adaptive significance will be incorporated into protocols to confirm or reject deleterious change. Phenotypic characteristics such as size composition, fecundity and growth will be measured to assess "adaptation".

Genetic Relatedness - Electrophoretic data analysis will provide information about the Lostine chinook population structure and "relatedness" after supplementation. Samples from different populations will describe gene flow and determine whether the differences among the hatchery and wild components are small relative to populations outside the Imnaha and Lostine river systems. Examination of microsatellite allele frequencies at polymorphic loci has the potential to increase understanding of hatchery influence on the wild population. Analysis will answer the question of whether the two components belong to a single panmictic population. We will sample wild and hatchery conspecifics at various life history stages (eyed egg, fry, parr, smolt) and compare genetic profiles to identify if and when artificial selectivity changes the profile.

Genetic Variability - Genetic variability is also an important aspect of salmon genetics. Genetic variation is the foundation that enables populations to adapt to a changing environment. It is well known that genetic variability is necessary for favorable natural selection to occur. Fisher (1930) recognized the correlation between genetic variation and the rate of phenotypic change by natural selection. Loss of genetic variability is also associated with inbreeding depression and an overall decrease in population fitness. Genetic drift reduces genetic variation within small populations. Therefore, localized chinook salmon populations that have been reduced in size may also experience reduced genetic variation (Allendorf and Ferguson 1990). The Imnaha and Lostine river chinook salmon population segments will be monitored for evidence of genetic drift and loss of genetic variation.

<u>Special Concerns</u> - RASP (1993) identifies four genetic risks (extinction, loss of within-population variability, loss of between-population variability, and domestication) that can be influenced by broodstock selection. Important considerations in broodstock selection include collection over the entire run and random selection among age classes and life histories. These criteria are not completely satisfied with the current Imnaha weir operation. The M&E plan will evaluate the impact of this design constraint on broodstock selection (*see "special concerns" in the population viability section*).

Life History Traits

Life history traits of fish represent a combination of genetic constraints and adaptive responses to environmental pressures (Ricker 1972; Schaffer and Elson 1975). These traits are defined as a succession of life stages that collectively exhibit a unique pattern of adaptive strategies, as reflected by their demonstrated characteristics within the environment (RASP 1993). A diversity of life history types serves to buffer the population against environmental unpredictability. The variability of these characteristics are what enabled spring chinook salmon to colonize and adapt to the localized conditions of the Imnaha and Lostine rivers. According to Allendorf et al. (1997), the variation in salmonid life history traits also helps to maintain genetic viability within a species. They recommend that stocks be managed as discrete identities and given priority when traits and the underlying genetics are unique. MacLean and Evans (1981) also advocate the identification and preservation of each individual stock and their characteristics as a primary management goal.

If the traits that distinguish one life history from another have a genetic basis, and if they enhance the fitness of individuals possessing those traits, then natural selection will favor that life history type. Although certain life history characteristics may be inherited and reflect adaptation to local conditions, it is incorrect to assert that the entire array of behaviors observed in salmon is entirely genetically controlled. Life history asymmetries may result, in part, from spatial and temporal variation in growth and survival among geographic areas. Age-at-smolting among Atlantic salmon, for example, depends on fish attaining a genetically determined size threshold; environmental conditions determine when that threshold is reached (Thorpe et al 1992). Density-dependent mechanisms influence not only growth and survival but, to varying degrees, the behavior of fish and thus the life history traits of those fish.

Because local wild population characteristics are a result of local environmental pressures and genetics, hatchery fish characteristics should resemble those of the wild population in order to be successful (Steward and Bjornn 1990). Therefore, maximum supplementation benefits will be obtained when the composition, distribution, and life history characteristics of the hatchery and wild Imnaha and Lostine chinook salmon population segments are similar and are such that the carrying capacity of the natural environment is fully exploited. Performance under the life history traits subcategory will be evaluated by four criteria: age-at-maturity, sex ratios, migration timing, and dispersion.

> *Age-at-maturity* - A varied age structure may be an adaptive response to a stream with vacillating environmental conditions. According to Schaffer and Elson (1975), when environmental conditions are harsh and unpredictable, selection favors populations in which adults spawn at different ages. Saunders and Schom (1985) suggested that the variability in age structures of Atlantic salmon is a safeguard against reproductive failure of any one year class. Individuals from one year class return over multiple years, thereby ensuring some contribution from that cohort.
>
> Age at maturity is influenced by genetic, gender, as well as environmental factors (Gall et al. 1988). Hence, salmonid maturity can be manipulated by selective breeding practices

as demonstrated by Tipping (1984, 1991). The difference in age at maturity between male and female fish, as seen in many salmonid populations, is thought to be related to the difference in gonadal investment between the sexes (Moyle and Cech 1988). Males require less growth before reaching sexual maturity than females.

Sex Ratios - An even male:female ratio is normally optimal in vertebrate populations with open, polygamous mating systems (Karlin and Lessard 1986). In some salmon populations, sex ratios have been inadvertently altered by hatchery practices. The Kalninka River chum salmon, *Oncorhynchus keta,* population changed from a 50:50 ratio to a ratio favoring males as a result of selecting only early returning fish for breeding purposes (Altukhov and Salmenkova 1990).

