Revised Master Plan for Yakima Subbasin Summer- and Fall-Run Chinook, Coho Salmon and Steelhead

VOLUME I

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Submitted by

The Confederated Tribes and Bands of the Yakama Nation

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EXECUTIVE SUMMARY

In this Revised Master Plan, the Yakama Nation proposes to implement hatchery programs for Yakima Basin Coho and summer- and fall-run Chinook salmon, as well as a Wild Steelhead Kelt Reconditioning program. The primary purpose of the proposed Coho and Chinook programs is to increase harvest of Coho and Chinook salmon in the Zone 6 and Yakima River Basin fisheries. The programs will also help meet the cultural objectives of providing salmon for ceremonial and subsistence use. In addition, increasing the number of fish spawning naturally in the Yakima River basin will contribute to the Yakama Nation's cultural objective of seeing salmon complete their life cycle in the wild. The integrated Coho and summer/fall Chinook programs are also designed to meet the conservation objectives of reestablishing locally-adapted populations upstream of Prosser Dam and increasing the spatial and temporal diversity of the naturally-spawning populations. The purpose of the Wild Steelhead Kelt Reconditioning program is to increase the number of repeat spawners in the Yakima River MPG populations and increase the overall number of naturally-spawning steelhead in the system. The program will also contribute to restoring opportunities for terminal harvest and providing fish for ceremonial and subsistence uses.

All three programs will be components of the ongoing Yakima-Klickitat Fisheries Project (YKFP) under which the Yakama Nation and its partners are enhancing existing populations of anadromous fish in the Yakima and Klickitat river basins and reintroducing stocks formerly present in the subbasins. The YKFP is attempting to evaluate all stocks historically present in the Yakima Subbasin and apply a combination of habitat restoration and hatchery supplementation or reintroduction to restore the Yakima Subbasin ecosystem with sustainable and harvestable populations of salmon, steelhead and other at-risk species. The decline of the Yakima River Basin Chinook, Coho and steelhead populations has greatly reduced the Tribe's ability to exercise its Treaty-reserved fishing right. The proposed programs are intended to enhance fishing opportunities for Tribal members guaranteed by the Treaty of 1855 and confirmed by *U.S. v Oregon*.

The Yakama Nation proposes two Coho hatchery programs: 1) **Upper Yakima Integrated Coho Program** and 2) **Lower Yakima Segregated Coho Program**.

Table ES-1 outlines the harvest, cultural, and conservation goals for the programs and the role the proposed hatchery programs are expected to play in meeting those goals. Detailed descriptions and rationales for the two proposed Coho hatchery programs are provided in Chapter 2. The initial phases of both Coho programs have been completed and the modifications proposed under this Master Plan will implement the final program phases (referred to as Phases 3 and 4).

Table ES-1. Overview of the two Yakima Coho programs addressed in this Master Plan.

	Upper Yakima Integrated Coho Program	Lower Yakima Segregated Coho Program
Natural population	Extirpated	None
ESA Status	Not Listed	Not Listed
Spawning Area	Yakima River tributaries and mainstem	Not intended to spawn
Harvest Goals	Contribute > 10,700 adults to all fisheries, including > 4,700 to Zone 6 and the Yakima River fisheries	
Yakama Nation Cultural Goal	Reestablish natural spawning of Coho in tributaries where they occurred historically	Meet treaty harvest entitlements per *U.S. v. Oregon* agreements
Conservation Goals	Increase the number of natural-origin returns to the Yakima Subbasin to >2,600 adults and reestablish a naturally-spawning Coho population.	None
Broodstock Origin	Lower Columbia hatchery Coho	Lower Columbia hatchery Coho
Hatchery Program Purpose	Harvest and reestablishment of a naturally-spawning Coho population	Harvest
Hatchery Broodstock Management	In Phase 3, the program will transition to using only local brood and 30% natural-origin broodstock. In Phase 4, the program will use 100% natural-origin broodstock.	This currently is and will continue to be a segregated program. It will transition to a segregated "stepping stone" program over time by using integrated HORs as broodstock, providing genetic continuity with the Upper Yakima integrated program.
Hatchery Broodstock Collection Locations	With implementation of this Master Plan, broodstock will be collected at Prosser and Roza dams.	With the implementation of this Master Plan, broodstock will be drawn from hatchery returns from the local program at Prosser to increase survival and homing.
Hatchery Program Size—Phases 3 and 4	500,000 parr equivalent 200,000 yearlings	500,000 yearlings
Hatchery Location	Melvin R. Sampson Hatchery	Prosser Hatchery
Smolt/Parr Release Locations	Tributaries and upper Yakima and Naches mainstem reaches	Prosser Hatchery
Marking/Tagging	100% CWT, 5-10% PIT tagged	100% ad clipped
Adult Outplants	Up to 1,000 segregated program adults will be outplanted into upper reaches of Yakima and Naches rivers. Adults will be collected at the Prosser Denil or Roza Adult Monitoring Facilities.	Not applicable

In addition, the Yakama Nation proposes two Chinook hatchery programs with distinct and separate purposes: 1) **Yakima Integrated Summer/Fall Chinook Program**, and 2) **Yakima Segregated Upriver Bright Program**.

Table ES-2 outlines the harvest, cultural, and conservation goals for the Yakima summer/fall Chinook and URB fall Chinook programs and the role the proposed hatchery programs are expected to play in meeting those goals. Detailed descriptions and rationales for the two proposed Chinook hatchery programs are provided in Chapter 3.

Table ES-2. Overview of the two Yakima Chinook salmon programs addressed in this Master Plan.

	Yakima Integrated Summer/Fall Chinook Program	Yakima Segregated Upriver Bright Program
Associated Natural Population	Yakima River Summer/Fall Chinook (extirpated)	Hanford/Priest Rapids URB Fall Chinook
ESU	Upper Columbia Summer/Fall Chinook ESU	Upper Columbia Summer/Fall Chinook ESU
ESA Status	Not Listed	Not Listed
Spawning Area	Yakima River, upstream of Prosser Dam	Lower Yakima River, downstream of Prosser Dam and the mainstem and Upper Columbia River
Hatchery Program Purpose	Harvest and reestablishment of a naturally-spawning, locally-adapted bimodal summer/fall Chinook population spawning above Prosser Dam	Harvest
Harvest Goals	Temporally and spatially expand fishing season in the Yakima River to historic patterns. Transition: contribute >15,000 adults to all fisheries Long term: contribute >20,000 adults to all fisheries	
Yakama Nation Cultural Goals	• Natural spawning of Chinook salmon over historic range and time periods in the Yakima River • Meet ceremonial and subsistence requirements	Meet treaty harvest entitlements as confirmed and specified in U.S. v. Oregon agreements
Conservation Goals for Natural Population	Transition: >5,500 total spawners (NOR+HOR) Long term: >4,000 natural-origin (NOR) spawners	Contribute toward U.S. v. Oregon combined escapement target at McNary Dam
Broodstock origin	Summer-run - Transition: Upper Columbia summer-fall Chinook via Entiat or Wells Hatcheries or local returns to Prosser	Hanford Reach fall Chinook via Priest Rapids Hatchery

	Yakima Integrated Summer/Fall Chinook Program	Yakima Segregated Upriver Bright Program
	Summer-run - Long-term: Upper Columbia summer-fall Chinook via local returns to Roza Dam or Naches weir(s) Fall-run Component: Hanford Reach fall Chinook via local returns to Prosser	
Broodstock Management	Transition to an **integrated** program over time as local, natural-origin returns become available for broodstock.	This program will be managed as a **segregated** hatchery population relative to the Yakima River summer-fall population.
Broodstock Collection Locations	Prosser Dam Summer-run - Long-term: local returns to Roza Dam or Naches weir(s)	Prosser Dam, Little White Salmon NFH, Priest Rapids Hatchery, Priest Rapids Dam
Hatchery Program Size	Summer-run: 1 million subyearlings Fall-run: 500,000 subyearlings	1.7 million subyearlings 210,000 yearlings
Hatchery Facility	Prosser Hatchery Summer-run - Long-term: TBD site upstream of Naches/Yakima R confluence	Prosser Hatchery
Marking/Tagging	100% CWT	100% ad clipped, 10% CWT
Release Locations	Summer-run - Transition: 50% of available subyearlings at Prosser Hatchery; remaining fish from temporary acclimation sites in Yakima River above confluence of Naches and Yakima Rivers Summer-run - Long-term: 50% of available subyearlings each from acclimation sites in Yakima River above confluence of Naches and Yakima Rivers	Prosser Hatchery

Finally, the Yakama Nation proposes to continue the existing Wild Steelhead Kelt Reconditioning program. Table ES-3 outlines the harvest, cultural, and conservation goals for the Yakima Wild Steelhead Kelt Reconditioning program and the contribution of the program to meeting those goals. A detailed description of the program is provided in Chapter 4.

Table ES-3. Overview of the Yakima steelhead kelt reconditioning program addressed in this Master Plan.

<table>
<tr><th></th><th colspan="6">Yakima Steelhead Kelt Reconditioning Program</th></tr>
<tr><td>Associated Natural Population</td><td colspan="6">Yakima River Steelhead MPG (4 populations)</td></tr>
<tr><td>ESU</td><td colspan="6">Mid-Columbia Steelhead ESU</td></tr>
<tr><td>ESA Status</td><td colspan="6">Threatened</td></tr>
<tr><td>Spawning Area</td><td colspan="6">Upper Yakima River, including the mainstem and all tributaries above the confluence with the Naches River; the Naches River system including Ahtanum Creek and Yakima Mainstem extending from the confluence of the Naches down to Toppenish Creek; Toppenish Creek; and Satus Creek</td></tr>
<tr><td>Program Purpose</td><td colspan="6">Increase the number of repeat spawners in the Yakima River MPG populations and increase the overall number of naturally-spawning steelhead in the system.</td></tr>
<tr><td>Harvest Goals</td><td colspan="6">Restore harvest opportunities for terminal fisheries in the Yakima Basin</td></tr>
<tr><td>Yakama Nation Cultural Goals</td><td colspan="6">Natural spawning of Steelhead over historic range and time periods in the Yakima River.
Meet ceremonial and subsistence requirements.</td></tr>
<tr><td rowspan="8">Conservation Goals for Natural Populations</td><td rowspan="3">Populations</td><td colspan="5">Natural Production</td></tr>
<tr><td colspan="2">Abundance</td><td colspan="3">Potential Goal Range</td></tr>
<tr><td>Recent</td><td>Historical</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>Satus Creek</td><td>1,100</td><td>4,000</td><td>1,000</td><td>1,500</td><td>2,000</td></tr>
<tr><td>Toppenish Creek</td><td>500</td><td>3,400</td><td>500</td><td>1,000</td><td>1,500</td></tr>
<tr><td>Naches River</td><td>1,200</td><td>8,400</td><td>1,500</td><td>3,450</td><td>5,400</td></tr>
<tr><td>Upper Mainstem</td><td>200</td><td>10,400</td><td>500</td><td>1,500</td><td>7,700</td></tr>
<tr><td>Total Yakima MPG</td><td>3,000</td><td>26,200</td><td>3,500</td><td>7,450</td><td>16,600</td></tr>
<tr><td>Kelt Collection Locations</td><td colspan="6">Prosser Dam</td></tr>
<tr><td>Program Size</td><td colspan="6">Up to 1,500 wild/natural kelts</td></tr>
<tr><td>Facility</td><td colspan="6">Prosser Hatchery used to temporarily recondition wild/natural kelts in artificial environment to increase survival to repeat spawner</td></tr>
<tr><td>Marking/Tagging</td><td colspan="6">100% PIT tagged</td></tr>
<tr><td>Release Locations</td><td colspan="6">Yakima River near Prosser Dam at a time and location that allows reconditioned kelts to choose their own mates, spawning locations, and spawn timing.</td></tr>
</table>

The Tribe's proposed program includes an adaptive management component to address uncertainty and determine when criteria are met for moving the programs from one phase to the next (Chapter 5).

This plan also describes proposed modifications to existing hatchery facilities at Prosser Hatchery. The integrated summer Chinook program would initially be conducted at Prosser Hatchery during the transition phase, followed by the long-term phase at an upstream hatchery and new acclimation sites on the upper Yakima and Naches Rivers. The fall component of the integrated summer/fall Chinook program and the segregated upriver bright fall Chinook program would both be conducted at the expanded Prosser Hatchery. The integrated Coho program would be conducted at the new Melvin R. Sampson Hatchery, which is currently under construction, and the segregated Coho program would continue to reside at the expanded Prosser Hatchery.

Facilities proposed to be modified and/or constructed under this Master Plan are described in detail in Chapter 6, with preliminary design drawings included in Appendix G. Highlights of the proposal include the following:

- **Prosser Hatchery** would be modernized with a variety of improvements to water supplies, fish culture incubators and rearing units, power and control systems, and support buildings in order to achieve the segregated Coho and fall Chinook production goals as well as support the transition phase of the summer Chinook Program.

- **Marion Drain Hatchery**: Summer and fall Chinook production at Marion Drain Hatchery will be phased out under this plan due to imprinting issues.

The Yakama Nation is submitting this Revised Yakima Summer/Fall Chinook and Coho Master Plan (BPA Project No. 1997-013-25) to fulfill the Council's requirement that all entities seeking funding for artificial production projects involving new construction and/or programs that will produce fish for reintroduction, submit plans and documentation consistent with the Council's Step Review process.

ACKNOWLEDGEMENTS

The authors thank the Yakama Tribal Council for their continued commitment to restoration and enhancement of Yakima Subbasin fisheries. In particular, we are grateful to the Yakama Nation Fish & Wildlife Committee for their guidance and encouragement. We also acknowledge Melvin Sampson, Paul Ward, and Lynn Hatcher (retired) for their direction and support as project /program managers. Our partners in the subbasin have provided valuable assistance, including the Bureau of Reclamation, Recovery Board, the Washington Department of Fish and Wildlife. Technical assistance in developing these programs and preparing this Master Plan was provided by DJ Warren & Associates, Aquaculture Specialist Mark Reiser, Meridian Environmental, and Malone Environmental Consulting. Finally, we deeply appreciate the efforts of the numerous fisheries technicians who, over the years, gathered the data that form the foundation of this Master Plan.

ABBREVIATIONS AND ACRONYMS

AHA	All-H Analyzer Tool
BPA	Bonneville Power Administration
BLM	Bureau of Land Management
CESRF	Cle Elum Supplementation and Research Facility
cf	Cubic feet
cfs	Cubic feet per second
CRITFC	Columbia River Inter-Tribal Fish Commission
CWT	Coded wire tag
EDT	Ecosystem Diagnosis and Treatment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
fpp	Fish per pound
gpm	Gallons per minute
HGMP	Hatchery and Genetic Management Plan
HOB	Hatchery-origin broodstock
HOR	Hatchery-origin return
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Technical Recovery Team
IEAB	Independent Economic Analysis Board
ISAB	Independent Scientific Advisory Board
ISIT	In-season Implementation Tool
ISRP	Independent Scientific Review Panel
M&E	Monitoring and Evaluation

MIPT	Monitoring Implementation Planning Team
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Oceanic and Atmospheric Administration – Fisheries
NOB	Natural-origin broodstock
NOR	Natural-origin return
NPCC	Northwest Power and Conservation Council
pHOS	Proportion of hatchery-origin fish in the natural spawning population
PIT Tag	Passive Integrated Transponder tag
PNI	Proportionate Natural Influence
pNOB	Proportion of Natural-origin Broodstock
RM	River mile
SAR	Smolt-to-adult survival rate
URB	Upriver Bright Chinook
USBR	United States Bureau of Reclamation
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
YKFP	Yakima-Klickitat Fisheries Project
YN	Yakama Nation

1.0 INTRODUCTION

1.1 BACKGROUND

This section provides a brief overview of the Yakama Nation's proposed Coho and Chinook salmon hatchery programs and Wild Steelhead Kelt Reconditioning program. Detailed information about the proposed programs is provided in Chapter 2 (Coho), Chapter 3 (Chinook) and Chapter 4 (Steelhead).

The hatchery programs described in this Revised Master Plan will be components of the Yakima-Klickitat Fisheries Project (YKFP), a joint project of the Yakama Nation (lead entity) and the Washington Department of Fish and Wildlife (WDFW) focused on enhancing existing populations of anadromous fish in the Yakima and Klickitat river basins and reintroducing stocks formerly present in the basins. Under the YKFP, the Tribe is committed to restoring salmon populations using a combination of hatchery and habitat strategies. The YKFP is an integral part of the comprehensive Yakima Subbasin and Recovery planning efforts.

Another important goal of the YKFP is to provide harvest opportunities. Fishing opportunities for Tribal members are guaranteed by the Treaty of 1855 and were confirmed in *U.S. v Oregon*. Long-term *U.S. v Oregon* agreements call for construction of a Yakima River hatchery for fall and summer Chinook (Appendix F). The existing Coho hatchery program and Wild Steelhead Kelt Reconditioning program are also part of an agreement under *U.S. v Oregon.*

1.2 PROPOSED HATCHERY PROGRAMS

The Yakama Nation proposes Coho, Chinook and Steelhead hatchery programs with the following goals, objectives and release numbers (Table 1-1):

Table 1-1. Overview of proposed Coho, Chinook and Steelhead programs.