Migration Timing - Timing is an important trait for the long term survival of an anadromous population. Streams may not be in suitable condition if adult return in not adapted to the watershed. Spawning too early or too late adversely affects embryo development and fry survival (Gharrett and Smoker 1993). Spawning too early for stream conditions can have a negative effect on spawner survival (Leider et al. 1984). Although timing is mediated somewhat by temperature and flow, it is primarily under genetic control (Gharrett and Smoker 1993). Numerous examples of altered run timing have been documented when wild populations were supplemented with poorly adapted hatchery fish (Tipping 1984; Leider et al. 1986; Steward and Bjornn 1990).

Dispersion - Salmon are renowned for their abilities to "home" back to the natal stream. Early this century, Taft and Shapovalov (1938) first documented the high degree of precision to which anadromous salmonids return to their stream of origin. Numerous other studies have verified this fidelity (Lister et al. 1981). Yet straying into non-natal streams has also been documented in salmon populations.

Evidence indicates that homing salmonids return to the same spawning area from which they emerged as fry. This finding led to the "sequential imprint hypothesis" (Lister et al. 1981). Olfactory cues stored during smolt emigration and later recalled in reverse order allow migrating adults to return to where they were spawned. Imprecise homing is thought to be related to inaccurate olfactory senses or a disruption of olfactory cues (Leider 1989). After the eruption of Mount St. Helens, Leider (1989) found substantial straying of steelhead from impacted streams. He attributed the straying to increased turbidity and wide ranging temperatures which disrupted sensory acuity.

Straying is not entirely detrimental nor benevolent. It can be the mechanism whereby underseeded streams are colonized and can protect populations from localized environmental catastrophes (Moring 1993). Conversely, extensive straying could potentially impact the genetic integrity of discrete stocks reducing their fitness (Lister 1981).

In general, straying rates tend to decrease with stocks that are reared in the same water where they are released (Lister et al. 1981). Currently, artificially propagated chinook salmon are reared at Lookingglass Hatchery (Grande Ronde subbasin) and released at the

Gumboot acclimation facility in the Imnaha River and at the Lostine River Acclimation facility. The observed percentage of Imnaha River coded-wire-tag adult hatchery reared chinook that strayed from the Imnaha River ranged from 9.5 to 31.1%, for a select number of brood years. The actual number of tag recoveries was generally low, ranging from 8 to 155 tags. The literature on out-system releases similar to the current Imnaha program, demonstrated that coho salmon stray rates were 6.1% higher than control groups (Flint 1981), and steelhead stray rates of 100% were documented (Hooton et al. 1981). Lastly, straying back to the rearing stream from out-system releases of hatchery steelhead smolts has been reported for the Alsea river and neighboring streams on the Oregon coast (Garrison and Peterson 1978). Based on scale analysis, Garrison and Peterson (1978) concluded that a substantial but unknown percentage of steelhead stocked from the Alsea hatchery into other nearby coastal streams were returning to the Alsea River.

Until our understanding of the interaction between genes, the environment, and life history variation improves, it is prudent to measure, preserve, and enhance both genetic and life history diversity in the Imnaha and Lostine chinook salmon population segments. However, the number and type of life histories that can reasonably be maintained through supplementation is a major uncertainty. Therefore, natural life history traits of wild chinook salmon will be used as a template against which hatchery fish are compared.

Population Viability

The Nez Perce Tribe is interested in reestablishing components of the spring / summer chinook salmon in all historic locations within the subbasin. To increase the chances of reestablishment, releases are planned for several of these historic locations. To evaluate this aspect of the program, acclimation and release locations will be surveyed for returning adults. Differential marks will be used to permit identification of release groups. Subsequent surveys of release areas will be conducted to determine if natural spawning is occurring and if this spawning is from released groups.

Knowledge about the population dynamics of Imnaha and Lostine chinook salmon is essential for evaluating management success. Traditionally, the most important biological statistics of a fish population have been population size, mortality or survival rates and reproduction (Ricker 1975). This subcategory is intended to assess the current status of chinook population segments and the prognosis for long-term persistence based on demographic trends and vital statistics. Changes in abundance, survival and reproduction will reflect chinook salmon response to supplementation at the population level. RASP (1992) states that "the stock-recruit model and the concepts of capacity and performance are the basis for a supplementation theory." Accurate and precise abundance estimates are the basis for determining performance and indicate the status of the stock relative to capacity. A common technique for evaluating performance includes developing stock recruitment curves and to further partition production curves by different life history stages. The usefulness of these models is highly related to the quality of input data. Three performance criteria under the *Population Viability* subcategory will be evaluated: abundance, survival and reproductive success.

Abundance - Accurate estimates of abundance and escapement are needed to assess whether Imnaha and Lostine chinook salmon are responding to supplementation. The primary measures of abundance are redd counts and escapement to the weirs. Annual spring chinook salmon redd surveys are conducted by co-managers on a coordinated basis. A long term historical database of redd counts in the Imnaha and Lostine river already exists. The benefit of supplementation will be based in part on time trend analysis of redd count data and adult return to the weirs. Ability to accurately discriminate between hatchery and wild fish is an important monitoring and broodstock management requirement.

To complement and aid in the understanding of adult abundance estimates, natural emigration yield will also be measured. Parr densities can be a useful indicator of abundance. The number of emigrants (presmolts and smolts) produced by a population is also an indication of that population's productivity. Annual juvenile yield will be estimated via the emigration traps in the Imnaha River (NPT) and n the Lostine river (ODFW).

Survival – Stock productivity is a direct function of survival (Steward 1996). The recovery of the Imnaha and Lostine chinook salmon population segments clings to the assumption that mortality rates now operating in smolt to adult spawner life stages can be abated. Emigrant traps, mainstem dams, the adult weir/traps, hatcheries and stream index areas will all serve as evaluation points for survival studies of both wild and hatchery fish. The key to estimating survival is the ability to mark, recapture and count marked and unmarked animals. PIT tags, fluorescent spray, coded wire tags and adipose fin clips will be employed as the primary means of identification. Parr-to-smolt, and smolt-to-adult survival rates will be calculated annually.

Reproduction - Reproductive success is a measure of the relative fitness of hatchery and natural adult chinook, expressed as the average number of progeny that survive to adulthood. An individual's reproductive success is influenced by a number of factors: the availability of suitable mates and spawning habitat, its gametic output, and trans-generational survival probabilities (Steward 1996). At the population level, reproductive success is sensitive to population size in ways other than the obvious one. According to Nelson and Soule (1987), reproductive performance is disproportionately and negatively influenced by inbreeding, a 5% - 10% decrease in fitness for a particular reproductive trait may lead to a total decrease in reproductive performance of 25% or more.

To assess declines or improvements in reproductive success in hatchery and wild chinook, we propose to monitor two reproductive characteristics. The proportion of returning adult salmon that actually spawn can be indexed by the number of fish per redd. An even male:female ratio is normally optimal in vertebrate populations with open, polygamous mating systems (Karlin and Lessard 1986). Hence ideally, there should be one pair of chinook spawners for each redd. Ratios of less than two fish per redd would indicate that males are mating with more than one female or that females are digging more than one redd. Conversely, ratios of more than two fish per redd is often attributed to prespawn mortality. Both types of skewed fish per redd ratios are indicative of reproductive problems.

Reproductive success is also measured by the number of recruits produced by each spawner. For the chinook population segments to remain stable, it must replace itself from one generation to the next. In order for the population to increase this spawner-recruit ratio must exceed one. Ricker and Beverton/Holt spawner-recruit curves represent this relationship graphically. These spawner-recruit curves will be established and amended annually when data from a complete spawner-recruit cycle is obtained.

Special Concerns: The current program uses a combination of weir counts, redd counts, and redds-per-spawner ratios to estimate abundance. The program would benefit from a more accurate and precise abundance measure made near the confluence of the Imnaha and Snake rivers. A potential technique would be to deploy a fish wheel or adult trap in the lower Imnaha River. We acknowledge that placement and operation of adult weirs and traps in larger river systems for purposes of broodstock collection and monitoring of adult abundance is problematic. Further development of this concept will occur during preparation of the detailed monitoring and evaluation plan. After calculating sample efficiency, this would provide a better estimate of abundance which translates into a better measure of adult production, adult progeny:parent ratios and escapement. All are indicators of population viability.

An adult trap located in the lower reach of the Imnaha River would also provide a means to collect brood stock for the production facility. This collection would have advantages over the current weir since the early portion of the run could be collected as well as spawners destined for spawning grounds located downstream of the weir, Lick Creek, or Big Sheep Creek.

Juvenile emigration abundance estimates require the operation of traps either continuously or representatively across all stream conditions. Currently facilities for emigration monitoring in the Imnaha River are not operated continuously due to logistics of operation during high flow/debris conditions. Modification or further of juvenile monitoring facilities development to allow sampling across the entire emigration period (fall/winter/spring) would strengthen the quality of the M&E data and adaptive management process.

The *Population Viability* subcategory embraces the RASP (1993) concepts of post-release survival, reproductive success, and long-term performance. They are treated as population characteristics that are influenced by genetic, life history and environmental factors.

Ecological Interaction

By ecological interactions we mean interactions involving targeted and non-targeted chinook population segments (including hatchery and wild chinook), and interactions between targeted chinook and other species. Two subcategories are identified: Intraspecific Interactions and Interspecific Interactions.

Intraspecific Interaction

At the intraspecific level, hatchery and natural fish can interact in several ways, with potentially harmful consequences. Of the intraspecific interactions reviewed by Steward and Bjornn (1990), all but cannibalism apply to chinook salmon:

- Exploitative and interference competition
- Altered territorial, predator avoidance, and migratory behaviors
- Inappropriate courtship and mating behaviors
- Disease and parasite transmission

The foregoing types of intraspecific interactions are grouped into three performance criteria: competition, reproduction, and disease. Significant intraspecific interactions between hatchery and natural fish are not anticipated in the near-term since natural production is clearly depressed. However, the potential for such interactions will increase as natural populations rebuild, and it may become necessary to monitor short-term disruptions in wild juvenile chinook salmon behavior caused by hatchery releases. The potential for negative interactions involving NEOH produced chinook salmon and chinook salmon from populations outside the basin is unknown, but is important due to the sensitive status of many of those populations.

If wild juvenile chinook salmon are present in significant numbers, introduced hatchery juveniles may be at greatest risk due to food limitations and disruptions in normal patterns of movement. The type and degree of intraspecific interactions involving juveniles will depend on environmental conditions and the quality (behavior, health, etc.) of hatchery fish as affected by rearing and release practices. The challenge is to develop strategies to maximize the benefits of supplementation and minimize the risk to the target population being supplemented. The following performance variables associated with potential risks will be monitored.