Program	Goals and Objectives	Releases
Upper Yakima Integrated Coho Program	Contribute to Zone 6 and Yakima Basin harvest, meet cultural objectives, and reestablish a locally-adapted Coho population in Yakima Basin tributaries where the population historically spawned.	500,000 parr 200,000 yearlings 1,000 adult outplants
Lower Yakima Segregated Coho Program	Contribute to Zone 6 and Yakima Basin harvest.	500,000 yearlings
Yakima Integrated Summer/Fall Chinook Program	Contribute to Zone 6 and Yakima Basin harvest, meet cultural objectives, and reestablish a locally-adapted, naturally-spawning summer/fall Chinook population in the Yakima River upstream of Prosser Dam.	Summer run: 1,000,000 subyearlings Fall run: 500,000 subyearlings
Yakima Segregated URB Harvest Program	Contribute to harvest in Zone 6 and the lower Yakima River (downstream of Prosser Dam).	1.7 million subyearlings 500,000 yearlings

Program	Goals and Objectives	Releases
Yakima Wild Steelhead Kelt Reconditioning Program	Contribute to restoring terminal harvest opportunities, meet cultural objectives, and increase the number of naturally-spawning steelhead and repeat spawners in the system.	Up to 1,500 wild/natural kelts reconditioned

The proposed programs will initially use three existing Tribal facilities, Prosser, Melvin R. Sampson (MRS), and Marion Drain hatcheries. Summer- and fall-run Chinook production at Marion Drain Hatchery will be phased out under this plan due to imprinting issues. Aquaculture programs currently operate at the Prosser site. The Prosser facility will be expanded to accommodate the proposed program modifications and Marion Drain will be phased out. The MRS facility is expected to become operational in fall 2019. A new summer-run Chinook facility will eventually be sited above the confluence of the Naches and Yakima Rivers. The Coho, Chinook and Steelhead program components proposed at each facility are identified in Table 1-2. Figure 1-1 shows existing and proposed artificial production facilities in the Yakima River Basin.

Table 1-2. Facilities proposed for Coho, Summer and Fall Chinook, URB Chinook and Steelhead program components.

Facility	Life Stage	Dates in Use
Coho – Integrated Program		
Melvin R. Sampson	Adult holding	Oct – Jan
Melvin R. Sampson	Incubation	Oct – Feb
Melvin R. Sampson	Yearling rearing	Mar – Mar
Coho – Segregated Program		
Prosser	Adult holding	Oct – Nov
Prosser	Incubation	Oct – Feb
Prosser	Juvenile rearing	Feb – April
Summer Chinook Program – Integrated Transition		
Prosser	Adult holding	Aug – Oct
Prosser	Incubation	Nov – Jan
Prosser	Early Rearing	Jan – Feb
Remote Acclimation Sites	Subyearling rearing	Feb – April
Summer Chinook Program – Integrated Long-Term		
TBD[1]	Adult holding	Aug – Oct
TBD[1]	Incubation	Nov – Jan
TBD[1]	Early Rearing	Jan – Feb
Remote Acclimation Sites	Subyearling rearing	Feb – April
Fall Chinook Program – Integrated		
Prosser	Adult holding for program upstream of Prosser	Sept – Nov

Facility	Life Stage	Dates in Use
Prosser	Incubate upstream of Prosser eggs for summer/fall program	Oct- March
Prosser	Rear summer/fall program juveniles	Jan – April
URB Program – Segregated		
Prosser	Adult holding for program downstream of Prosser	Sept – Nov
Prosser	Incubate eggs (URB) for program downstream of Prosser	Oct – Jan
Prosser	Rear juveniles (URB) for downstream of Prosser program	Jan – Feb
Wild Steelhead Kelt Reconditioning Program		
Prosser	Adult holding	Mar – Oct

[1] New facility sited above the confluence of the Naches and Yakima Rivers.

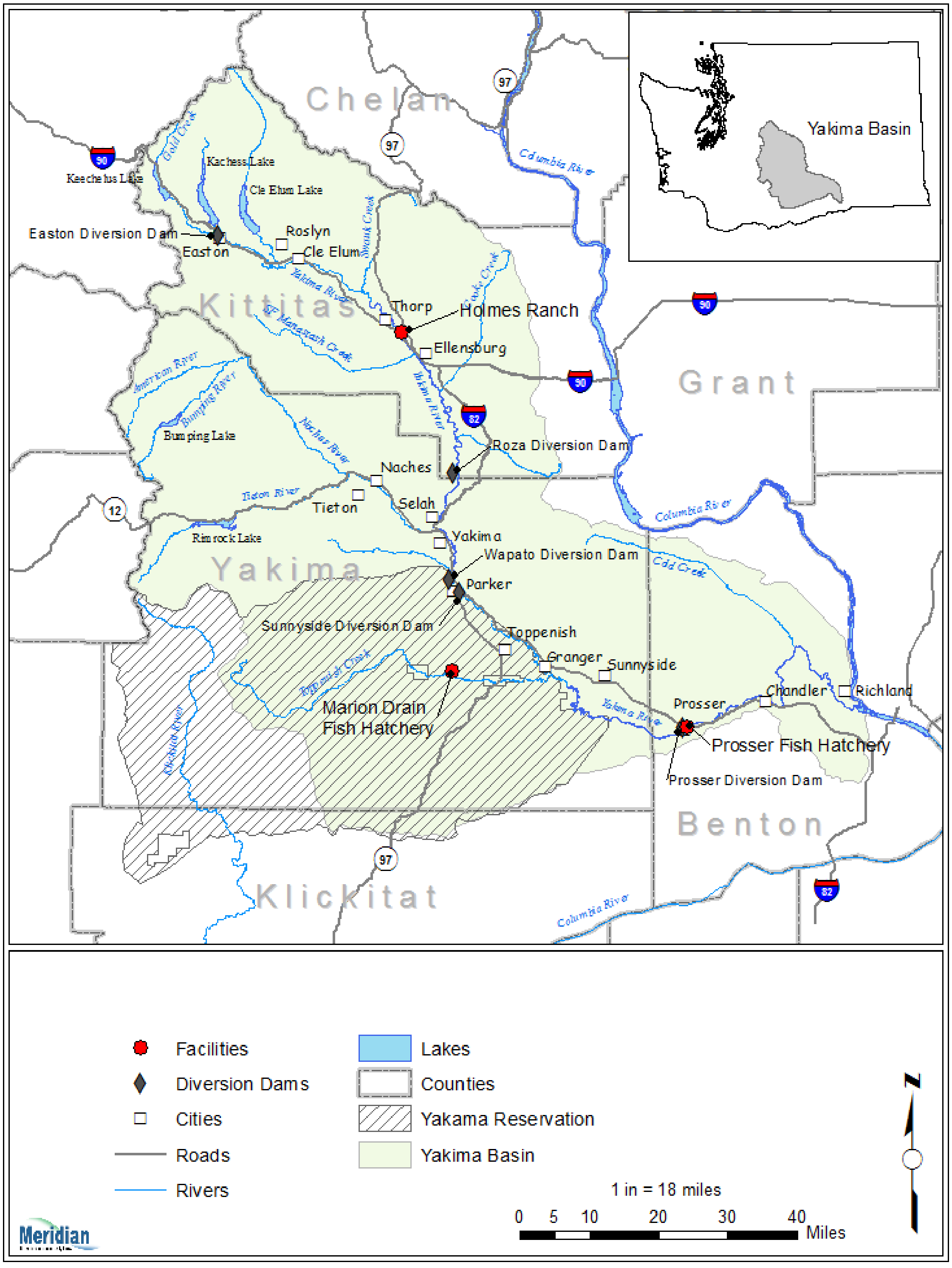


Figure 1-1. Existing and proposed artificial production facilities in the Yakima River Basin.

1.3 NORTHWEST POWER AND CONSERVATION COUNCIL'S THREE-STEP REVIEW PROCESS

The Northwest Power Act of 1980 directs BPA to protect, mitigate and enhance the fish and wildlife affected by the development and operation of federal hydroelectric facilities on the Columbia River and its tributaries. To help accomplish this mission, the NPCC makes recommendations to BPA concerning which projects to fund. The NPCC gives deference to project proposals developed by state and Tribal fishery managers. As part of its Columbia River Basin Fish and Wildlife Program (FWP), the NPCC has a three-step process for reviewing artificial propagation projects proposed for BPA funding (NPCC 2006).

The Major Project Review (or Step Review) was established by the Council as a means to thoroughly evaluate projects seeking BPA funding through the FWP. The premise is that only projects that are targeted to meet a need within the Basin and clearly defined in terms of biological benefits will be eligible for funding. Project proponents must think carefully about what they want to achieve and how they want to achieve it. Projects must also be designed to be as cost effective as possible. The long-term implications of proposed projects, as well as the short-term gains, must be considered. The goal of the Step Review is to consider funding only for programs that have successfully completed the planning process from project concept through final design. As stated in the Major Project Review document, any project funded through the Fish and Wildlife Program "must be thoroughly reviewed in advance to ensure its design, construction and proposed operations are compatible with the environment and consistent with financial planning for the subbasin where it is located and the Columbia Basin as a whole" (NPCC 2006).

The Yakima River Summer- and Fall-run Chinook and Coho Salmon Hatchery Master Plan was submitted to the Council in 2012 (YN 2012). The Independent Scientific Review Panel requested the co-managers provide additional information prior to proceeding with Step 2 (ISRP 2012-13). The YN provided the requested response in 2013 (YN 2013). The ISRP found the Coho and Summer/Fall Chinook programs proposed in the Master Plan *Meet Scientific Review Criteria (Qualified)* and requested additional information on eleven key issues (ISRP 2013-08). The YN provided a response to address the ISRP's comments on the Coho program (YN 2018), and the ISRP provided a response with additional questions and comments (ISRP 2018-06). This revised Master Plan addresses the ISRP's comments and requests for additional information on the 2012 Master Plan and the ISRP's additional response comments on the Chinook (2013) and Coho programs (2018). Responses to ISRP comments are in Appendix K. This document also provides updates to the Coho and Chinook program goals and objectives (Sections 2 and 3), describes the proposed steelhead kelt reconditioning program (Section 4), describes proposed facilities (Section 6), provides updated costs (Section 9), and includes a monitoring and evaluation plan (Appendix J).

1.4 DOCUMENT OVERVIEW AND ORGANIZATION

Chapter 1 is an overview of the proposed project and the Council's review process for new or modified hatchery programs.

Chapter 2 provides an overview of the population status of Coho salmon, describes existing habitat for the population, and summarizes the current and proposed hatchery programs. The YN is proposing two Coho programs, a segregated program focused on harvest and an integrated program designed to provide harvest opportunities as well as increase the number of naturally-spawning Coho in the Yakima

Basin. This chapter also presents the scientific framework for the programs, including biological objectives, key assumptions, and projected outcomes for the proposed programs. This chapter contains an analysis of the Coho program's consistency with the Council's eight scientific principles, a discussion of the program links to related fisheries and habitat measures, and a review of the program's consistency with the Council's artificial production policies.

Chapter 3 provides an overview of the population status of summer and fall-run Chinook, describes existing habitat for the populations, and summarizes the current and proposed hatchery programs. This chapter also presents the scientific framework for the programs, including biological objectives, key assumptions, and projected outcomes for the proposed programs. This chapter also contains an analysis of the Chinook program's consistency with the Council's eight scientific principles, a discussion of the program links to related fisheries and habitat measures, and a review of the program's consistency with the Council's artificial production policies.

Chapter 4 provides an overview of the population status of steelhead in the Yakima Basin, describes existing habitat, and summarizes the current and proposed Wild Steelhead Kelt Reconditioning programs. This chapter also presents a brief overview of the scientific basis for the proposed kelt reconditioning program. A more detailed overview of the scientific rationale for long-term kelt reconditioning programs was provided in the Snake River Kelt Reconditioning Program Master Plan (CRITFC 2016), which was recently approved by the NPCC.

Chapter 5 presents the adaptive management framework for the proposed programs, which includes a monitoring and evaluation plan.

Chapter 6 describes the conceptual design of facilities needed to support the proposed hatchery programs, including existing and proposed facility upgrades at Prosser and MRS hatcheries.

Chapter 7 describes the Yakima Basin, the current status of fish and wildlife resources in the basin, and current and planned management actions. This chapter also describes aquatic management and resource issues at local and regional scales.

Chapter 8 identifies the environmental compliance requirements that must be met by the proposed programs.

Chapter 9 provides cost estimates for facility planning and design, construction, capital equipment, environmental compliance, operations and maintenance, monitoring and evaluation, and projected ten-year future costs. Costs are presented separately for each major project facility: Prosser Hatchery and Marion Drain Hatchery.

Chapter 10 lists the documents cited in this Master Plan.

The following appendices provide supporting information and documentation as follows:

- Appendix A — Draft Hatchery and Genetic Management Plan: Coho Reintroduction Project
- Appendix B — Draft Hatchery and Genetic Management Plan: Yakima River Summer/Fall Chinook Production Program

- Appendix C — Draft Hatchery and Genetic Management Plan: Yakima River Steelhead Kelt Reconditioning Program
- Appendix D — Bioprogramming Reports and Hatchery Operations Schedule Technical Memo: Coho, Summer and Fall Chinook and Steelhead Kelt
- Appendix E — Water Supply Reports
- Appendix F — Memorandum of Agreement between Yakama Nation, BPA, Corps of Engineers and Bureau of Reclamation
- Appendix G — Preliminary Design Drawings
- Appendix H — Detailed Program Cost Estimates
- Appendix I — Floodplain Evaluation
- Appendix J — Monitoring and Evaluation Plan
- Appendix K — Responses to ISRP Comments on the 2012 Step 1 Master Plan and Responses to 2013 and 2018 ISRP Response Comments

2.0 PROPOSED HATCHERY PROGRAMS FOR COHO

2.1 POPULATION STATUS

Coho were extirpated from the Yakima Subbasin by the early 1980s. Historical returns of Coho to the Yakima River Basin are estimated to have been in the range of 44,000 (Kreeger and McNeil 1993) to more than 100,000 fish annually. Habitat loss and high pre-terminal exploitation rates contributed to the demise of the natural Coho population in the Yakima Basin.

The Yakima River Coho population has not been defined formally by Endangered Species Act petitions or listings because it is derived from reintroduced non-native stocks. Those Coho currently found in the Yakima Basin are the progeny of hatchery releases that began in the mid-1980s. The presence of naturally-spawning Coho in the Yakima River and its tributaries has high cultural significance to the YN.

Artificial production of Coho was initiated in the Yakima River Basin as part of the *U.S. v Oregon* Columbia River Fish Management Plan with a stated purpose of providing “a directed tribal harvest within the Yakima River system”. Through the mid-1980s and early 1990s, approximately 700,000 Coho were imported annually from out-of-basin hatcheries and released as pre-smolts in the Yakima River below the Wapato Irrigation Diversion Dam.

In 1996, the scope of the project was expanded with the goal of determining the feasibility of re-establishing a naturally-spawning Coho population and a significant fall Coho fishery in the Yakima River Basin (BPA 1996). Phase 1 of this project was completed in 2003. Phase 2 was initiated in 2004 and is ongoing. Details on Phase 1 and Phase 2 are provided below in section 2.3.

2.2 HABITAT CONTEXT

To be successful, hatchery programs must be part of an integrated, “all H” (Hatchery, Habitat, Harvest, and Hydro) strategy. Protecting existing high-quality stream habitat and restoring degraded habitat is essential to restoring sustainable fisheries. The Yakima Subbasin and Recovery Plans identify major habitat factors limiting fish production and propose strategies and actions to improve habitat quality and quantity. These habitat strategies are expected to provide benefits to all resident and anadromous fish species in the Basin.

Because both natural and hatchery produced fish require quality stream habitat to complete their life-cycle, habitat improvement actions will continue to be major components of the Coho restoration program for the basin. These actions are being developed and implemented by the Yakama Nation, BPA and other state, city, county and federal agencies working in the basin (see Table 7-4). The results of this work are further described in the YKFP annual reports and other publications.

Habitat work has focused on improving floodplain habitat, riparian zones, restoring natural flow and temperature regimes, screening water diversions and providing fish passage at barriers. Some significant habitat improvement actions undertaken in the Yakima River Basin over the last 30 years include:

- 41 major water diversions have been equipped with fish screens (USDI 2008).
- 16 fish passage facilities have been upgraded or built at various locations in the basin (USDI 2008).
- Three of four major irrigation return drains met turbidity and suspended sediment levels established in the TMDL, resulting in considerable improvement in these attributes in the mainstem Yakima River (http://www.ecy.wa.gov/programs/wr/cro/yakimabasin.html).
- Target flows (enacted by Congress) and tribal treaty instream flows (affirmed by the Yakima Superior Court) are in place in the Yakima Basin.
- The Roza-Sunnyside Board of Joint Control implemented a water quality policy, a water quality monitoring program, and used State Revolving Loan Funds to help finance on-farm irrigation upgrades that significantly reduced suspended sediment and DDT loading to the Yakima River (http://www.ecy.wa.gov/programs/wr/cro/yakimabasin.html).
- The North Yakima Conservation District assisted with the conversion of over 8,000 acres of hop fields to drip irrigation systems. This effort, along with much work and investment by Yakima Valley farmers, resulted in significant improvements in water quality for the Yakima River (http://www.ecy.wa.gov/programs/wr/cro/yakimabasin.html).

A comprehensive approach to address water resource and ecosystem issues affecting fish passage, habitat and human water requirements is being developed through the Yakima River Basin Integrated Water Resource Management Plan described in the Final Programmatic EIS (USDI and WDOE 2012). This plan includes seven elements: reservoir fish passage, structural and operational changes to existing facilities, surface water storage, groundwater storage, habitat/watershed protection, enhanced water conservation and market reallocation.

The analysis in the Final EIS evaluated potential changes in Coho production under different habitat restoration scenarios. The analysis was performed by the Bureau of Reclamation using both AHA and EDT modeling. The analysis evaluated three scenarios:

- Future Without Integrated Plan (FWIP) – Represents fish population increases from habitat improvements that would continue under current programs and funding levels

- Restoration – Represents fish population increases from habitat improvements that would result from implementing the Integrated Plan's fish habitat enhancement program. The actions identified in the Yakima Steelhead Recovery Plan were used as a surrogate in the modeling effort to characterize these habitat improvements.

- Restoration with Fish Passage (Integrated Plan) – Represents fish population increases from the habitat restoration scenario plus providing fish passage at Cle Elum, Keechelus, Kachess, Bumping, and Tieton dams.

The analysis concluded[1]:

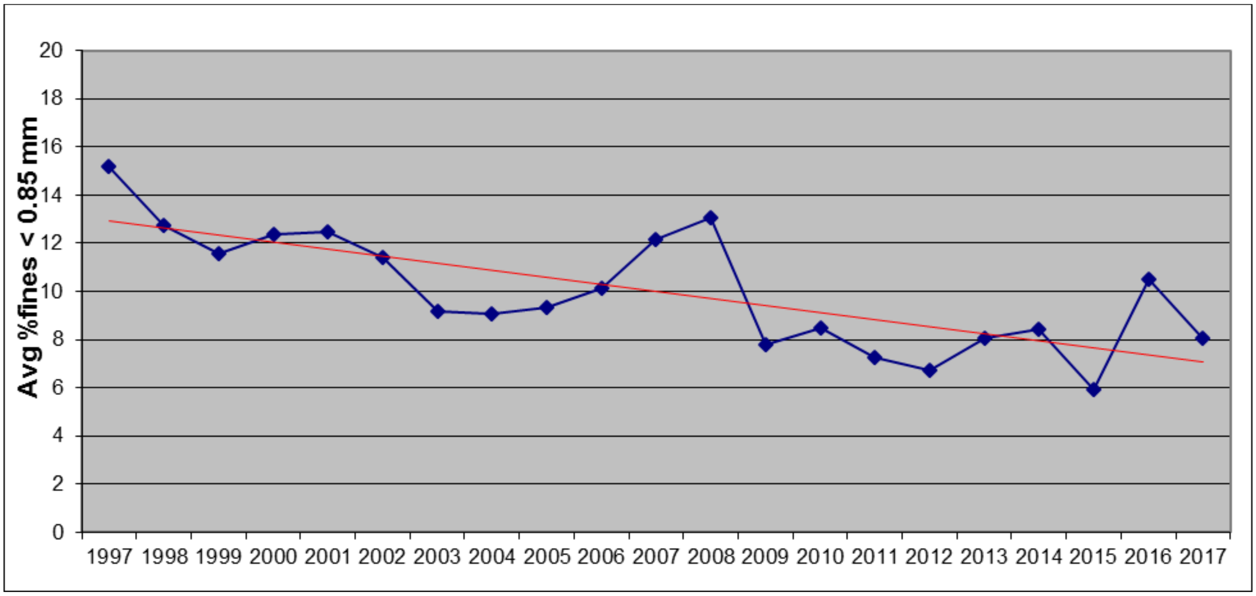
- Habitat conditions under the FWIP would increase baseline Coho production by 35 percent relative to the Baseline (11,983 adults vs. 8,806 adults at the mouth of the Columbia).
- Implementing the Integrated Plan would increase Coho production compared to the FWIP condition by an additional 26 percent (15,069 adults vs. 11,983 adults at the mouth of the Columbia).
- Implementing the Integrated Plan would increase Coho production by 71 percent compared to the baseline level (15,069 adults vs. 8,806 adults at the mouth of the Columbia).

This Master Plan assumes the Integrated Plan would be implemented and that habitat would improve as assumed in modeling[2]. The EDT productivity and capacity assumptions for this scenario (USDI and WDOE 2012) were incorporated into this Master Plan (see Section 2.5.2).

To quantify the success of habitat restoration efforts in the basin, Yakama Nation biologists track key environmental attributes through time (YKFP 2010). For example, fine sediment levels are tracked throughout the basin (Figure 2-1). This data is entered into the EDT model to estimate theoretical change in salmon abundance and to prioritize habitat actions by stream and environmental attribute.

More details on the habitat strategy in place in the Yakima Basin are described in Sections 7.3 and 7.4.2 of this Master Plan.

[1] The percent increase for each scenario was calculated from data found in Table 5-6, page 5-45 of the Final EIS and is based on escapement to the mouth of the Columbia River (i.e., after ocean harvest but before freshwater harvest).
2 Note that the FWIP will be implemented regardless of the outcome of the Integrated Plan.



Source: YKFP 2018

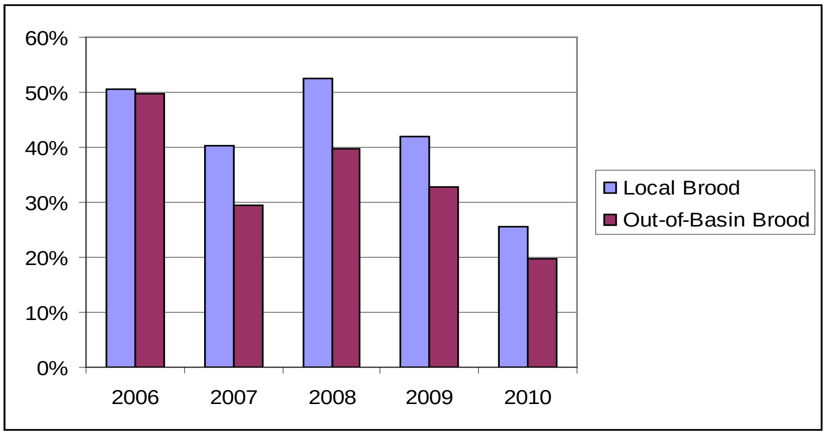
Figure 2-1. Overall average percent fine sediment (< 0.85 mm) in spawning gravels of the Upper Yakima River, 1997-2017.

2.3 CURRENT HATCHERY PROGRAM

2.3.1 Yakima Coho Program Phase 1 (1996-2003)

As described above, in 1996 the YN initiated a project to determine the feasibility of reestablishing a naturally-spawning Coho population and a significant Coho fishery in Zone 6 and the Yakima River Basin. In Phase 1 of this effort, the feasibility of achieving these goals was confirmed. During this phase, Coho hatchery releases were moved to locations above the confluence of the Yakima and Naches rivers. Key findings include:

- Hatchery releases from the local brood source (Yakima River returns) had significantly higher smolt-to-smolt survival from release sites to McNary Dam than releases from out-of-basin (non-Yakima River origin) hatchery broodstock (Figure 2-2).
- The number of adult Coho returns to the historical spawning habitats in upriver areas generally increased during Phase 1 (see Figure 2-3 below).



Source: Bosch et al. 2007, updated through 2010 by Yakama Nation staff

Figure 2-2. Smolt-to-smolt survival rate from release sites to McNary Dam for local and out-of-basin hatchery broodstock 2006-2010 (data pooled for all release sites).

During the Phase 1 period, the YN completed several studies to evaluate predation and competition by hatchery Coho with listed and sensitive species (Dunnigan 1999; Murdoch and Dunnigan 2002; Murdoch and LaRue 2002; Murdoch et al. 2004; Murdoch et al. 2005). Results of these studies indicate low predation rates and species-specific habitat segregation (YN 2007). These findings are also consistent with Pearsons and Temple (2007) and Temple et al. (2017) who studied ecological impacts of spring Chinook and Coho supplementation in the upper Yakima Basin and concluded that early stages of salmon supplementation did not impact non-target taxa studied beyond predetermined containment objectives (e.g., abundance, condition, size, biomass).

2.3.2 Yakima Coho Program Phase 2 (2004-present)

Phase 1 results provided the baseline data needed to demonstrate that Coho reintroduction was possible and that reestablishment of Coho in the basin would not substantially affect other species of concern (Chinook, steelhead, and Cutthroat Trout). The second phase of the Yakima Coho program began in 2004.

Phase 2 goals are to:

- Increase Coho spawning in tributaries.
- Phase out imported releases of Coho in the Yakima Basin, replacing them with fish reared from locally collected broodstock.
- Test and monitor new acclimation techniques.

Phase 2 is expected to end with the implementation of this Master Plan. To date, the program's Phase 2 research has made the following findings:

- Hatchery-origin Coho with a legacy of as many as 10 to 30 generations of hatchery influence can reestablish a naturally-spawning population after as few as 3 to 5 generations of being outplanted in the wild (Bosch et al. 2007).

- Studies of residualism, predation and competition conducted during Phases 1 and 2 indicate the Coho program will have an acceptable level of impact on Chinook and steelhead populations. Results from these studies are described in Section 2.9 in the discussion of the consistency of the proposed Coho programs with NPCC Artificial Production Principle 1. These results, plus the need to meet legal mandates (*U.S. v Oregon*), justify continuing Coho releases into the basin.

- The release-to-adult return rate for hatchery-origin smolts and parr released into the Naches and Upper Yakima is more than sufficient to provide broodstock required by the hatchery program, as discussed in Section 2.5. Releases also provide substantial harvest benefits.

- Parr and smolt plants in the tributaries using acclimation have resulted in a substantial increase in the number of redds observed in tributaries.

- Initial results of adult Coho hatchery-origin outplants indicated that Coho spawned successfully and produced large numbers of offspring.

2.3.3 Hatchery Releases

Pursuant to *U.S. v Oregon* court-mandated agreements, more than 700,000 hatchery-reared Coho salmon have been released annually into the Yakima River since the mid-1980s (Table 2-1). After incubation and rearing in the hatchery environment to the yearling life-stage, smolts are released from acclimation sites in the Naches and Upper Yakima subbasins or Prosser Hatchery in the early spring of their migration year. After incubation and rearing in the hatchery environment to the subyearling life-stage, parr are released directly into streams in the Naches and Upper Yakima subbasins in the summer prior to their migration year. Currently, Coho juveniles released into the Yakima Basin are a combination of in-basin production from broodstock collected near Prosser Dam and out-of-basin stock reared at Eagle Creek National Fish Hatchery and moved to the Yakima Basin for final rearing and release. The number of smolts and parr produced from local broodstock collected at Prosser Dam are shown in Table 2-2, along with data on the number of broodstock spawned, fecundity, egg to parr or smolt survival, and average release size. Prespawning survival is generally greater than 95% as fish are spawned within one week of collection.

Table 2-1. Total releases of Coho hatchery juveniles in the Naches and Upper Yakima subbasins by brood year and acclimation site.

	Release Sites					Broodstock Source			
	Smolts			Parr		Local Brood		Out of Basin Smolts	
Brood Year	Upper Yakima	Naches	Prosser	Upper Yakima	Naches	Smolts	Parr		Total Smolts[1]
1997	436,000	1,257,000	-						1,693,000
1998	502,155	502,239	-						1,004,394
1999	498,872	429,318	-						928,190
2000	187,659	379,904	-						567,563
2001	263,288	357,530	-						620,818
2002	403,000	407,002	-						810,002
2003	313,207	291,494	-						604,701
2004	322,417	332,455	-						654,872

	Release Sites					Broodstock Source			
	Smolts			Parr		Local Brood		Out of Basin Smolts	Total Smolts[1]
Brood Year	Upper Yakima	Naches	Prosser	Upper Yakima	Naches	Smolts	Parr		
2005	338,127	554,784	50,000						942,911
2006	426,632	516,753	81,114						1,024,499
2007	358,412	440,783	219,098						1,018,293
2008	304,638	269,936	182,719	12,000	25,000	324,598	37,000	432,695	757,293
2009	407,184	341,414	245,455	13,000	12,000	610,423	25,000	383,630	994,053
2010	443,030	131,972	190,836	15,000	15,000	522,027	30,000	243,811	765,838
2011	311,102	359,067	322,100	365,035	73,572	992,269	438,607	-	992,269
2012	339,034	305,197	221,567	10,555	29,565	446,295	40,120	419,503	865,798
2013	353,139	373,072	367,382	9,000	18,232	524,967	27,232	568,626	1,093,593
2014	408,112	298,619	267,830	93,525	92,023	974,561	185,548	-	974,561
2015	141,000	141,000	204,358	-	-	204,358	-	282,000	486,358
2016	407,196	369,521	205,967	-	-	205,967	-	776,717	982,684
2017	438,331	267,211	470,000	114,141	138,624	641,589	252,765	533,953	1,175,542
2008-17 Average	*355,277*	*285,701*	*267,821*	*63,226*	*40,402*	*544,705*	*103,627*	*364,094*	*908,799*

1 Releases from 1997-2007 were from approximately 90% out-of-basin and 10% in-basin broodstock.

Table 2-2. In hatchery data for Coho parr and smolts reared at Prosser Hatchery using local broodstock.

Brood Year	Females Spawned	Males Spawned	Total eggs	Average Fecundity	Eyed eggs	Smolts Released	Smolt Size (fish/lb)	Parr Released	Parr size (fish/lb)	Egg to Parr or Smolt Survival
2010	343	360	920,737	2,684	762,342	522,027	10.5	30,000	165	72.41%
2011	651	641	1,970,078	3,026	1,859,406	992,269	11.2	438,607	180	54.98%
2012	425	455	775,494	1,824	646,465	446,295	11.9	40,120	165	73.55%
2013	328	301	823,513	2,510	724,207	524,967	14.5	27,232	152	78.03%
2014	570	525	1,388,800	2,240	1,249,920	974,561	15.1	185,548	154	92.57%
2015	174	180	363,015	2,086	287,781	204,358	14.5	0	167	71.01%
2016	198	212	428,270	2,162	352,153	205,967	12.4	0	162	58.49%
2017	490	515	1,163,940	2,042	1,024,267	641,589	14.3	252,765	155	87.24%
Average	*397*	*399*	*979,231*	*2,322*	*863,318*	*564,004*	*13.1*	*121,780*	*163*	*73.54%*

Summer parr plants have been the primary method for increasing fish production in upper basin tributaries. Parr are directly released into tributaries in July. Smolts released in the upper basin are held in ponds or mobile acclimation units for approximately 4 weeks prior to being released in April. Mobile units are portable aluminum raceways that are 20 feet long, 4 feet wide and 5 feet tall. They are installed near a stream in an area that has existing disturbance (such as spur roads, USBR screening areas), and are plumbed into creeks. The units hold up to 10,000 Coho smolts.

A subsample of parr and smolts are PIT-tagged so that survival rate and behavior data can be collected. Survival of PIT-tagged Coho pre-smolts from tagging to McNary Dam juvenile smolt detection averaged 56.5%, 28.5%, and 10.5% for fish released from Prosser Hatchery, Naches tributaries, and Upper Yakima tributaries, respectively, for juvenile migration years 1999-2014 (Neeley 2018). Initial results show that outmigrating smolts released as parr and smolts have similar SAR indices from McNary Dam (smolts) to Bonneville Dam (age-3 adults) (Table 2-3). Mean McNary smolt to Bonneville age-3 adult return indices for PIT-tagged Coho released as smolts in Lower Yakima, Naches, and Upper Yakima tributaries were 3.73%, 3.96%, and 4.46%, respectively; for PIT-tagged Coho released as parr in Naches and Upper Yakima tributaries, mean SAR indices were 2.82% and 5.05%, respectively. Annual variation in McNary smolt to Bonneville adult survival between the different release sites and life stages may be due to difference in acclimation site exit timing, migration timing, and quality of smolts at time of release. Infrastructure deficiencies (e.g., wells, chillers, raceway condition, etc.) at Prosser Hatchery may have affected survival of the Lower Yakima smolt releases in some years.

Table 2-3. McNary Dam smolt to Bonneville Dam age-3 adult return (SAR) indices for PIT-tagged Coho released as smolts or parr[1] in Lower Yakima, Naches, and Upper Yakima mainstem or tributary areas, brood years 2003-2014. SAR indices are inclusive of ocean and lower Columbia River harvests.

Brood Year	Smolt Releases			Parr Releases[1]	
	Lower Yakima[2]	Naches	Upper Yakima	Naches	Upper Yakima
2003	3.78%	6.14%	2.92%		
2004	2.28%	3.16%	3.67%	1.09%	
2005	3.11%	3.31%	2.36%	1.41%	1.96%
2006	9.76%	6.81%	4.17%	5.52%	7.84%
2007	8.16%	2.84%	4.35%	0.52%	3.16%
2008	4.10%	7.59%	8.80%	5.84%	8.30%
2009	0.20%	1.89%	3.37%	1.99%	3.20%
2010	1.67%	1.80%	1.76%	0.98%	3.23%
2011	6.57%	7.15%	11.64%	6.11%	10.49%
2012	1.15%	1.48%	2.58%	1.01%	2.59%
2013	3.35%	2.33%	4.91%		3.03%
2014	0.66%	3.01%	3.05%	3.73%	6.74%
Average	*3.73%*	*3.96%*	*4.46%*	*2.82%*	*5.05%*
Geomean	*2.46%*	*3.40%*	*3.85%*	*2.03%*	*4.33%*

[1] PIT-tagged fish released as parr in brood year 2003, 2004 (Upp. Yak.), and 2013 (Naches) experienced very poor (<1%) survival to McNary Dam as juvenile smolts and were omitted from this analysis.
[2] Primarily Prosser Hatchery releases and some Chandler canal releases used to study entrainment rate.