> *Competition* – Competition is defined as the demand of more than one organism for the same resource of the environment in excess of the immediate supply (Darwin 1859). Intraspecific competition is one of the main mechanisms that regulates population size in Teleosts species (Moyle and Cech 1988). Since it is an objective of both the Imnaha and Lostine supplementation projects to produce "wild-like" hatchery chinook, competition for resources will occur where hatchery and wild chinook coexist if resources are limiting. The effects of intraspecific competition will be investigated by comparing diets and feeding behavior. If the diets of hatchery and wild fish are similar and growth rates of wild juveniles decline, deleterious competition for limited resources may be inferred.
>
> *Reproduction* – Supplementation requires the stocking of fish into natural habitat in order to increase the abundance of the natural fish population. Previous studies demonstrate that hatchery chinook are able to spawn successfully and increase naturally-reproducing chinook populations (Dauble and Watson 1990; Mullan 1987; Cochnauer and Elam 1990). Yet some studies suggest that hatchery fish are less likely to reproduce than wild

fish and are competitively inferior (Leider et al. 1984; Fleming and Gross 1993). Therefore, knowledge of relative breeding success is important. Spawning surveys will be conducted for evidence of successful breeding, interbreeding and prespawning mortality among hatchery and wild chinook.

Disease – The purpose of disease monitoring is to assess changes in the hatchery and wild component of the Imnaha and Lostine chinook populations. Disease organisms and environmental stressors are normal challenges that face fish populations. However, when pathogens become so numerous or when environmental conditions exceed tolerance levels, fish health becomes a concern for managers. Horizontal transmission of disease from hatchery to wild fish has been documented in salmon (Hastein and Lindstad 1991). Therefore it is imperative that fish health experts be capable of detecting overt diseases in hatchery and wild chinook. Focus will be on disease agents known to cause significant mortality among chinook such as *Renibacterium salmoninarum,* the causative agent of bacteria kidney disease (BKD).

Interspecific Interactions

Population segments of chinook salmon in the Imnaha and Lostine rivers are expected to interact significantly with resident trout, steelhead and other fish species. The potential for interspecific interactions involving chinook salmon will depend on resource demand and availability, and the degree of overlap of competitors, predators, and prey in space and time. The performance criteria to be evaluated under this subcategory are interspecific competition and trophic dynamics (predator-prey interactions).

Competition – In most cold-water lotic communities, fish have a considerable degree of behavioral plasticity that allows them to minimize competition for resources. Ecological segregation is also possible due to the relatively small number of species found in these streams (Moyle and Cech 1988). However, if the existing fish community is highly structured and competitor species have exploited the niche formerly occupied by abundant chinook, then enhancement through supplementation may be difficult in the Imnaha and Lostine rivers. According to the "Competitive Exclusion Principle" two species cannot occupy the same niche indefinitely (Hardin 1960). Fausch and White (1981) found competitive interaction between two salmonid species in a Michigan stream. The dominant introduced species caused ecological displacement of the indigenous species leading to niche divergence. The interspecific competition resulted in poorer survival, reproduction and growth due to exclusion from the preferred habitat.

Since growth rates are highly sensitive to per capita resource availability, it may be a useful indicator of competition (Backiel and Le Cren 1978). Growth rates will be monitored along with densities of potential competitor species. Observations of competitive behaviors and habitat use will be made in conjunction with intraspecies studies at time of release.

Trophic Dynamics – Diet analysis makes predation easier to document than competition. Among 23 community experiments on predation and prey reviewed by Sih et al. (1985), predation was detected in 22 fish communities. Yet predation's influence on community structure is just as difficult to quantify as competition. Although predation is probably the most frequent cause of death in stream fish communities, demonstrating how it regulates distribution and abundance is arduous (Crowder 1990). Predators can regulate the population size of prey species when they consume a higher percentage of the prey as the prey density increases. Only then will predation act as a density-dependent factor on the prey population (Brewer 1988).

There is reason to believe that predation is a major source of mortality for anadromous salmonids in both fresh and saltwater. Pisciverous fishes prey heavily on wild and hatchery salmonids in spawning and rearing tributaries (Larsson 1985; Ruggles 1980). Juvenile salmonids are especially vulnerable to predation in the lower sections of the Snake and Columbia rivers (Palmer et al. 1986; Gray and Rondorf 1986). Sharks, sea lions, harbor seals and lampreys are all encountered in coastal and high sea areas by salmon (Ricker 1976). Evaluating the effects of predation during the complete life cycle of Imnaha and Lostine chinook populations is beyond the scope of this M&E plan. However, diet analysis in these rivers can confirm the presence of predation on wild and hatchery chinook if not the effect of predation. Survival studies during emigration periods may also infer the potential of predation as a source of mortality.

Natural Environment

Stock status and performance can be evaluated only with respect to the properties of the natural environment in which the population is found. For this reason, information on the Natural Environment was identified as a priority need to be addressed through monitoring and evaluation. Interactions between abiotic and biotic components of the ecosystem are addressed under the Natural Environment category. Biophysical processes affecting habitat carrying capacity and other factors regulating chinook salmon abundance are also discussed under the Natural Environment category. The Natural Environment category is defined by two subcategories: Production Potential and Biological Community.

Production Potential

An assessment of supplementation opportunities must consider the amount and quality of habitat available within the environment, at scales ranging from the individual stream channel unit, to the watershed, and to the ocean. For practical reasons, we focus primarily on factors that regulate population abundance and determine carrying capacities of freshwater habitats. Several performance criteria relating to the physical structure and function of the Imnaha and Lostine rivers and how it affects salmonid habitat and production are identified. Riparian areas are included because they represent important linkages between terrestrial and aquatic environments.

If possible, the production potential of the Imnaha and Lostine rivers should be defined as it existed under pristine conditions, as it currently exists, and as it might exist at some point in the future. The process of identifying and quantifying production potential and limiting factors should also suggest opportunities for habitat protection and enhancement.