Adult Coho plants have also been used to evaluate the feasibility of increasing fish abundance in several tributaries (Table 2-4). To determine the spawning success and effects on resident trout of these adult outplants, an intensive monitoring program was conducted in Taneum Creek for brood/spawn years 2007-2014. The results of this evaluation show that Coho spawned successfully and have the potential to produce large numbers of returning adult offspring per smolt that survive to McNary Dam as juveniles (Table 2-5). The total biomass of all salmonids in the stream increased and there were no discernable impacts to resident trout (Temple et al. 2009).

Table 2-4. Number of adult female[1] Coho outplanted into Naches and Upper Yakima subbasin tributaries, 2007-2017.

Year	Nile Creek	Ahtanum Creek	Taneum Creek	Wilson Creek	SF Cowiche Creek	Easton Reach	Lake Cle Elum
2007	20	20	150	20	20		
2008	20	20	150	20	20		
2009	20	20	150	20			
2010	20	20	150	20			
2011			150				
2012			60				
2013			9				
2014			360			300	300
2015							
2016							
2017			20				

[1] Males were planted on a one-to-one basis when sufficient males were available.

Table 2-5. Results from Taneum Creek adult outplant study, 2007-2014.

Outplant/ Brood Year	Number of Adult Females Outplanted	Redds	Number of Juvenile Coho PIT Tagged	McNary Juvenile Detections[1]	Bonneville or upstream Adult Detections[1]	McNary Juvenile & Adult Detections[1]	McNary Juvenile to Bonneville Adult SAR Index[2]
2007	150	75	1,299	94	1		
2008	150	50	1,868	82	16	7	8.54%
2009	150	130	4,515	177	14	4	2.26%
2010	150	134	1,054	73	7	3	4.11%
2011	150	100	743	30	9	4	13.33%
2012	60	54	1,941	70	0		
2013	9	5	231	0	0		
2014	360	200	752	12	1		
Pooled			*12,403*	*538*	*48*	*18*	*3.35%*

1 Actual detections of juveniles and adults (unexpanded estimates).
2 Post-harvest SAR index (i.e., after adults removed in ocean and freshwater harvest). Post-harvest survival from tagging (parr) to adult returns at McNary was 0.76% during the study.

These results demonstrate the restoration potential of a broad and diverse outplanting program that is mimicking nature by subjecting fish to a multi-year array of environmental conditions with smolts migrating in the year they are planted, parr migrating one year after planting, and the progeny of adult outplants migrating two years after planting. The key to the overall success of the program will be improving smolt survival to McNary Dam. YN efforts to achieve this are discussed in other sections of this Master Plan.

2.3.4 Natural Production

Adult salmon populations in the Yakima River Basin are counted at Prosser Dam using video equipment installed in all three adult fish ladders. Although adult passage over spillways is believed to occur when flows are favorable, Prosser Dam counts are generally considered by Yakama Nation biologists to be within +/- 5% of actual fish passage. Total adult Coho returns to Prosser Dam and the Prosser Hatchery denil are used as an estimate of escapement, and averaged over 5,600 fish (NORs and HORs combined) from 1999-2018 (Table 2-6), an order of magnitude improvement from the average for years prior to initiation of Phase 1 of the project (Figure 2-3). New marking protocols made it possible to distinguish hatchery- and natural-origin Coho returns beginning with return year 2001. Since 2001, an average of more than 800 natural-origin adults have returned annually to Prosser Dam (Table 2-7).

Table 2-6. Estimated Coho returns and escapement in the Yakima River, 1999-2018. Note that this table reports returns by adult return year.

Adult Return Year	Total Returns (NORs + HORs)		Escapement (after terminal harvest; NORs + HORs)			
			Prosser Dam		Hatchery Denil	
	Adult	Jack	Adult	Jack	Adult	Jack
1999	3,906	91	3,852	91		
2000	4,444	1,841	4,390	1,826		
2001	5,032	68	4,978	68		
2002	515	343	475	343		
2003	2,192	162	2,192	162		
2004	2,367	74	2,325	64		
2005	2,897	225	2,890	225		
2006	4,478	175	4,335	175	125	0
2007	3,461	64	3,153	60	300	4
2008	4,636	1,917	3,890	1,809	700	58
2009	9,843	873	8,517	573	1,300	300
2010	5,776	567	4,811	183	915	384
2011	8,073	171	6,424	121	1,594	50
2012	5,511	264	4,298	164	1,200	100
2013	3,173	848	2,290	395	837	412
2014	25,368	584	20,997	427	4,263	157
2015	3,314	300	2,210	105	1,095	195
2016	3,383	374	1,693	188	1,690	186
2017	3,920	274	3,051	222	804	34

Adult Return Year	Total Returns (NORs + HORs)		Escapement (after terminal harvest; NORs + HORs)			
			Prosser Dam		Hatchery Denil	
	Adult	Jack	Adult	Jack	Adult	Jack
2018	2,218	835	1,672	440	518	365
Average	*5,225*	*503*	*4,422*	*382*	*1,180*	*173*

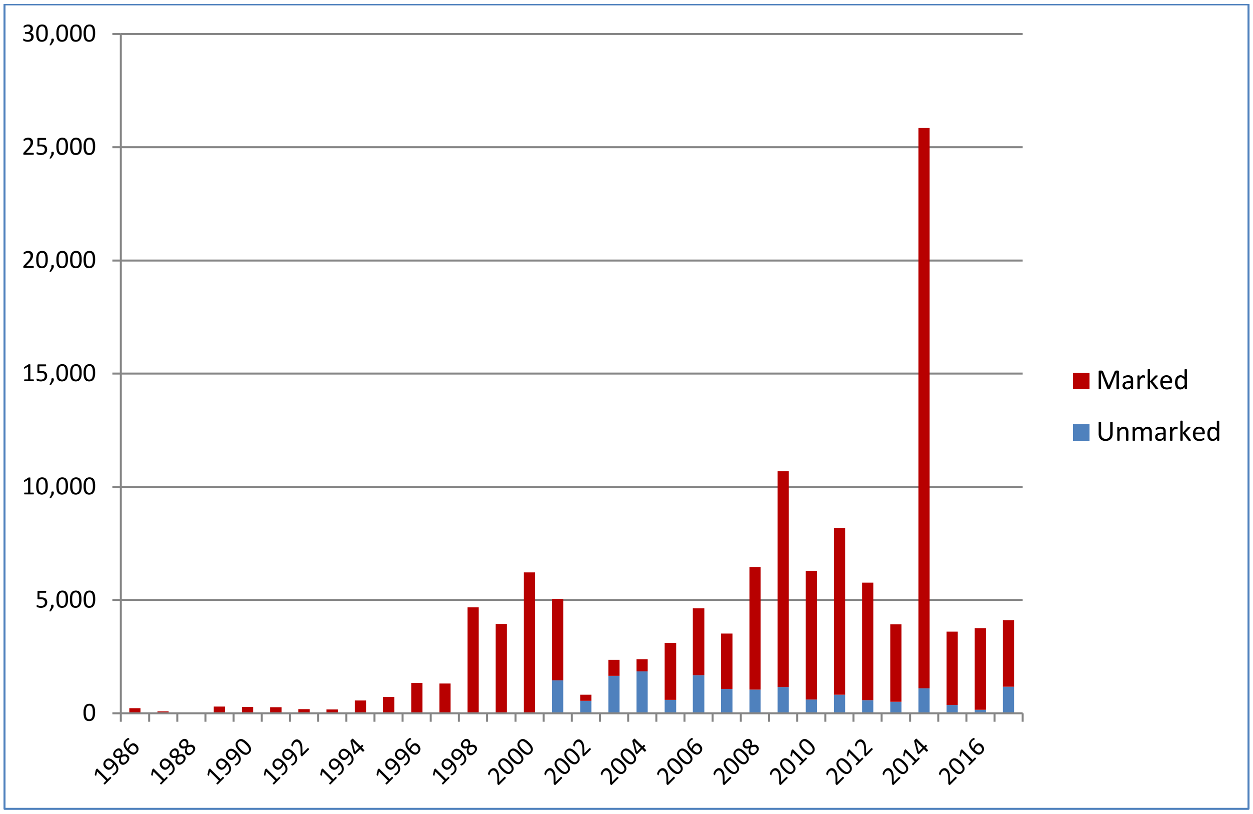


Figure 2-3. Estimated counts of marked (presumed hatchery-origin) and unmarked (presumed natural-origin) Coho (adults and jacks) at Prosser Dam or the Prosser Hatchery denil, 1986-2018. New marking protocols made it possible to distinguish hatchery- and natural-origin Coho returns beginning with return year 2001.

Table 2-7. Estimated counts of marked (presumed hatchery-origin) and unmarked (presumed natural-origin) adult and jack Coho at Prosser Dam and Prosser Hatchery Denil, 1986-2018.

Adult Return Year	Total Adults		Total Jacks	
	HORs	NORs	HORs	NORs
1986	230	0	0	0
1987	82	0	1	0
1988	18	0	0	0
1989	282	0	9	0
1990	289	0	0	0
1991	230	0	39	0
1992	137	0	53	0
1993	162	0	3	0
1994	532	0	28	0
1995	651	0	74	0
1996	921	0	417	0
1997	1,241	0	71	0
1998	4,625	0	54	0
1999	3,852	0	91	0
2000	4,390	0	249	1,577
2001	3,546	1,432	47	21
2002	166	309	98	245
2003	669	1,523	27	135
2004	505	1,820	39	25
2005	2,418	472	105	120
2006	2,898	1,562	61	114
2007	2,404	1,049	32	32
2008	4,131	459	1,280	587
2009	8,835	982	700	173
2010	5,153	573	530	37
2011	7,216	802	147	24
2012	4,948	550	231	33
2013	2,703	424	728	79
2014	24,178	1,082	566	18
2015	2,943	362	291	9
2016	3,280	103	329	45
2017	2,693	1,162	241	15
2018	2,020	170	747	58
Average (2001-2018)	*4,484*	*824*	*344*	*98*

Coho redd counts and spawner distribution have increased substantially since reintroduction efforts began (Table 2-8 and Figure 2-4), with an average of about 425 redds observed annually in tributaries in the upper watersheds from 2004-2018 and an average of 183 redds from 1998-2003.

Table 2-8. Yakima Basin Coho redd counts and distribution, 1998-2018.

Year	Yakima River	Naches River	Tributaries	Total
1998	53	6	193	252
1999	104	0	62	166
2000	142	137	67	346
2001	27	95	25	147
2002	4	23	16	43
2003	32	56	55	143
2004	33	87	150	270
2005	57	72	153	282
2006	44	76	187	307
2007	63	87	195	345
2008	49	60	242	351
2009	229	281	485	995
2010	75	276	327	678
2011	82	243	196	521
2012	148	228	172	548
2013	45	69	67	181
2014	320	86	751	1,157
2015	16	0	47	63
2016	27	37	54	118
2017	92	36	177	305
2018	46	103	100	249
Avg. 1998-2003				*183*
Avg. 2004-2018				*425*

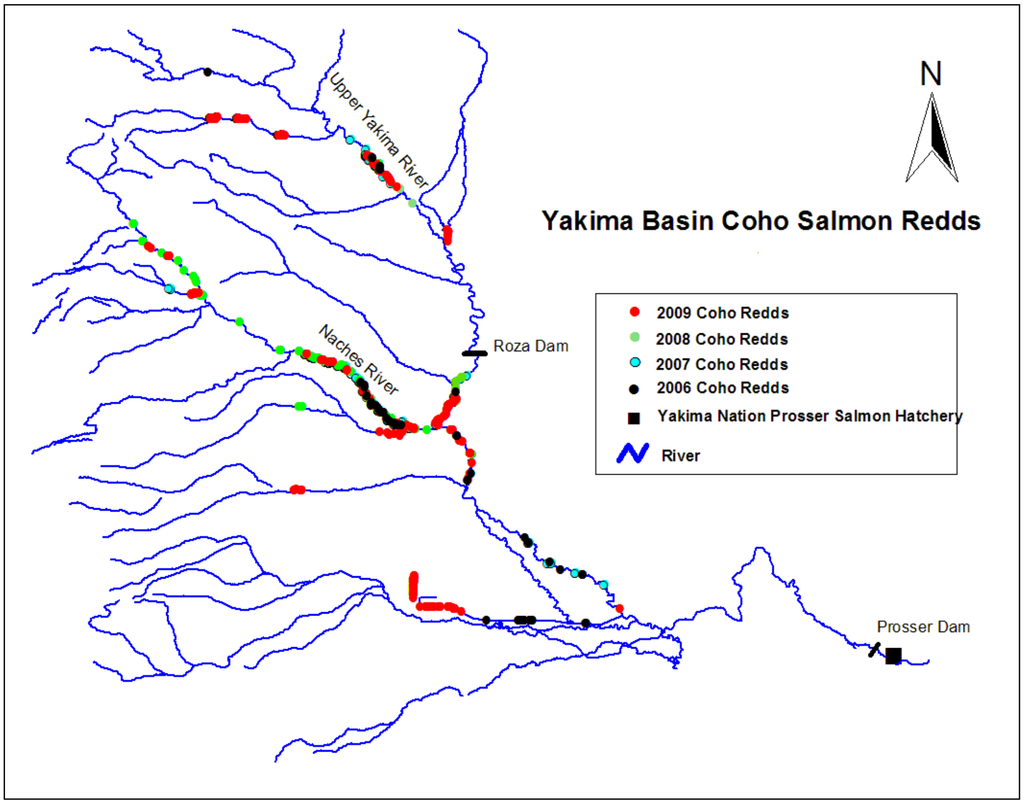


Figure 2-4. Distribution of Coho redds in the Yakima River Basin.

Beginning with the hatchery-origin smolt and parr release data presented in Table 2-1, we estimated post-harvest release to Bonneville adult return survival (SAR) indices (Table 2-9) using the following steps:

1. Apply average estimates for smolt survival to McNary Dam from Neeley 2018 (smolts) and Neeley 2019 (parr) to the Table 2-1 Upper Yakima and Naches smolt and parr release estimates.

2. Apply PIT-based McNary Dam smolt to Bonneville Dam adult return survival estimates (Table 2-3) to the resulting Upper Yakima and Naches release by life stage to McNary smolt survival estimates from step 1.

We recognize that the SAR indices presented in Table 2-9 run counter to general scientific expectations about parr versus smolt survival and beg some questions about present and future management. We provide the following additional information for clarification.

- Fish released in the Upper Yakima River travel up to 4 times farther than fish released in the Naches River from release to the confluence of these two rivers just north of the city of Yakima. Travel distance is a significant survival factor for coho smolt survival as fish are subjected to additional mortality factors (e.g., increased stress, additional predation risk, etc.) as they migrate downstream as smolts (YN unpublished data). Upper Yakima fish must navigate Roza Dam and the Roza reach which has also been documented to be a significant factor limiting juvenile survival (Kock et al. 2016).

- Parr are generally released in July (the summer prior to their migration year), and lower survival in the Naches subbasin from release to smolt migration the following spring is likely due to environmental conditions. This is a colder system and does not provide overwintering conditions that are as conducive to juvenile rearing, growth and survival as the Upper Yakima subbasin.
- We are still experimenting with release locations for parr in the Naches subbasin. One goal of releasing parr in smaller, upper tributaries (higher in the watershed) has been to increase the geographic distribution of spawners. There are potential release locations lower in the Naches subbasin with shorter travel distances that have not yet been tried, but could provide better parr-to-smolt survival.
- Implementation of the Yakima Basin Integrated Plan will result in changes in habitat and migration conditions throughout the Basin; we do not yet know how these improvements will affect the various release strategies but we do expect improved survival for all releases in the future.
- The YN believes the diversity in release locations and life stages that have been used and are proposed to continue provide a hedge against environmental variability that is likely to increase with climate change. We will continue to monitor and evaluate survival by release stage and location over time and expect to modify the program in the future as we accumulate more information and the costs and benefits of our various strategies become more clear.

For smolt releases, the post-harvest SARs back to Prosser Dam (adult returns) were also estimated using PIT tag data from the different release groups (Table 2-10).

We estimated comparable natural-origin (NOR) release to Bonneville Dam adult return indices (Table 2-9) for PIT-tagged juvenile parr from the Taneum Creek adult outplant study for years when environmental conditions were favorable (Table 2-5).

Finally, pre-harvest SARs were estimated by adjusting the SARs in Table 2-9 and Table 2-10 by the exploitation rate below Prosser Dam (smolts) and below Bonneville Dam (parr) (Table 2-11). These are the estimated survival rates before accounting for harvest removals.

Table 2-9. Estimated post-harvest release to Bonneville Dam adult survival (SAR) index for Coho released as smolts or parr in the Upper Yakima and Naches Basins, brood years 2005-2014.

Brood Year	Hatchery-Origin					Natural-origin parr
	Smolt Releases			Parr Releases		
	Prosser	Upper Yakima	Naches	Upper Yakima	Naches	Taneum Creek
2005	2.63%	0.25%	0.78%			
2006	5.52%	0.90%	2.00%			
2007	5.36%	0.42%	1.12%			
2008	2.15%	0.18%	1.47%	1.23%	1.01%	0.86%
2009	0.07%	0.15%	0.43%	0.60%	0.36%	0.31%
2010	0.57%	0.21%	0.69%	0.54%	0.15%	0.66%
2011	4.42%	1.34%	2.44%	2.03%	0.63%	1.21%
2012	0.90%	0.30%	0.66%	0.36%	0.13%	
2013	1.25%	0.57%	0.15%	0.08%	0.00%	
2014	0.15%	0.50%	0.53%	0.64%	0.29%	
Mean	*2.30%*	*0.48%*	*1.03%*	*0.78%*	*0.37%*	*0.76%*
Geomean	*1.17%*	*0.38%*	*0.79%*	*0.55%*	*0.33%*	*0.68%*

Table 2-10. Estimated post-harvest release to Prosser Dam adult survival (SAR) index for Coho released as smolts in the Upper Yakima and Naches Basins, brood years 2005-2014.

Brood Year	Hatchery-Origin		
	Smolt Releases		
	Prosser	Upper Yakima	Naches
2005	1.68%	0.16%	0.50%
2006	2.61%	0.43%	0.95%
2007	1.52%	0.12%	0.32%
2008	1.84%	0.16%	1.25%
2009	0.16%	0.33%	0.94%
2010	0.52%	0.20%	0.63%
2011	3.93%	1.20%	2.17%
2012	0.53%	0.17%	0.39%
2013	0.57%	0.26%	0.07%
2014	0.10%	0.33%	0.36%
Mean	*1.35%*	*0.34%*	*0.76%*
Geomean	*0.81%*	*0.26%*	*0.54%*

Table 2-11. Estimated pre-harvest release to Prosser Dam adult survival (SAR) index for Coho released as smolt or parr in the Upper Yakima and Naches Basins.

Index	Hatchery-Origin				
	Smolt Releases[1]			Parr Releases[2]	
	Prosser	Upper Yakima	Naches	Upper Yakima	Naches
Mean	*2.54%*	*0.63%*	*1.43%*	*0.87%*	*0.41%*
Geomean	*1.53%*	*0.49%*	*1.03%*	*0.61%*	*0.37%*

1 Values in Table 2-10 adjusted to account for total exploitation rate (47%), i.e., value/(1-0.47); see Table 2-23.
2 Values in Table 2-9 adjusted to account for adult fish passage survival from Bonneville through McNary Dam (92%) and ocean and lower Columbia River (below Bonneville Dam) harvest (17%), i.e., value*0.92/0.83.

2.3.5 Harvest

Harvest data for Yakima River-origin Coho are presently limited because few fish have been coded wire-tagged until recent years. All H Analyzer (AHA) modeling in this Master Plan assumes that natural- and hatchery-origin Yakima River Coho currently have a total exploitation rate of approximately 47 percent (see section 2.5.2). This includes Coho caught in marine, Columbia River and Yakima River fisheries. Hatchery-origin releases are currently not adipose fin-clipped and are not subject to additional mortality in selective fisheries. The proposed program will ad-clip all segregated program releases, subjecting these returns to a higher harvest rate than unmarked Coho.

Recreational harvest in the Yakima River is estimated by WDFW and averages about 1-2% of total escapement (Table 2-12). Because of the quantity and relatively higher quality of Coho available to tribal fishers in Zone 6 Columbia and Klickitat River fisheries, Yakima River terminal tribal harvest is typically at or near zero even though regulations allowing fall season fisheries in the Yakima River are propagated annually by the Yakama Nation. Total harvest of Yakima-destined Coho in the Zone 6 fisheries was calculated using data from Table 2-1, Neeley (2018), and Table 2-3. We estimated Bonneville adult returns for smolts released in brood years 2005-2014 and compared these with total estimated hatchery-origin returns to Prosser Dam. Total harvest in fisheries from Bonneville Dam to Prosser Dam averaged about 4,100 adult Coho annually or about 36% of the estimated Yakima-destined adult Coho return to Bonneville Dam.

Table 2-12. Estimated Coho returns and recreational harvest in the Yakima River, 1999-2018.

Adult Return Year	Total Returns		WA Recreational Harvest		
	Adult	Jack	Adult	Jack	Harvest Rate
1999	3,906	91	54	0	1.4%
2000	4,444	1,841	54	15	1.1%
2001	5,032	68	54	0	1.1%
2002	515	343	40	0	4.7%
2003	2,192	162	0	0	0.0%
2004	2,367	74	42	10	2.1%
2005	2,897	225	7	0	0.2%
2006	4,478	175	18	0	0.4%
2007	3,461	64	8	0	0.2%
2008	4,636	1,917	46	50	1.5%
2009	9,843	873	26	0	0.2%
2010	5,776	567	50	0	0.8%
2011	8,073	171	55	0	0.7%
2012	5,511	264	13	0	0.2%
2013	3,173	848	46	41	2.2%
2014	25,368	584	108	0	0.4%
2015	3,314	300	9	0	0.2%
2016	3,383	374	0	0	0.0%
2017	3,920	274	65	18	2.0%
2018	2,218	835	28	30	1.9%
Average	*5,225*	*503*	*36*	*8*	*1.1%*

2.4 PROPOSED HATCHERY PROGRAMS

This Master Plan proposes two hatchery programs for Yakima Coho: (1) a locally-adapted integrated harvest program upstream of Prosser Dam using facilities at the new Melvin R. Sampson hatchery, and (2) a segregated harvest program downstream of Prosser Dam using facilities at Prosser Hatchery. The first program will be referred to as the **Upper Yakima Integrated Coho Program** and second program as the **Lower Yakima Segregated Coho Program**. An overview of the two programs is presented in Table 2-13. The remainder of section 2.4 provides details on the proposed programs.

Table 2-13. Overview of Proposed Upper Yakima Integrated Coho and Lower Yakima Segregated Coho Programs.

	Upper Yakima Integrated Coho Program	Lower Yakima Segregated Coho Program
Natural population	Extirpated	None
ESA Status	Not Listed	Not Listed
Spawning Area	Yakima River tributaries and mainstem	Not intended to spawn
Harvest Goals	Contribute > 10,700 adults to all fisheries, including > 4,700 to Zone 6 and the Yakima River fisheries	
Yakama Nation Cultural Goal	Reestablish natural spawning of Coho in tributaries where they occurred historically	Meet treaty harvest entitlements per *U.S. v. Oregon* agreements
Conservation Goals	Increase the number of natural-origin returns to the Yakima Subbasin to >2,600 adults and reestablish a naturally-spawning Coho population.	None
Broodstock Origin	Lower Columbia hatchery Coho	Lower Columbia hatchery Coho
Hatchery Program Purpose	Harvest and reestablishment of a naturally-spawning Coho population	Harvest
Hatchery Broodstock Management	In Phase 3, the program will transition to using only local brood and 30% natural-origin broodstock. In Phase 4, the program will use 100% natural-origin broodstock.	This currently is and will continue to be a segregated program. It will transition to a segregated "stepping stone" program over time by using integrated HORs as broodstock, providing genetic continuity with the Upper Yakima integrated program.
Hatchery Broodstock Collection Locations	With implementation of this Master Plan, broodstock will be collected at Prosser and Roza dams.	With the implementation of this Master Plan, broodstock will be drawn from hatchery returns from the local program at Prosser to increase survival and homing.
Hatchery Program Size—Phases 3 and 4	500,000 parr equivalent 200,000 yearlings	500,000 yearlings
Hatchery Location	Melvin R. Sampson Hatchery	Prosser Hatchery
Smolt/Parr Release Locations	Tributaries and upper Yakima and Naches mainstem reaches	Prosser Hatchery
Marking/Tagging	100% CWT, 5-10% PIT tagged	100% ad clipped
Adult Outplants	Up to 1,000 segregated HOR adults will be outplanted into upper reaches of Yakima and Naches rivers. Adults will be collected at the Prosser Denil or Roza Adult Monitoring Facilities.	Not applicable

2.4.1 Program Need and Justification

The Yakama Nation was guaranteed fishing rights by the Treaty of 1855. These rights were confirmed in *U.S. v Oregon* in 1969. Since 1977, the parties to *U.S. v Oregon* have been involved in negotiating a series of plans for fisheries management in the Columbia River Basin. These plans have been adopted by the orders of the U.S. District Court for the District of Oregon. The planning process is the principal forum through which issues about anadromous fish harvest, stock restoration, and production are addressed. The 2008-2017 Plan identifies a short-term production goal of 1.0 million Coho to be released in the Yakima River Basin. The 2008-2017 Accords have been reauthorized through 2022.

Historically, Yakama Tribal members fished for Chinook, Coho, steelhead and other species in the Yakima River and throughout the Columbia River Basin. Because of high pre-terminal harvest rates and degraded habitat, the native Yakima Coho population was extirpated. To meet treaty obligations, a program is needed that will increase harvest toward historic levels and restore natural production of historic salmon populations in the Yakima Basin. Because it will require decades of work before basin habitat is able to produce Coho at sufficient levels to meet harvest and natural production goals, artificial production will be used in the short term to produce Coho for re-colonizing stream habitat and to meet tribal harvest needs.

Hatchery Coho production was initiated in the Yakima Basin under the YKFP program and was expected to progress through four phases: 1) selection and introduction of a donor stock, 2) test and initiate re-colonization of natural habitat, 3) continued colonization and transition to local broodstock, and 4) a local adaptation phase. Phase 1 has been completed and Phase 2 ends with the implementation of this Master Plan; therefore, this Master Plan addresses the third and fourth phases of the program.

2.4.2 Program Goals and Objectives

The program goals and objectives for the Yakima Integrated and Segregated Coho programs are:

- **Yakima Integrated Coho Program:** The primary objective of the integrated Coho program is to increase harvest of Coho in the Zone 6 and Yakima River basin fisheries. The integrated program is also expected to increase the number of fish spawning naturally in the Yakima River basin, which will contribute to the Yakama Nation's cultural objective of seeing Coho complete their life cycle in the wild. In addition, the integrated program is designed to reestablish a locally-adapted Coho population above Prosser Dam in the Yakima and Naches River subbasins and increase the spatial diversity of the naturally-spawning population.

- **Yakima Segregated Coho Program:** The primary objective of the segregated program is to increase harvest of Coho in the Zone 6 and Yakima River basin fisheries consistent with *U.S. v Oregon* agreements.

2.4.3 Yakima Integrated Coho Program

The integrated Coho program will reside at the new Melvin R. Sampson (MRS) Hatchery near the town of Thorpe, WA. During Phases 3 and 4, the program goal is to release up to 200,000 smolts and up to 500,000 parr (Table 2-14). These production goals have been approved by NMFS (2016). The program may shift to releasing all smolts (i.e., up to 700,000 smolts) if the combined parr and smolt release strategy does not meet adult return objectives, or if drought conditions preclude summer parr releases.

In addition, the program will outplant up to 1,000 hatchery-origin Coho adults from the segregated program collected at Roza and Prosser Dams. The purpose of outplanting segregated program adults is to colonize reaches that do not yet support natural spawning. There is likely to be a surplus of segregated program fish returning to Prosser, beyond those adults needed for broodstock, and during the initial years of the program, any genetic differences between segregated and integrated program adults will be minimal.

Table 2-14. Release goals and broodstock management strategy for the Yakima integrated Coho program.

Program Goal	Current	Phase 3	Phase 4
Hatchery-origin brood (HOB)	720	570	0
Natural-origin brood (NOB)	40	240	810
Smolts released	540,000[1]	200,000	200,000
Parr Released	100,000[1]	500,000	500,000
Adult Outplants	30-100	1,000	TBD
pNOB	5%	30%	100%

[1] Releases using local brood are accounted for here in the current 'integrated' program. Releases using imported brood are accounted for in the current 'segregated' program in Table 2-18.

Approximately 810 Coho adults, including natural- and hatchery-origin returns, would be collected at Roza Dam for broodstock for the integrated program. Adults may also be collected at Prosser Dam as a backup source. Broodstock would be collected and spawned from October through January. During Phase 3, the program goal is to transition to using 30% natural-origin returns as broodstock, and in Phase 4, the goal is to use 100% natural-origin broodstock. The transition from the current program to Phases 3 and 4 is described in more detail below. All adults used for broodstock in the integrated program will be DNA-sampled for parentage-based tagging (PBT).

All juveniles from the integrated program will be coded wire-tagged, but not adipose fin-clipped. This tagging approach is designed to reduce harvest of Coho from the integrated program in pre-terminal fisheries and to distinguish them from adult returns from the Prosser segregated program, which will be adipose fin-clipped. The overall marking strategy (ad-clip the segregated program release and CWT-only the integrated program releases) will allow evaluation of the main research question, which is to assess the trend in natural-origin (unmarked, untagged) returns over time. A portion (5-10%) of juveniles from the integrated program will also receive PIT tags. We intend to evaluate survival differences among the release groups using PIT tags (for example, see Tables 2-3 and 2-5) and will use this information to adaptively manage the release groups.

Parr, Smolt and Adult Release Locations

Integrated program fish will be released into targeted tributaries in the upper Yakima and Naches watersheds (Figure 2-5). The prioritized list of tributaries identified for Coho reintroduction is provided in Table 2-15, along with release strategies that may be used in the particular location. We do not intend to use the same release strategy in the same location in any given year. Adult outplants are the preferred strategy in tributaries where ESA-listed species are present to minimize negative interactions. Juvenile releases will continue to focus on tributaries where Bull Trout and steelhead are not present or occur at low abundance. In tributaries that support spawning and rearing habitat for Bull Trout, Coho adults will be outplanted well downstream of known Bull Trout spawning and rearing habitat to minimize the risk of Coho adults preying on Bull Trout. In the future, additional tributaries could be subject to juvenile acclimation and release, in consultation with the U.S. Fish and Wildlife Service (USFWS) and NMFS. The number and life stage of Coho released would depend on a number of factors that include habitat conditions and presence of sensitive species within the tributaries. The Yakama Nation would review drought reports on an annual basis and focus releases of Coho into streams that are not expected to experience dewatering during summer months.

Parr will be released directly into streams. Smolts will be acclimated for approximately 4 weeks prior to release. Smolts will be acclimated in ponds adjacent to tributaries in which they will be released to help encourage their return as adults to these locations. A number of existing ponds, including Jack Creek, Hundley, Boone, and Easton will continue to be used to acclimate Coho smolts from the MRS Hatchery. Mobile acclimation units will be used for a small number of Coho smolts in the basin. Similar to the mobile acclimation units currently being used by the Yakama Nation, these units will consist of portable aluminum raceways that are 20 feet long, 5 feet wide, and 4 feet tall.

The selection of one or more release strategies for individual tributaries considered both abiotic and biotic factors including the size and quality of available habitat, presence or absence of other sensitive species, and logistical constraints (i.e., accessibility). The foundation and biological justification for generating optimal release numbers are based on natural production estimates from the Ecosystem Diagnosis and Treatment (EDT) model. Adjustments were made to release numbers to account for a reduced fitness factor of hatchery fish that may lack the natural productivity and relative fitness of a fully adapted natural population. In a review of relative fitness of hatchery and natural salmon, Berejikian and Ford (2004) reported the relative fitness of hatchery salmon ranges from approximately 20% to as high as 100% depending on the species, brood source, and number of generations the hatchery line has experienced. For our purposes, we assumed a 50% relative fitness factor for hatchery-origin Coho.