Hydrology – Although fish communities are adapted to the typical seasonal variability of stream flows, insufficient or excessive discharge can limit fish biomass (Binns and Eiserman 1979). Flow can effect migration timing and spawning success. Stream flow also indirectly effects fish production potential because it influences water temperatures, channel type, riparian habitat and substrates. Therefore, we will monitor hydrological inputs in the form of snowpack and rainfall and hydrological outputs in the form of stream discharge. Correlations between these data and stock status variables related to production potential will be analyzed.

Water Quality – Water temperature effects on salmon physiology, growth and survival are well documented (Steward 1996). Preferred temperatures and tolerance limits at various life stages are also known for spring chinook salmon. The production potential of the Imnaha and Lostine rivers are directly related to the thermal regimes found in these streams. Available historical data will be compiled and summary statistics calculated. Monitoring sites will be established in consequential stream reaches where temperatures are suspected of exceeding tolerance limits for chinook. Special attention will be given to areas of spawning, incubation and rearing.

Riparian Quality – Riparian zones along a stream occur between upland habitat and the stream edge. An intact riparian zone is essential for stream health (Naiman et al. 1993). Riparian vegetation provides shade, cover, intercepts runoff, contributes nutrients for oligotrophic streams and acts as a source of large woody debris. The maintenance of an intact riparian zone along the Imnaha and Lostine rivers is fundamental for sustaining chinook production potential. Monitoring and assessment of riparian areas should be coordinated with the state of Oregon, U.S. Forest Service, U.S. Geological Service and other appropriate agencies.

Biological Community

Salmon populations and the biological community of which they are a part mutually influence each other. This is because salmon are both sources and processors of energy, and by their numbers and ecology, either directly or indirectly influence the distribution and abundance of other species. It is also true that the presence of other species affects the abundance and ecological role of salmon. Most of the direct forms of interaction expected under the supplementation program will be monitored under *Ecological Interactions* performance criteria. Under the Biological Community subcategory we are more concerned with the possibility of a decline in the variety and abundance of native aquatic species, either as a consequence of supplementation or due to other causes. Our basic premise is that chinook salmon populations can be re-established only in biological and physical environments that are within the adaptive range of the species. A diverse, stable, and productive biological community is indicative of a normally functioning ecosystem and is essential to supplementation success. For this reason, we propose to monitor the variety of key freshwater species using a number of indices of ecological well-being.

Species diversity – The diversity of aquatic species in a stream environment is determined by biogeography, competition, predation and the stream's abiotic characteristics. A diverse community is characterized by a relatively large number (richness) of species (Crowder 1990). Data on fish and macroinvertebrate species composition in the Imnaha and Lostine rivers will be compiled from existing sources. Diversity can be measured with a variety of indices (Pielou 1975; Grassle et al. 1979; Magurran 1988). These indices are useful indicators of experimental effect such as supplementation. A "before and after" design allows comparison of species richness on the supplemented stream. Fish and macroinvertebrate samples will be taken annually and used to test for differences between pre- and post-supplementation conditions.

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Appendix E
Evaluation of Existing Facilities

Table E-1. Review of Existing Facilities in the Columbia River Basin that Produce Spring Chinook (Data from IHOT reports and personal communications with operating agencies)