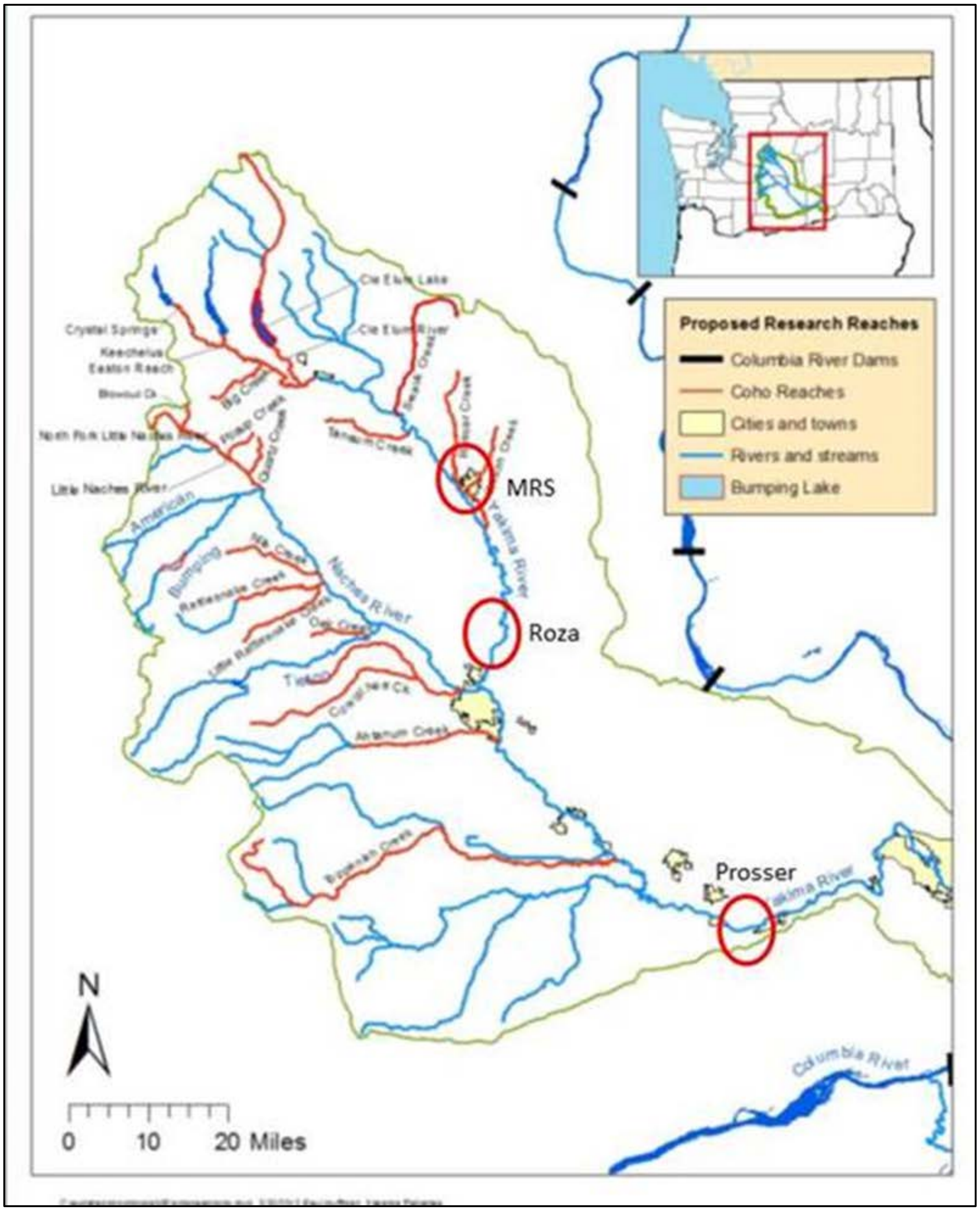


Figure 2-5. Location of proposed release sites for integrated Coho program smolts and parr in targeted tributaries above the confluence of the Naches and Yakima Rivers.

Table 2-15. Prioritized list of Yakima Basin tributaries identified for Coho reintroduction under the proposed Upper Yakima integrated Coho program.

Location	Release Strategy			Priority
	Parr Releases	Adult Outplants	Smolt Releases	
Naches River				
Cowiche Creek, including South Fork	x	x	x	First
Rattlesnake Creek		x	x (may be decommissioned)	First
Little Naches	x	x		First
Quartz Creek	x			First
Nile Creek	x			First
Tieton River		x		First
South Fork Tieton River		x		Second
North Fork Tieton River		x		Second
Rock Creek	x			Second
North Fork Little Naches	x	x		Second
Bumping River		x		Second
American River	x	x		Second
Upper Yakima River				
Wilson Creek	x	x		First
Reecer Creek	x	x		First
Swauk Creek	x	x		First
Iron Creek	x			First
First Creek	x			First
Blue Creek	x			Second
Williams Creek			x	First
Taneum Creek		x		First
Big Creek		x		First
Mainstem Upper Yakima (including acclimation sites)	x	x	x (four existing sites)	First
Upper Cle Elum River	x	x		First
Cabin Creek	x			First
Lower Cle Elum River (below dam)	x			First
Manastash	x	x		Second
Cherry Creek	x			Second
Mercer Creek	x			Second
Coleman Creek	x	x		Second
Naneum Creek	x			Second
Little Creek	x	x		Second
Teanaway River	x	x		Second
Jack Creek			x (existing)	Second
Indian Creek	x			First
Stafford Creek	x			Second
Jungle Creek	x			Second
Yakima River downstream of Naches/Upper Yakima Confluence				
Ahtanum Creek	x	x	x (smolt release)	Second

Source: Final EIS, Melvin R. Sampson Hatchery (BPA 2017).

2.4.3.1 Yakima Integrated Coho Program Phase 3

The main objectives in Phase 3 of the integrated program are to: 1) use only local broodstock (Yakima River Coho returns), 2) increase the proportion of natural-origin returns used for broodstock (pNOB) to 30%, and 3) increase the number of Coho spawning naturally in upper watershed tributaries. We expect Phase 3 to last about six years (two generations) which will allow substantial colonization of tributaries and increase the number of natural-origin returns. We expect hatchery-origin fish to demonstrate increased local adaptation as well. During Phase 3, broodstock will consist of up to 810 fish collected from hatchery (70%) and natural-origin (30%) adults returning to the Prosser Denil or RAMF.

Transition to Local and Natural-origin Broodstock

During Phase 1 and 2 of the Coho program, hatchery releases from the local brood source (Yakima River hatchery-origin returns) had significantly higher smolt-to-smolt survival than releases from out-of-basin (non-Yakima River origin) hatchery-origin broodstock. During Phase 3, the program goal is to collect only local hatchery-origin broodstock returning to Prosser and Roza dams and to incorporate approximately 30% NORs into the broodstock (Table 2-14). These strategies are expected to increase the productivity and fitness of the integrated hatchery and natural-origin population.

Since 2001, an average of more than 4,000 hatchery-origin adults have returned annually to Prosser Dam (Table 2-7). This run size is sufficient to support an integrated program using 70% local hatchery-origin brood (about 590 HOB). Since 2001, an average of more than 800 natural-origin adults have returned annually to Prosser Dam (Table 2-7). On average, this run size is sufficient to support an integrated program with 30% pNOB (about 240 NOB), which would be less than 30% of the average NOR run size.

A sliding scale broodstock collection table illustrates the NOR run sizes required in Phases 3 and 4 to transition to using 30% and 100% pNOB, respectively (Table 2-16).

Table 2-16. Sliding scale broodstock collection table for Phases 3 and 4 of the Yakima integrated Coho program (assumes 810 broodstock are needed for a full program). Phase 3 pNOB goal is 30%, even if run size exceeds 810 NORs. Phase 4 pNOB goal is 100%.

NOR Run Size at Prosser	NOB	HOB	pNOB	Percent of NOR Run Size Collected for Brood	Approx. NOR Escapement	NOR Terminal Harvest
300	90	720	11%	30%	200	0%
500	150	660	19%	30%	350	0%
810	243	567	30%	30%	550	<2%
1,200	360	450	44%	30%	800	<2%
1,800	540	270	67%	30%	1,200	<2%
2,400	720	90	89%	30%	1,600	<5%
3,000	810	0	100%	27%	1,900	10%
3,600	810	0	100%	22%	2,400	12%

Parr and Smolt Releases

Release to adult survival data indicate that parr releases have contributed substantially to program results observed during Phases 1 and 2 (Table 2-9). Therefore, this approach will be expanded as part of the Phase 3 integrated program. Parr spend less time in the hatchery, making this a preferred release strategy. The proposed release numbers (500,000 parr and 200,000 smolts) may be adjusted as additional monitoring and evaluation data on the survival and productivity of each release strategy becomes available.

Parr plants may be discontinued periodically in some tributaries and the stream(s) monitored for juvenile and adult production and habitat conditions. This approach allows biologists to continually probe the ability of the system to produce naturally sustainable Coho without hatchery intervention.

Adult Outplants

Initial results of adult Coho outplants in Taneum Creek indicated that Coho spawned successfully and produced offspring that survived well to adult return in years when environmental conditions were favorable (Table 2-5). This adult planting strategy will be continued in Phase 3 with up to 1,000 outplants annually, prioritizing the tributaries where integrated parr or smolts are not being outplanted (Table 2-15). Adult outplants will consist of MRS segregated program hatchery-origin adults returning to the Prosser Denil or Roza Adult Monitoring Facilities (RAMF). Stocking and evaluations will be similar to the protocol described above for the parr plants.

2.4.3.1 Yakima Integrated Coho Program Phase 4

The main objectives in Phase 4 of the integrated program are to: 1) increase the proportion of natural-origin returns used for broodstock (pNOB) to 100% when run sizes allow, and 2) increase the number of Coho spawning naturally in upper watershed tributaries. In Phases 3 and 4, all escaping fish (after broodstock collection) will be allowed to return to the spawning grounds as a major objective of this program is natural stock restoration, and all returning fish will either be the progeny of fish that spawned in the wild or crosses of natural-origin fish from the MRS Hatchery. Hatchery-origin spawners (most of which will be from localized parr releases) should demonstrate increasing local adaptation. This strategy is consistent with that of the Levi George spring Chinook Hatchery program, which has maintained an average PNI of 0.66 (Fast et al. 2015; Bosch 2017).

During Phase 4, broodstock collection protocols will allow only taking at most one of every three natural-origin fish passing upstream of the Prosser Denil or Roza Dam brood collection facilities. If fewer than 800 natural-origin fish are available for broodstock in any given year due to reduced natural-origin returns, the program would revert to Phase 3 protocols (up to 30% pNOB). Thus, no more than 30% of the NOR run would be collected as brood.

The strategy for achieving integrated program objectives for broodstock collection and escapement is defined by a set of Decision Rules (Table 2-17). These fundamental rules will be modified only when new information indicates that basic assumptions are no longer appropriate.

Table 2-17. Decision Rules for the Upper Yakima Integrated Coho program under Phases 3 and 4.

Phase 3	Phase 4
Natural-origin broodstock (NOB) will be the smaller of 30% of the natural-origin (NOR) run at Prosser or 250 NOB (the 30% target for pNOB).	The program will use 100% natural-origin broodstock (NOB). If NOR run-size falls below 810, the program will revert to Phase 3 rules (30% pNOB or less, depending on NOR run size).

2.4.4 Yakima Segregated Coho Program

The segregated Coho program will continue to reside at Prosser Hatchery and will have an on-station smolt release goal of 500,000 fish (Table 2-18). Segregated program fish will be released into the hatchery outflow stream that flows into the Yakima River about ¼ mile below Prosser Dam. The major change from the current program is that all fish culture activities will occur in-basin.

During the initial years of the segregated program, broodstock will come from segregated hatchery fish returning to the basin at either Prosser or Roza dams. In later years, surplus adults from the integrated program may be incorporated as broodstock. This type of broodstock interchange is referred to as a stepping stone program. By using locally-adapted fish for broodstock, average hatchery fish survival is expected to increase over time.

With implementation of this Master Plan, broodstock for the segregated program will consist of approximately 600 fish collected from adults returning to the Prosser Hatchery denil trap, the Prosser Dam denil trap, or from fish stranded in the Chandler irrigation canal. Smolts will be 100% adipose fin-clipped prior to release to allow maximum retention in selective fisheries. A subsample will be coded wire-tagged. Thus, fish from the integrated and segregated programs will be differentially marked and may be distinguished as adults.

After broodstock is collected for the segregated program, up to 1,000 adults from the segregated program will be used as adult outplants for the integrated program (i.e., in the Upper Yakima or Naches tributaries). Finally, any remaining captured fish from the segregated program would be processed and distributed for tribal ceremonial and subsistence use. Fish escaping above capture points at and near Prosser Dam and Hatchery may spawn in the wild. However, we expect the majority of these fish to remain in reaches of the Yakima below its confluence with the Naches River in Yakima, WA. PIT-detection data indicate that these fish do not ascend Roza Dam.

Table 2-18. Release goals and broodstock management strategy for the Yakima segregated Coho program.

Program Goal	Current	With Prosser Hatchery Upgrades
Hatchery-origin brood (HOB)	< 600 (imported)	600 (local)
Smolts released	270,000 (average)[1]	500,000

1 These are current releases using imported brood. Currently, the entire Coho program releases a total of about 910,000 smolts and 100,000 parr using both local and imported brood (Table 2-1).

All segregated program Coho smolts will be released below Prosser Dam in the lower Yakima River. This release site is downstream of major rearing areas for spring Chinook and ESA listed steelhead and minimizes ecological interactions (i.e., predation and competition) with these species.

2.4.5 Summary of Proposed Coho Programs

In summary, the proposed programs would result in the following changes to ongoing Coho hatchery programs currently being conducted in the Yakima Basin:

- **Increase in the number of parr releases and decrease in the number of smolt releases in the upper subbasins.** The proposed Coho programs would increase the number of Coho parr released from 100,000 up to 500,000 annually and reduce the number of Coho smolt releases in the upper subbasins. However, an additional 500,000 segregated program smolts will be released below Prosser Dam. As a result, a total of 1.2 million Coho juveniles (parr and smolt) will be released (500,000 integrated parr, 200,000 integrated smolts, and 500,000 segregated smolts). This is an increase from current releases, which have averaged 900,000 smolts and parr (brood years 2008-2017).

- **Acclimation and release of integrated program Coho into tributaries that have not yet been seeded.** In the future, juveniles may be acclimated and released in additional tributaries, in consultation with the USFWS and NMFS.

- **Transition to using local broodstock and integration of natural-origin returns into broodstock.** Both the integrated and segregated programs will transition to using 100% local broodstock (i.e., adult returns to the Yakima subbasin). In addition, the integrated program will incorporate natural-origin broodstock (30% in Phase 3 and 100% in Phase 4) based on the natural-origin run size at Prosser Dam.

2.5 SCIENTIFIC FRAMEWORK

2.5.1 Biological Objectives

Biological objectives for Phases 3 and 4 of the Coho program are presented in Table 2-19. In Phase 3, the harvest objective is to provide an average of 8,400 Coho adults for harvest in ocean and freshwater fisheries, of which 2,900 Coho are expected to be caught in the Zone 6 and Yakima River terminal fisheries. In Phase 4, the harvest objective is to provide an average of 10,700 Coho adults for harvest in ocean and freshwater fisheries, including 4,700 Coho harvested in the Zone 6 and Yakima River terminal fisheries.

The integrated program also has an objective to reestablish a self-sustaining, naturally-spawning population of Coho in the Yakima River. In Phase 3, the escapement target is 4,400 naturally-spawning fish (NORs and HORs combined). In Phase 4, the target is 2,600 NORs (counted at Prosser Dam), including about 810 NORs used for broodstock in the integrated program. Additional biological objectives for Phase 4 are to manage the integrated harvest program to achieve a PNI greater than 0.67.

Achieving these harvest and escapement targets will require additional improvements in habitat quality and quantity. These improvements will come from the continued implementation of habitat actions in the Yakima River Basin (see Table 7-4 and Section 7.3).

Table 2-19. Biological objectives and performance indicators for the Yakima River Coho program.

Biological Objective	Performance Indicators	
	Integrated Program	Segregated Program
Phase 3		
Total Spawning Escapement (Natural and Hatchery Origin)	>4,400 (NOR+HOR) spawners	NA
NOR Spawning Escapement		NA
Total Harvest	Average annual harvest contribution from both programs to all fisheries > 8,400 Coho	
Zone 6 Fishery and Yakima River	Average annual harvest contribution from both programs to Zone 6 and Yakima River fisheries > 2,900 Coho	
Broodstock collection	All local broodstock, 30% pNOB	All local broodstock
Trigger to Initiate Phase 4	2,400 natural-origin returns to Prosser (a 3-year running average)	
Phase 4		
Total Spawning Escapement (Natural and Hatchery Origin)	>4,000 (NOR+HOR) spawners	NA
NOR Returns	>2,600 natural-origin returns (1,860 spawners, 810 brood)	NA
Total Harvest	Average annual harvest contribution from both programs to all fisheries > 10,700 Coho	
Zone 6 Fishery and Yakima River Terminal Fishery	Average annual harvest contribution from both programs to Zone 6 and Yakima River fisheries > 4,700 Coho	
pNOB	All local broodstock, 100% pNOB	NA
pHOS	Not managed[1]	< 5% stray rate
PNI	> 0.67	NA

[1] Consistent with the Levi George spring Chinook program and the intent of an integrated program that uses only NOR broodstock, pHOS will not be managed. Long-term data for the Levi George program indicate that such management can still result in maintaining a PNI near 0.67.

2.5.2 Key Assumptions

The key assumptions for natural and hatchery Coho production in Phase 3 and Phase 4 are identified below. Assumptions may be modified each year based on research and monitoring and evaluation outcomes. These assumptions were incorporated into the All-H Analyzer (AHA) tool to forecast the harvest and conservation benefits of the Coho programs.

2.5.2.1 Natural Production Assumptions

The natural production assumptions used in the AHA model are shown in Table 2-20. The productivity and capacity assumptions are based on EDT modeling results used in the Integrated Plan (USDI and WDOE 2012) and are adjusted to included fitness loss (i.e., fitness loss is applied as a multiplier). Fitness assumptions are discussed below. Phase 3 productivity and capacity assumptions are the baseline or current assumptions about the system. Phase 4 assumptions are adjusted to account for 1) habitat restoration actions (ongoing and proposed) under the Integrated Plan, described in Section 2.2, and 2) fitness improvements as the program becomes fully integrated and the population becomes locally-adapted.

The smolt-to-adult survival (SAR) assumption for natural-origin Coho is based on PIT tag data for Taneum Creek parr (brood years 2008-2011), which are naturally-spawned parr from adults outplanted into Taneum Creek. This is the best available data for the Yakima River naturally-spawning Coho population. The AHA model uses the pre-harvest SAR (i.e., survival before harvest removals) from Bonneville (smolt) to Bonneville (adult return), then applies assumptions about juvenile and adult fish passage survival through the mainstem Columbia River from the FCRPS Biological Opinion. The post-harvest Bonneville to Bonneville SAR for Taneum Creek parr (BY 2008-2011) was 4.3%. The pre-harvest SAR was then calculated by adjusting the post-harvest SAR by the exploitation rate in the ocean and lower Columbia River fisheries below Bonneville Dam (17%; Table 2-23). Juvenile fish passage survival from McNary through Bonneville Dams is assumed to be 75% (93% per project); adult fish passage survival is assumed to be 92% (98% per project).

Table 2-20. Natural production assumptions for Yakima Coho in Phases 3 and 4.

	Phase 3	Phase 4
Productivity (Smolts/Spawner)[1]	34	94
Capacity (Smolts)[1]	72,059	197,641
Fitness	0.50	0.80
Post-harvest BON-to-BON SAR[2]	4.3%	4.3%
Pre-harvest BON-to-BON SAR[3]	5.1%	5.1%
Juvenile Fish Passage Survival	75%	75%
Adult Fish Passage Survival	92%	92%

1 Productivity and capacity values including fitness loss.
2 Based on PIT tag data for naturally spawned Taneum Creek parr (Table 2-5).
3 Adjusted to account for harvest in the ocean and lower Columbia River (below Bonneville Dam) fisheries (17% exploitation rate in the two fisheries combined; Table 2-23).

Fitness

In the past, hatchery releases of Coho consisted of fish originating outside of the Yakima River Basin (i.e., not locally adapted). Although the current hatchery program is beginning to use local broodstock, most releases are still from out-of-basin brood. In a review of relative fitness of hatchery and natural-origin salmon, Berejikian and Ford (2004) cited studies that have demonstrated the relative fitness of hatchery salmon ranges from approximately 20 percent to as high as 100 percent depending on the species, brood source, and number of generations the hatchery line has experienced. This Master Plan assumes out-of-basin hatchery fish have a fitness factor 50 percent that of a locally-adapted Yakima River population[3]. It is then assumed that by following an integrated hatchery strategy (as defined by the HSRG), population fitness can be improved over time.

The HSRG defines an integrated program as follows:

> *A hatchery program is an* ***Integrated Type*** *if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild*. (HSRG et al. 2004). *For a natural/hatchery composite population at equilibrium (Ford 2002), the influence of the hatchery and natural environments on the adaptation of the composite population is determined by the proportion of natural-origin broodstock in the hatchery (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). The larger the ratio pNOB/ (pHOS+pNOB), the greater the strength of selection in the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, this ratio must exceed 0.5.*

This ratio is referred to as the proportionate natural influence (PNI). The Master Plan sets broodstock management (pNOB and PHOS) targets such that a PNI of 0.67 is achieved in Phase 4. AHA modeling shows that if this PNI value is achieved, the relative fitness of the integrated population will increase to approximately 80 percent.

Recent science supports the idea that this level of fitness improvement[4] is possible in locally-adapted populations. The Yakama Nation's Coho program in the mid-Columbia River tributaries, which is very similar to the proposed program in the Yakima River basin, illustrates that adaptive divergence is occurring in the reintroduced population (Campbell et al. 2017). While genetic variation and structure of reintroduced populations are likely to reflect source stocks for multiple generations, they may shift over time once established in nature (Campbell et al. 2017). For example, Tymchuk et al. (2006) reported that phenotypic effects of domestication in a Pacific Coho Salmon population can be largely diluted within two generations by backcrossing with wild salmon, indicating that local adaptation can occur relatively quickly even in farmed salmon with many generations in culture. Similarly, the work of Liermann et al. (2017) in the Elwha River demonstrates that transplanting hatchery-dominated Coho adults into newly available habitat can result in immediate freshwater production that is comparable to other systems. Chittenden et al. (2010) failed to observe any genetic differences between wild- and hatchery-born Coho salmon in the Chehalis River in British Columbia. While this may be due to the long-term mixing of these genotypes from hatchery introgression into wild populations, it could also be due to strong selection in nature with fish proving capable of maintaining highly fit genotypes whether or not they experienced part of their life history under cultured conditions.

A study in the Umpqua River, Oregon reported by Thériault et al. (2011) found no significant difference in reproductive success in the wild between hatchery-origin Coho with two hatchery-origin parents and those with two natural-origin parents indicating that environmental rather than genetic effects played a larger role in this study. Ford et al. (2006) reported reduced natural smolt production in a naturally-spawning Puget Sound tributary Coho population after 60 years of intensive hatchery supplementation. However, subsequent studies (Spromberg et al. 2015; Feist et al. 2017; McIntyre et al. 2018), some

[3] Note that the historical Yakima River Coho population has been extirpated. The focus of the Master Plan is to create a locally-adapted Coho population in the Yakima River. The 50 percent fitness assumption is the standard value used by the HSRG in AHA modeling.

[4] Fitness improvement may be evaluated by looking at trends in life stage survivals, SARs, and migration survival, as well as total juvenile production, measured at Chandler or McNary Dam.

specific to the Puget Sound, report significant mortality threats to Coho from urbanization effects indicating that observed differences in Ford et al. (2006) could also be due to environmental and not genetic effects.

2.5.2.2 Hatchery Production Assumptions

Estimates of the number of broodstock required for each program are based on in-hatchery data for the Prosser program (Table 2-21). The fecundity and egg-to-parr or smolt assumptions are based on data in Table 2-3. Pre-spawning mortality is minimal because adults are spawned within one week of being collected.

Table 2-21. Broodstock requirements, in-hatchery metrics, and smolt/parr release numbers for Yakima Coho programs.

	Current	Upper Yakima River Integrated - Phase 3	Upper Yakima River Integrated - Phase 4	Lower Yakima River Segregated
Brood Source	Local + Imported	Local	Local	Local HORs
Broodstock Required	1,090	810	810	600
Pre-spawn Mortality	2.0%	2.0%	2.0%	2.0%
Fecundity	2,322	2,322	2,322	2,322
Eggs	1,240,180	921,602	921,602	682,668
Egg-to-Parr/Smolt Survival	73.5%	76%*	76%*	73.5%
Smolts and Parr Released	~910,000	~700,000	~700,000	~500,000

*Assumes slight increase in egg-to-parr/smolt survival with incorporation of NORs into brood.

Additional hatchery production assumptions used in the AHA model are shown in Table 2-22. The goal of both the integrated and segregated programs is to use 100% local broodstock in Phases 3 and 4. The post-harvest SAR index is based on the return of adults to Prosser Dam divided by the estimated number of outmigrating juveniles passing Prosser Dam.

The smolt-to-adult survival (SAR) assumptions for hatchery-origin returns are based on PIT tag data for parr and smolt releases (brood years 2005-2014). For hatchery-origin fish, the AHA model uses the pre-harvest release to Prosser SAR (i.e., survival before harvest removals). The pre-harvest release to Prosser SAR was 0.49% for parr and 0.76% for smolts released in the upper subbasins (geomean for BY 2006-2014, averaging the two subbasins; Table 2-10) and 1.53% for smolts released at Prosser Dam. The pre-harvest SARs were calculated by adjusting the release to Bonneville (adult returns) post-harvest SARs by the exploitation rate in the ocean and lower Columbia River fisheries (below Bonneville Dam; 17%; Table 2-23) and expected adult fish passage survival through from Bonneville to McNary Dams (92%; FCRPS BiOp).

Table 2-22. Hatchery production assumptions for Yakima Coho in Phases 3 and 4.

	Phase 3		Phase 4	
	Upper Yakima Integrated Program	Lower Yakima Segregated Program	Upper Yakima Integrated Program	Lower Yakima Segregated Program
Local Broodstock	100%	100%	100%	100%[1]
pNOB	30%	NA	100%	NA
Pre-harvest SAR (Prosser to Prosser)[2] - smolts	NA	1.53%	NA	1.53%
Pre-harvest SAR (upper subbasins to Prosser)[2] - smolts	0.76%	NA	0.76%	NA
Pre-harvest SAR (upper subbasins to Prosser)[3] – parr	0.49%	NA	0.49%	NA

1 In Phase 4, the segregated program may begin to incorporate integrated HORs into the broodstock.
2 Post-harvest SAR (Table 2-10) adjusted to remove ocean and lower Columbia R. harvests (17% exploitation rate).
3 Post-harvest SAR (Table 2-9) adjusted to account for adult fish passage survival (92%) from Bonneville through McNary Dams and to remove ocean and lower Columbia R. harvests (17% exploitation rate).

2.5.2.3 Harvest Rate Assumptions

Current harvest rate assumptions for NORs and HORs are based on information in the Joint Staff report (WDFW and ODFW 2018), adult returns of marked Coho to Bonneville Dam, adult returns of marked Coho to Prosser Dam, and terminal harvest rate data collected by WDFW. The total exploitation rate for NORs in the ocean and non-tribal mainstem Columbia River fisheries, which primarily take place in the lower Columbia River (Zones 1-5), is approximately 15-20% (WDFW and ODFW 2018b). In AHA, we assume a total exploitation rate of 17% for these two fisheries combined. The harvest rate on Yakima Coho in the upper Columbia River was estimated as 35% based on the average number of Coho harvested between Bonneville and Prosser Dams (calculated as the difference between Yakima-destined adult returns to Bonneville and adult returns to Prosser) divided by the number of adults passing Bonneville Dam. The terminal harvest rate assumption of 1% is based on recreational harvest data from WDFW (Table 2-23). Tribal terminal harvest is negligible.

The Phase 3 and 4 harvest rate assumptions are based on the current harvest rate assumptions for these fisheries, with two exceptions. First, during Phase 3, it is assumed that Zone 6 harvest of unmarked (integrated program) fish would be reduced to 20% to allow more adult returns to recolonize the spawning grounds in the Yakima Basin. Second, segregated program releases will be ad-clipped during Phases 3 and 4 (they are not currently externally marked). Therefore, the harvest rates in ocean and lower Columbia fisheries for segregated HORs are assumed to be three times the harvest rates for unmarked fish. Integrated HORs will not be externally marked, and therefore harvest rates for integrated HORs are the same as for NORs in Phases 3 and 4.

Table 2-23. Harvest rate assumptions for Yakima Coho during Phase 3 and Phase 4.

	Current		NORs		Integrated HORs		Segregated HORs	
	NORs	HORs	Phase 3	Phase 4	Phase 3	Phase 4	Phase 3	Phase 4
Ocean Harvest Rate	11%	11%	11%	11%	11%	11%	30%	30%
Lower Columbia Harvest Rate (Zone 1-5)	7%	7%	7%	7%	7%	7%	24%	24%
Upper Columbia Harvest Rate (Zone 6)	35%	35%	20%	35%	20%	35%	35%	35%
Terminal Harvest Rate	1%	1%	1%	1%	1%	1%	1%	1%
Total Exploitation Rate	47%	47%	34%	47%	34%	47%	66%	66%

2.5.3 Expected Outcomes by Phase based on AHA Modeling

The expected outcomes of the hatchery program in each phase were calculated using the All-H Analyzer (AHA) model based on the proposed hatchery strategies and key assumptions about in-basin and out-of-basin conditions. Expected outcomes for the current program, integrated program (Phase 3 and 4) and segregated program are shown in Tables 2-24 and 2-25. These are the average outcomes expected during each program phase based on the key assumptions about habitat, fish passage, harvest, and SARs described in section 2.5.2. These assumptions are used as inputs in the AHA model, which calculates the equilibrium status of the population in terms of adult abundance (escapement and harvest) and run composition (NORs and HORs). AHA also incorporates assumptions about density dependence in the freshwater portion of the life cycle using the Beverton-Holt survival function, ocean survival (including effects of annual variability), and fitness effects due to hatchery influence on the natural spawning population. AHA is static in the sense that harvest rates and hatchery production do not vary as a function of run size. However, the model is flexible enough to accommodate the inputs desired. Documentation for the AHA model is provided in HSRG (2009b), found at: http://hatcheryreform.us/wp-content/uploads/2016/05/4_appendix_c_analytical_methods_and_info_sources.pdf.

Table 2-24. Expected outcomes for the current and proposed Yakima Coho programs based on All-H Analyzer modeling.

	Current (all releases)	Integrated Coho – Phase 3	Integrated Coho – Phase 4	Lower Yakima River Segregated
Adult Outplants	30-100	Up to 1,000 segregated HORs	Up to 1,000 segregated HORs	NA
Hatchery Smolts	810,000	200,000	200,000	500,000
Hatchery Parr	100,000	500,000	500,000	0
Natural-origin Smolts	46,226	60,084	122,474	0
Ocean Harvest	1,172	793	1,118	2,743
Lower Columbia Harvest	664	449	633	1,536
Zone 6 Harvest	3,088	1,194	2,945	1,703

	Current (all releases)	Integrated Coho – Phase 3	Integrated Coho – Phase 4	Lower Yakima River Segregated
Terminal Harvest	53	44	50	29
Total Harvest	4,977	2,480	4,746	6,012
Natural-origin Returns to Basin (brood + escapement)	851	1,512	2,676	0
Hatchery-origin Returns to Basin (brood + escapement + hatchery surplus)	4,070	3,915	2,664	2,448
Total Adult Returns to Yakima Basin	4,921	5,427	5,340	2,448
Imported Broodstock (HOR)	1,010	0	0	0
Local Broodstock (NOR)	4	243	810	0
Local Broodstock (HOR)	67	567	-	600
Natural-origin Escapement	848	1,269	1,866	0
Hatchery-origin Escapement (includes in-basin strays from seg. program)	1,986	3,191	2,203	1,440
Total Escapement	2,834	4,460	4,069	1,440
In-basin Strays from Segregated program	101	1,008*	360	1,008**
Out-of-basin Strays (segregated fish straying to other basins)	302			432
Hatchery Surplus	2,017	158	462	841
pNOB	0%	30%	100%	NA
Effective pHOS***	65%	67%	49%	
PNI	0.01	0.31	0.67	NA
Total Run Size (harvest + returns to Basin; includes in-basin strays/adult outplants and out-of-basin strays from seg. program)	10,199	7,907	10,086	8,892

* Includes adult outplants; assumes outplants will take place during Phase 3 and be discontinued in Phase 4.
** Using assumptions for Phase 3 (up to 1,000 segregated HORs outplanted).
*** Assumes HORs have 80% relative reproductive success compared to NORs; i.e., effective pHOS = (HORs*80%)/(HORs*80% + NORs).

Table 2-25. Combined outcomes (by phase) for the current and proposed Yakima Coho programs based on All-H Analyzer modeling.

	Current (includes all releases)	Phase 3 – Integrated and Segregated Programs Combined	Phase 4 – Integrated and Segregated Programs Combined
Adults Outplanted	30-100	Up to 1,000	Up to 1,000
Hatchery Smolts	810,000	700,000	700,000
Hatchery Parr	100,000	500,000	500,000
Natural-origin Smolts	46,226	60,084	122,474
Ocean Harvest	1,172	3,537	3,862
Lower Columbia Harvest	664	1,986	2,170
Zone 6 Harvest	3,088	2,897	4,647
Terminal Harvest	53	73	79
Total Harvest	4,977	8,492	10,758
Natural-origin Returns to Basin (brood + escapement)	851	1,512	2,676
Hatchery-origin Returns to Basin (brood + escapement + hatchery surplus)	4,070	6,364	5,113
Total Adult Returns to Basin	4,921	7,876	7,789
Imported Broodstock (HOR)	1,010	0	0
Local Broodstock (NOR)	4	243	810
Local Broodstock (HOR)	67	1,167	600
Natural-origin Escapement	848	1,269	1,866
Hatchery-origin Escapement (includes in-basin strays from seg. program)	1,986	3,191	2,203
Total Escapement	2,834	4,460	4,069
In-basin Strays from Segregated program	101	1,008	360
Out-of-basin Strays (segregated fish straying to other basins)	302	432	432
Hatchery Surplus	2,017	998	1,302

	Current (includes all releases)	Phase 3 – Integrated and Segregated Programs Combined	Phase 4 – Integrated and Segregated Programs Combined
Total Run Size (harvest + returns to Basin; includes in-basin strays/adult outplants and out-of-basin strays from seg. program)	10,199	16,799	18,978

2.6 OTHER ALTERNATIVES CONSIDERED

Other alternatives were considered but rejected because they do not meet legal requirements, fail to achieve biological objectives or are inconsistent with study findings from Phase 1 and Phase 2. A brief description of the alternatives not carried forward, along with the rationale for their elimination, is presented below.

Under **Alternative A**, the current Coho program as described in Section 2.3 would be continued. However, the current program rears an insufficient number of smolts to meet the requirements of *U.S. v. Oregon*. Program size is limited because Prosser Hatchery has been prioritized for the propagation of fall-run Chinook. In addition, the current program relies on out-of-basin broodstock, which produce juveniles with lower SARs than local broodstock, and require that the program depend on outside facilities for propagation. For these reasons, this alternative was eliminated from further consideration.

Under **Alternative B**, production of hatchery Coho would be eliminated. Actions would continue to be implemented in the basin to increase habitat quality and quantity, which in turn would increase the productivity of local fish populations. The program would rely on the natural colonization of habitat by adult Coho strays from other basins or hatchery programs.

This action would mean that treaty obligations to provide Coho for tribal harvest would not be met for decades, if ever and would also delay achieving the long-term objective of creating sustainable runs of Coho for decades, if not tens of decades. Therefore, this alternative was not selected for advancement.

Under **Alternative C**, the segregated program would produce one million smolts at the Prosser Hatchery. Broodstock would come from locally-adapted hatchery-origin adults returning to the facility. All smolts would be released below Prosser Dam. No fish would be released into the Upper Yakima or Naches rivers.