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Columbia River mainstem – below Bonneville Dam									
Willamette	ODFW	Salmon Creek near confluence with Willamette	Spring chinook Steelhead Trout	N N N	COE ODFW BPA	Salmon Creek	N		554 miles
McKenzie	ODFW	McKenzie River near Springfield, OR	Spring chinook	N	COE ODFW	McKenzie River Cogswell Creek	N		513 miles
Marion Forks	ODFW	Santiam River near Detroit, OR	Spring chinook Steelhead Trout	N N N	COE	Marion Creek, Horn Creek	N		503 miles
South Santiam	ODFW	S. Santiam River below Foster Dam	Spring chinook Steelhead Fall chinook	N N N	ODFW COE	Foster Reservoir	N		501 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Cowlitz Salmon (Salkum)	WDFW	Cowlitz River near Mossyrock, WA	Spring Chinook Coho Steelhead Fall Chinook	N N N N	Tacoma City Light	Cowlitz River Wells	N		499 miles
North Toutle	WDFW	Green River near Castle Rock, WA	Spring Chinook Coho Steelhead Fall Chinook	N N N N	Mitchell Act	Green River	N		460 miles
Fallert Creek	WDFW	Kalama River near Kalama, WA	Spring Chinook Fall Chinook Coho	N N N	Mitchell Act	Kalama River Fallert Creek	N		438 miles
Kalama Falls	WDFW	Kalama River near Kalama, WA	Spring Chinook Fall Chinook Coho	N N N	Mitchell Act	Kalama River Wells Unnamed creek	N		438 miles
Lewis River and Speelyai	WDFW	Lewis River near Woodland, WA	Spring Chinook Coho	N N	Mitchell Act	Lewis River Colvin Creek Unnamed stream	N		429 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Clackamas	ODFW	Clackamas River near Estacada, OR	Spring chinook Steelhead	N N	ODFW Mitchell Act PGE City of Portland	Clackamas River Well	Y	N	424 miles
Bonneville	ODFW	Columbia River, west of Cascade Locks, OR	Spring Chinook Coho Steelhead Fall Chinook	Y1 N N N	Mitchell Act COE NMFS	Tanner Creek Wells	N		357 miles
Columbia River mainstem – above Bonneville Dam									
Warm Springs	USFWS	Warm Springs River near Warm Springs, OR	Spring chinook	N	?	Warm Springs River	N		428 miles
Round Butte	ODFW	Deschutes River near Madras, OR	Spring chinook Steelhead Brown trout	N N	PGE	Lake Billy Chinook	N		428 miles
Klickitat	WDFW	Klickitat River near Glenwood, WA	Spring Chinook Coho Fall Chinook	N N N	Mitchell Act	Klickitat River Springs	N		377 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Carson	USFWS	Wind River near Carson, WA	Spring Chinook	N	Mitchell Act	Wind River Tyee Creek Tyee Spring	N		377 miles
Oxbow	ODFW	Columbia River near Cascade Locks, OR	Spring chinook Coho Steelhead	N N N	Mitchell Act	Oxbow Springs	Y	Y	357 miles
Little White Salmon	USFWS	Little White Salmon River near Stevenson, WA	Spring chinook Fall chinook	N N	Mitchell Act	Little White Salmon River Springs	N		357 miles
Spring Creek	USFWS	Columbia River at Underwood, WA	Fall chinook Spring chinook	N N	Mitchell Act/John Day mitigation	Columbia River Springs Well Unnamed creek	N		347 miles
Umatilla	ODFW	Columbia River near Irrigon, OR	Spring chinook Steelhead Fall chinook	N N N	BPA	Wells	Y	Y	244 miles
Irrigon	ODFW	Columbia River near John Day Dam	Steelhead Trout Spring chinook2	N N Y	LSRCP	Wells	Y	Y	244 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Mid-Columbia									
Winthrop	USFWS	Methow River near Winthrop, WA	Spring chinook	?	GCFMP Mitchell Act?	Methow River Springs Wells	N		480 miles
Methow	WDFW	Methow River near Winthrop, WA	Spring Chinook Chewuch Methow Twisp	 ? ? ?	Douglas PUD	Methow River Wells	N		480 miles
Leavenworth	USFWS	Icicle Creek near Leavenworth, WA	Spring chinook Steelhead	?	Mitchell Act	Icicle Creek Snow & Nada lakes	Y	N	394 miles
Entiat	USFWS	Entiat River near Entiat, WA	Spring chinook	?	Mitchell Act	Entiat River Packwood spring Well	N		393 miles
Cle Elum	YIN		Spring chinook	?	BPA	?			387 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Rock Island Complex	WDFW	Columbia River near Wenatchee, WA	Spring chinook Chiwawa Summer chinook Wenatchee Methow/Okan. Sockeye Wenatchee	? ? ?	Chelan PUD		N		376 miles
Snake River									
Sawtooth	IDFG	Salmon River near Stanley, ID	Spring chinook Steelhead	N N	LSRCP	Salmon River Wells	Y	N	529 miles
Rapid River	IDFG	Rapid River near Riggins, ID	Spring chinook	N	Idaho Power		N		368 miles
McCall	IDFG	N.F. Payette River, McCall, ID	Summer chinook	?	LSRCP	Payette Lake	N		351 miles
Kooskia	USFWS	Clear Creek near Kamiah, ID	Spring Chinook	N	LSRCP	Clear Creek	N		332 miles
Clearwater	IDFW	Clearwater River, Ahsaka, ID	Spring chinook	N	LSRCP	Dworshak Reservoir	N		302 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-53°F or <48 constant)	Distance from Imnaha subbasin (Gumboot)
Dworshak	USFWS	Clearwater River, Asahka, ID	Spring chinook Steelhead	N ?	LSRCP		N		302 miles
Lyons Ferry	WDFW	Snake River near Dayton, WA	Tucannon sp Chinook Snake River fall chinook Steelhead	Y Y N	LSRCP	Wells	Y	N	257 miles

Table E-2. Review of Existing Facilities in the Columbia River Basin that Produce Species other than Chinook (Data from IHOT reports and personal communications with operating agencies)

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-48°F)	Distance from Imnaha subbasin (Gumboot)
Coastal									
Alsea	ODFW	Alsea River Near Alsea, OR	Rainbow Trout Steelhead	N N		Alsea River	N		508 miles
Columbia River Basin									
Pahsimeroi	IDFG	Ellis, ID	Steelhead	N	Idaho Power				604 miles
Leaburg	ODFW	McKenzie River near Springfield, OR	Steelhead Trout	N	COE	McKenzie River	N		531 miles
Klaskanine	ODFW	North Fork Klaskanine River near Astoria, OR		N		Klaskanine	N		504 miles
Gnat Creek	ODFW	Gnat Creek near Astoria, OR	Steelhead	N	Mitchell Act	Gnat Creek	N		504 miles
Grays River	WDFW	West Fork Grays River	Fall Chinook Coho Steelhead	N	Mitchell Act	West Fork Grays River Wells Unnamed stream	Y		497 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-48°F)	Distance from Imnaha subbasin (Gumboot)
Big Creek	ODFW	Big Creek, 16 miles east of Astoria, OR	Steelhead Fall Chinook	N	Mitchell Act	Big Creek	N		488 miles
Elokomin Salmon	WDFW	Elokomin River near Cathlamet, WA	Fall Chinook Coho	N	Mitchell Act	Elokomin River Clear Creek Unnamed stream	N		477 miles
Beaver Creek	WDFW	Elochoman River near Cathlamet, WA	Steelhead Sea run Cutthroat	N N	Mitchell Act	Elochoman River Beaver Creek Well – 1 cfs	Y	N	477 miles
Abernathy	USFWS	Abernathy Creek	Fall Chinook	N	Mitchell Act	Abernathy Creek Well	Y	N	468 miles
Roaring River	ODFW	Roaring River near Albany, OR	Steelhead Trout	N N	ODFW	Roaring River Some filtered	N		466 miles
Cowlitz Trout	WDFW	Cowlitz River near Longview, WA	Steelhead Sea run Cutthroat	N N	Tacoma City Light	Well Ozonated Columbia River			460 miles
Merwin Dam	WDFW	North Fork Lewis River	Steelhead Sea-run Cutthroat Trout	N	PacifiCorp	Lake Merwin Ozone from June-Sept.			437 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-48°F)	Distance from Imnaha subbasin (Gumboot)
Eagle Creek	USFWS	Eagle Creek near Portland, OR	Coho Steelhead	N N	Mitchell Act	Eagle Creek springs	N		432 miles
Magic Valley	LSRCP	Snake River near Filer, ID	Steelhead	N	LSRCP	Springs	N		432 miles
Hagerman	LSRCP		Steelhead	N	LSRCP	Springs	N		432 miles
Wells	WDFW	Columbia River near Wells Dam	Summer chinook Fall chinook Steelhead Trout	N N	Douglas PUD	Columbia River Wells			427 miles
Sandy	ODFW	Cedar Creek near Sandy, OR	Coho	N	Mitchell Act	Cedar Creek springs	N		422 miles
Niagara Springs	IDFG	Wendell, ID	Steelhead	N	Idaho Power				418 miles
Washougal	WDFW	Washougal River near Washougal, WA	Fall Chinook Coho	N N	Mitchell Act	Washougal River 3 creeks	N		417 miles
Skamania	WDFW	North Fork Washougal River near Washougal, WA	Steelhead Sea-run Cutthroat	N	Mitchell Act	North Fork Washougal River Vogel Creek	N		417 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-48°F)	Distance from Imnaha subbasin (Gumboot)
Vancouver	WDFW	Columbia River near Vancouver, WA	Steelhead Trout Catfish		Mitchell Act	Well Springs	N		416 miles
Chelan PUD/ Turtle Rock	WDFW	Columbia River near Chelan Falls, WA	Steelhead Trout Kokanee	N	PUD	Wells Springs Columbia River			410 miles
Eastbank	WDFW	Columbia River near Wenatchee, WA	Steelhead		Chelan PUD				376 miles
Rocky Reach	WDFW	Columbia River below Rocky Reach Dam	Fall chinook	N	Chelan PUD	Columbia River			374 miles
Oak Springs	ODFW	Deschutes River near Maupin, OR	Steelhead Trout	N	ODFW	Springs	N		361 miles
Willard	USFWS	Little White Salmon upstream of LWS hatchery	Coho	N	Mitchell Act	Little White Salmon River Wells Springs	N		357 miles
Cascade	ODFW	Eagle Creek near Cascade Locks, OR	Coho	N	Mitchell Act	Eagle Creek	N	N	357 miles

Hatchery Name	Operator	Location	Species/ Stock currently produced	ESA listed	Authorization	Water Source	Pathogen Free Water For Incubation	Incubation Temperature criteria met? (41-48°F)	Distance from Imnaha subbasin (Gumboot)
Priest Rapids	WDFW	Columbia River below Priest Rapids Dam	Fall chinook	N	Grant PUD	Columbia River Wells			304 miles
Wallowa	ODFW	Wallowa River, Enterprise, OR	Steelhead Trout	N N	LSRCP	Wallowa River Spring Creek ?	N		67 miles

Appendix F
Costs Estimates for Proposed Facilities

Open:

"Northeast Oregon Hatchery Project
Spring Chinook Master Plan Appendix F"

Appendix G - Spawning Matrix from the Captive Brood Annual Operations Plan

Spawning Matrix from the Captive Brood Annual Operations Plan

Our approach to this considers the total spawning population, multiple age classes, and cryopreserved semen as well as a balance with the logistic limitations associated with spawning. Furthermore, we have some concern about potential sibling crosses and inbreeding. We will attempt to use the following decision-making process to spawn. We may need to adjust these protocols as we learn more about the process, but will follow similar principles.

Each week, fish that are ready to spawn will be placed in a holding container. This will allow the separation and enumeration of, for example, four and five year-old females as well as three, four, and five year-old males. Once this process is complete, we will determine the female:male ratio of fish that are ready to spawn. The female:male ratio will determine the type and number of matrices to be used during spawning. The focus is on making each parent's contribution to the next generation as equal as possible, increasing the numbers of fish in a matrix, making sure females were fertilized by more than one male, and having the highest numbers in each matrix cell for a given number of spawners (i.e., a 2 x 2 matrix is preferred over a 1 x 3 matrix). Based on genetic and logistics considerations, the preferred ratio to work with is even numbers of males and females, where we would use 3 x 3 or 2 x 2 matrices (in that order) during spawning (it is not desirable to use 1 x 1 matrices). The female:male ratio (x) will fall into one of seven categories:

A) $x > 4:1$,

B) $4:1 \geq x > 3:2$,

C) $3:2 \geq x > 1:1$,

D) $x = 1:1$,

E) $1:1 > x \geq 2:3$,

F) $2:3 > x \geq 1:4$, or

G) $1:4 > x$.

Generally we hope to be in category C, D, or E. Each category is associated with a particular spawning matrix. After the first matrix is assigned, we will recalculate the female:male ratio of the remaining spawners. If the new ratio is in the same category, we will use the same matrix design. If the ratio is in a new category we will use the new, appropriate matrix. This is an iterative process that will occur after each successive matrix assignment.

The preferred ratio is one that falls in Category D. Under Category D we will spawn fish in a 3 female x 3 male matrix. Once fewer than 12 spawners are available, care should be taken during matrix development so that 1 x 1 matrices are avoided. For example, if eight spawners are available we should spawn using two 2 x 2 matrices rather than one, 3 x 3 matrix and one, 1 x 1 matrix.

If the ratio of available spawners reaches Category E, we will spawn fish in a 2 female x 3 male matrix. If the ratio of available spawners reaches Category F, we will develop a working ratio by inverting the original ratio (i.e., if the female:male ratio is 0.32:1, the working ratio would be 1:0.32 or 3.125:1 males:females). We will then round up to the nearest whole number the males in the ratio (i.e., if the ratio is 3.125:1, round to 4:1). We will spawn the fish using a matrix design equal to the rounded ratio (for example, a 1 female x 4 male matrix). We will continue to use this matrix until the ratio of available spawners changes to a new category or all fish are spawned. Once fewer than 12 spawners are available, care should be taken during matrix development so that 1 x 1 matrices are avoided. For example, if seven spawners are available we should spawn using one, 3 x 4 matrix rather than one, 2 x 3 matrix and one, 1 x 1 matrix. If this matrix is used throughout the spawning cycle, it is imperative to make sure that the last group of fish is accounted for appropriately in a final matrix. In categories E and F we will attempt to make sure that the minimum number of either sex in a matrix is two (for example, if the ratio is 1:2 we will use a 2 x 4 matrix) and the maximum number of either sex in a matrix is four.

If the ratio of available spawners reaches Category C, we will spawn fish in a 3 female x 2 male matrix. If the ratio of available spawners reaches Category B, we will round up to the nearest whole number the females in the ratio (i.e., if the ratio is 2.4:1, round to 3:1.). We will spawn the fish using a matrix design equal to the rounded ratio (for example, a 3 female x 1 male matrix). We will continue to use this matrix until the ratio of available spawners changes to a new category or all fish are spawned. Once fewer than 12 spawners are available, care should be taken during matrix development so that 1 x 1 matrices are avoided. For example, if seven spawners are available we should spawn using one, 4 x 3 matrix rather than one, 3 x 2 matrix and one, 1 x 1 matrix. If this matrix is used throughout the spawning cycle, it is imperative to make sure that the last group of fish is accounted for appropriately in a final matrix. In categories B and C we will attempt to make sure that the minimum number of either sex in a matrix is two (for example, if the ratio is 2:1 we will use a 4 x 2 matrix) and the maximum number of either sex in a matrix is four.

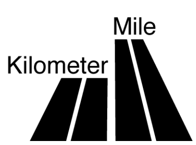
If the ratio reaches Category G, we will develop matrices using the protocols for Category F. We will cryopreserve a semen sample from males in excess of a 1 female:4 male ratio. We will recycle the males from which semen is cryopreserved so they may be incorporated into the brood during later spawns.

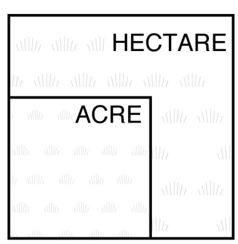
If the ratio reaches Category A, we will attempt to use cryopreserved semen samples to increase the parent population to a 4 female:1 male ratio. If too few cryopreserved semen samples are available to accomplish a 4:1 ratio, we will attempt to use recycled males to increase the parent population to a 4:1 ratio. If too few cryopreserved semen samples and recycled males are available to achieve this ratio, and if broodstock was available from Grande Ronde River stocks, we will consider using conventional male broodstock to increase the parent populations to a 4:1 ratio. If all of these options combined do not allow us to achieve a 4:1 ratio, we will modify the spawning matrix to ensure that all eggs are fertilized using whatever matrices are necessary.

In general, we will try to achieve different ages and no duplicate ages within each matrix. For example, if we were using a matrix that called for 3 males, our preference would be to have 1 male from each age class. Our second choice in this example would be to have 2 males from one age class and 1 male from a second age class. Our last choice would be to have 3 males from 1 age class, especially the same age class as the female. We will begin by assigning females, then males to matrix 1, then to matrix 2, then to matrix 3, and so on. When we have to use more than one fish from a given age class, we will initially target mates from a different age class and then target mates from the age class with the greatest number of fish.

Metric Conversion Chart

Symbol	When You Know the Number of	Multiply by	To Find the Number of	Symbol
in	inches	25.4	millimeters	mm
ft	feet	0.3048	meters	m
mi	miles	1.6093	kilometers	km
ft^2	square feet	0.0929	square meters	m^2
ft^3	cubic feet	0.02832	cubic meters	m^3
ac	acres	0.4046	hectares	ha
lb	pounds (avdp)	0.4535	kilograms	kg
degrees F	degrees Fahrenheit	5/9(after subtracting 32)	degrees Celsius	degrees C
m	meters	3.2808	feet	ft
km	kilometers	0.6213	miles	mi
m^3	cubic meters	263	gallons	gal
m^3	cubic meters	35.3147	cubic feet	ft^3
ha	hectares	2.4710	acres	ac
kg	kilograms	2.2046	pounds (avdp)	lb
degrees C	degrees Celsius	9/5(after adding 32)	degrees Fahrenheit	degrees F





Hectare: about two and one-half acres