This alternative would meet treaty harvest obligations for Coho but would not achieve the long-term conservation objective of restoring natural production to the Naches and Upper Yakima rivers. Implementing this alternative at Prosser Hatchery would require doubling the water chilling capacity and groundwater withdrawals and taking an additional 25 cfs of river water just before releasing juvenile fish. Costs associated with these improvements were deemed excessive compared to the small increase in harvest that would occur.

2.7 CONSISTENCY WITH NPCC SCIENTIFIC PRINCIPLES

The Yakama Nation has made every effort to design the proposed project to conform to the NPCC's eight scientific principles and major project review requirements. This section describes how the proposed Coho programs are consistent with the eight principles.

2.7.1 Principle 1: The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems.

Language from the NPCC Fish and Wildlife Program further amplifies Principle 1:

> *"The physical and biological components of ecosystems together produce the diversity, abundance and productivity of plant and animal species, including humans. The combination of suitable habitats and necessary ecological functions forms the ecosystem structure and conditions needed to provide the desired abundance and productivity of specific species."*

This Master Plan recognizes that the aquatic and terrestrial habitats present within and outside of the Yakima Basin determine the abundance, productivity, and diversity of the basin's fish populations. The quality and quantity of habitat within the basin has been evaluated through field surveys and modeling that identified habitat factors that are likely limiting fish production in the basin. Strategies and actions to address these limiting factors were developed and incorporated into the Yakima Subbasin Plan (YSFWPB 2004). These actions are being implemented annually as funds allow, and their effectiveness is being tracked through monitoring and evaluation efforts.

The biological objectives for the Coho program are based on Ecosystem Diagnosis and Treatment (EDT) and AHA modeling of the entire life cycle of and ecosystem inhabited by Yakima River Coho. This ecosystem includes the Yakima River Basin, Columbia River, Columbia River estuary and the Pacific Ocean. The analysis showed what is possible for Coho in the basin over both the short and long term. It also showed that factors outside the basin will play an important role in determining whether the program will be successful. For example, adult and juvenile migration success through the FCRPS reduces the number of Coho returning to the basin each year. Fewer adult returns equates to a reduction in the probability of achieving program objectives.

The Master Plan recognizes that humans also rely on the productivity of the ecosystem to provide societal needs, and that many of these needs are in direct conflict with the needs of other species. Agriculture in the basin requires large amounts of river water to grow the crops which produce hundreds of millions of dollars in revenue to farmers each year. Much of this water comes at the expense of aquatic species such as Coho that rely on it for all phases of their life cycle. Basin stakeholders have been working cooperatively to balance the needs of humans and fish. This balance is being achieved by setting instream flows, guaranteeing water rights to farmers, screening diversions and implementing upland and riparian habitat actions designed to protect the riverine environment.

2.7.2 Principle 2: Ecosystems are dynamic, resilient and develop over time

The NPCC Fish and Wildlife Program states the following:

> *"Although ecosystems have definable structures and characteristics, their behavior is highly dynamic, changing in response to internal and external factors. The system we see today is the product of its biological, human and geological legacy. Natural disturbance and change are normal ecological processes and are essential to the structure and maintenance of habitats."*

Habitat conditions in the Yakima Subbasin have been degraded over time (YSFWPB 2004). Human activities such as logging, agriculture, and rural development have all resulted in a decrease in both habitat quality and quantity. The Yakima Subbasin Plan identifies limiting factors resulting from habitat degradation and proposes a number of strategies to return subbasin habitat more closely to pre-development conditions. Implementation of these strategies will help protect fish populations from catastrophic events as well as smaller scale disruptions. It is recognized that habitat protection and restoration activities that take into account natural processes as well as human-caused changes require a long-term commitment.

Although the short-term goal of the program is focused on harvest using artificial production, in the long term, it is expected that habitat actions will increase natural fish population productivity, abundance and diversity to the point where they are self-sustaining. This may allow a large portion of the hatchery program to be reduced or eliminated.

An active monitoring and evaluation program will be used to detect trends in habitat condition and fish abundance. This information is used to determine the need for, and location of, habitat actions to be implemented. Fish population monitoring will occur directly through implementation of this Master Plan and other YKFP activities while habitat effectiveness monitoring will occur coincident with implementation of Yakima Subbasin and Recovery Plans. Information gathered through monitoring and evaluation will be used to make changes to the Master Plan (Principle 7 below and Section 5).

2.7.3 Principle 3: Biological systems operate on various spatial and time scales that can be organized hierarchically

The NPCC Fish and Wildlife Program language elaborates on this concept as follows:

> *"Ecosystems, landscapes, communities and populations are usefully described as hierarchies of nested components distinguished by their appropriate spatial and time scales. Higher-level ecological patterns and processes constrain, and in turn reflect, localized patterns and processes. There is no single, intrinsically correct description of an ecosystem, only one that is useful to management or scientific research. The hierarchy should clarify the higher-level constraints as well as the localized mechanisms behind the problem."*

The ability to implement a successful Coho program is constrained by factors occurring both within and outside of the Yakima River Basin. Human-induced factors outside of the basin have an ongoing effect on Yakima Coho populations. Human impacts to their migration corridor and ocean and freshwater harvest continue to reduce the number of fish that return to the basin each year. Because these factors and their effect on fish survival are not in the direct control of the Yakama Nation, they are not explicitly addressed in the Master Plan. The Tribe will continue to work through other forums to implement actions to reduce the effect of out-of-basin activities on anadromous fish populations in the Yakima Subbasin.

This Master Plan focuses on implementing actions that are within the control of the Tribe (and basin partners) to meet the harvest and long-term conservation objectives for the Coho program. Actions are designed to protect Coho through each phase of their life-cycle that occurs in the basin. Coho habitat restoration actions target tributaries in the upper portion of the basin where Coho spawn and rear as fry (Naches River and Upper Yakima River above Roza Dam). These tributaries were affected historically by farming and logging practices.

Water is at a premium in the Yakima Basin for both agriculture and municipal purposes, particularly in the summer. Such demands are the primary factors constraining production of most anadromous species in the basin. Downstream improvement actions are focused on providing sufficient flows with the proper temperature regime to produce large numbers of healthy smolts and ensure the survival of adult migrants. Water diversions are being screened and the quality of irrigation returns improved to protect aquatic ecosystem health.

Until habitat quality improves, Treaty harvest rights need to be met through artificial production. Long term, as habitat improves, it may be possible to rely more on natural Coho production to achieve program objectives. When this occurs, Coho hatchery production may be reduced or eliminated. However, the scale of habitat improvements may be tempered by the growing human population that places demands on natural resources such as water and land. It is likely that the Tribe will have to rely on artificial production to meet Treaty rights for many decades.

2.7.4 Principle 4: Habitats develop, and are maintained, by physical and biological processes

The NPCC Fish and Wildlife Program states that:

> *"Habitats are created, altered and maintained by processes that operate over a range of scales. Locally observed conditions often reflect more expansive or non-local processes and influences, including human actions. The presence of essential habitat features created by these processes determines the abundance, productivity and diversity of species and communities. Habitat restoration actions are most effective when undertaken with an understanding and appreciation of the underlying habitat-forming processes."*

Habitat conditions observed in a particular reach may signal that impacts are occurring elsewhere in the basin or at a larger scale. For example, changes in the amount and/or timing of stream flow or sediment input to a channel may be the result of human activity or natural processes in adjacent upland areas or stream reaches. Habitat actions and strategies proposed in the Yakima Subbasin Plan (YSFWBP 2004) emphasize actions at the watershed (subbasin) level rather than at the habitat unit scale. Strategies include:

- Protecting stream corridor structure and function
- Restoring passage and connectivity between habitat areas

- Restoring floodplain function and channel migration processes
- Restoring riparian condition
- Restoring normative flow regimes
- Restoring degraded water quality, including water temperature

The Yakima Subbasin Plan proposes a variety of actions to implement these strategies, taking into account the limited usefulness of some types of habitat actions as well as the acceptability of some actions to members of the public.

2.7.5 Principle 5: Species play key roles in developing and maintaining ecological conditions

This principle is elaborated in the NPCC Fish and Wildlife Program:

> *"Each species has one or more ecological functions that may be key to the development and maintenance of ecological conditions. Species, in effect, have a distinct job or occupation that is essential to the structure, sustainability and productivity of the ecosystem over time. The existence, productivity and abundance of specific species depend on these functions. In turn, loss of species and their functions lessens the ability of the ecosystem to withstand disturbance and change."*

Anadromous fish returning to the Yakima River deliver marine-derived nutrients as their carcasses decompose after spawning. These nutrients increase stream productivity and provide a food source for both terrestrial and aquatic species (Cederholm et al. 2000).

Past salmon harvest management in the ocean and Columbia River and habitat degradation have contributed to the decreased abundance of some species in the Yakima Basin. This has decreased the amount of nutrients delivered to portions of the Basin. Release of hatchery Coho pursuant to *U.S. v Oregon* agreements helps to mitigate for the loss of marine-derived nutrients in the mainstem Yakima River. Actions proposed in this Master Plan would improve delivery of marine-derived nutrients from both natural-origin and hatchery Coho salmon. It is expected that Coho abundance, diversity and spatial distribution would increase, restoring some lost functionality and increasing the resilience of the overall ecosystem.

2.7.6 Principle 6: Biological diversity allows ecosystems to persist in the face of environmental variation

Specific language from the NPCC Fish and Wildlife Program states:

> *"The diversity of species, traits and life histories within biological communities contributes to ecological stability in the face of disturbance and environmental change. Loss of species and their ecological functions can decrease ecological stability and resilience. It is not simply that more diversity is always good; introduction of non-native species, for example, can increase diversity but disrupt ecological structure. Diversity within a species presents a greater range of possible solutions to environmental variation and change. Maintaining the ability of the ecosystem to express its own species*

> *composition and diversity allows the system to remain productive in the face of environmental variation."*

The diversity of fish populations will be ensured primarily through habitat improvement and protection actions across the basin (YSFWBP 2004). Should environmental conditions, for example, result in the failure of a spawning population in one portion of the subbasin, the presence of healthy populations in other parts of the basin would enable the species to persist.

The Tribe recognizes that while hatchery programs may provide substantial harvest and conservation benefits, they also pose risks to native fish communities. Hatchery strategies have the potential to prevent fish from taking advantage of favorable habitat conditions, decrease population productivity, and increase competition, predation and disease. Parr plants may be discontinued periodically in some tributaries and the stream(s) monitored for juvenile and adult production and habitat conditions. This approach allows biologists to continually probe the ability of the system to produce naturally sustainable Coho without hatchery intervention.

2.7.7 Principle 7: Ecological management is adaptive and experimental

Expanding on this, the NPCC Fish and Wildlife Program states:

> *"The dynamic nature, diversity, and complexity of ecological systems routinely disable attempts to command and control the environment. Adaptive management — the use of management experiments to investigate biological problems and to test the efficacy of management programs — provides a model for experimental management of ecosystems. Experimental management does not mean passive "learning by doing," but rather a directed program aimed at understanding key ecosystem dynamics and the impacts of human actions using scientific experimentation and inquiry."*

This Master Plan includes a Monitoring and Evaluation Plan (Appendix J) to track key Coho performance metrics over time. Program performance will drive decisions about program implementation. For example, NOR adult abundance triggers are used to determine when the program shifts to using 100% natural-origin broodstock. In short, fish performance is used to adaptively manage the program.

As noted above, parr plants may be discontinued periodically in some tributaries and the stream(s) monitored for juvenile and adult production and habitat conditions. This approach is designed to provide feedback on habitat quality and the need to continue hatchery production in specific portions of the basin.

2.7.8 Principle 8: Ecosystem function, habitat structure and biological performance are affected by human actions

The NPCC Fish and Wildlife Program elaborates this fundamental observation as follows:

> *"As humans, we often view ourselves as separate and distinct from the natural world. However, we are integral parts of ecosystems. Our actions have a pervasive impact on the structure and function of ecosystems, while at the same time, our health and well-being are tied to these conditions. These actions must be managed in ways that protect and restore ecosystem structures and conditions necessary for the survival and recovery*

> *of fish and wildlife in the basin. Success depends on the extent to which we choose to control our impacts so as to balance the various services potentially provided by the Columbia River Basin."*

A common thread in the eight scientific principles is effect of human actions on anadromous fish and their habitats. This Master Plan, in concert with the Yakima Subbasin Plan (YSFWBP 2004), is designed to address both the human-caused degradation of Yakima Subbasin salmon stocks and the cultural, economic, commercial, and recreational importance of those stocks by restoring and increasing naturally-spawning populations and accommodating treaty harvest rights.

Habitat strategies in the Yakima Subbasin Plan address human degradation of stream habitat, and are designed to target the key habitat factors limiting fish abundance, productivity, spatial structure, and life history diversity. A prioritization strategy has been developed to guide the action selection and implementation process. The Subbasin Plan does not account for, or assume, any improvements in habitat conditions in the mainstem Columbia or estuary.

The Coho programs proposed in this Master Plan do not focus on habitat restoration. Instead, the programs attempt to balance the harvest rights of the Tribe with the impacts hatchery programs and harvest have on native fish communities. Prior to submitting this Master Plan, extensive work was performed to determine the effects (predation and competition) the Coho program would have on natural populations of Chinook salmon and steelhead. These effects have been documented to be low, and along with Tribal treaty rights, provide strong justification for the program.

Harvest levels will be closely monitored in cooperation with the co-managers, and in-season adjustments will be made when necessary. Selective sport fisheries that require release of unmarked fish will be maintained throughout the basin. Tribal fisheries will be regulated using traditional time, area, and gear restrictions. Harvest management strategies may be altered based on monitoring and evaluation results.

To further reduce human impacts to the ecosystem, this program proposes to:

- Convert to a locally-adapted broodstock.
- Eliminate hatchery production in tributaries after six years of stocking to determine if the run can sustain itself naturally.
- Operate the hatchery programs consistent with HSRG guidelines for segregated and integrated harvest programs.
- Implement an adaptive management plan that uses attainment of performance indicators to drive hatchery operations and decisions.
- Reduce hatchery production over time as natural Coho production increases.

2.8 SUBBASIN-WIDE RISK ASSESSMENT

Risks associated with the proposed Yakima River Coho program are considered quite low. Alterations to the historical habitat and flow regime extirpated natural Coho population in the 1980s. Hatchery releases to the system benefit Yakima River Coho by increasing population abundance. Potential program risks will be reduced by transitioning to local broodstock and operating the program consistent with HSRG principles.

A potential risk to be considered is that hatchery-origin fish may stray and spawn in areas outside of the Yakima River. Straying has may decrease the productivity of the natural populations inhabiting these areas. Hatchery strays will be minimized by transitioning to broodstock locally adapted to the Yakima River. In addition, juvenile hatchery fish will be released relatively high in the watershed or acclimated in ponds prior to release so that they imprint on the water signature of their natal stream. Also, some returning adults will be placed in tributaries high in the basin in an attempt to re-colonize its upper extent. During Phase 1 of the Coho program, YN biologists evaluated the potential ecological effects (e.g., predation and competition) of the Coho program on other salmonid species in the basin and concluded that impacts of supplementation activities were minimal.

2.9 CONSISTENCY WITH NPCC ARTIFICIAL PRODUCTION PRINCIPLES

The Yakima Coho programs have been designed to be consistent with the NPCC artificial production principles, as described below.

1. ***The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.***

The Coho program is designed to meet the Tribe's treaty harvest rights. The size of the current Coho program was established as part of *U.S. v Oregon*. Artificial production is appropriate for Yakima Coho because the species was extirpated in the Yakima River Basin due to habitat degradation from activities such as agriculture, forestry, and urban development. Because habitat conditions are not likely to improve to levels capable of supporting a large natural Coho population for many decades, artificial production is required to meet treaty obligations in the near term.

The Yakama Nation has conducted studies to determine the ecological effects the program may have on other species (e.g., predation, competition, and disease). Studies on predation and competitive interactions between hatchery Coho and Chinook and steelhead found little evidence of substantial negative effects (Dunnigan 1999, Dunnigan 2001, Dunnigan et al. 2002, Dunnigan and Hubble 1998, Pearsons et al. 2007, Temple et al. 2014), and that positive effects on fish growth might occur from restoring lost marine-derived nutrients (Bilby et al. 1998, Wipfli et al. 2003).

Residualism

Residualism is the failure of some hatchery-reared juveniles to out-migrate from freshwater as smolts (Sharpe et al. 2011). Residual fish remain in freshwater throughout their lives, and may therefore compete with and prey on other species (Dunnigan 1999; Dunnigan et al. 2002). Sampson and Fast (2000) reported 2.9 and 13.6 residual Coho per kilometer per 50,000 smolts released into the upper Yakima and Naches Rivers, respectively, indicating that current Coho residualism is relatively low.

Temple et al. (2012) also evaluated the presence and abundance of residualized hatchery smolts in the North Fork Teanaway River, below the Jack Creek acclimation pond, and in the mainstem Yakima River above Roza Dam. They found that some spring Chinook salmon smolts did not out-migrate, but very few Coho smolts residualized. No Coho residuals have been observed since 2007. Because of the low number of observed residualized hatchery Coho, existing impacts on nontarget fish species from competitive interactions with residual hatchery Coho are estimated to be low. In an effort to reduce the amount of residual Coho, the Yakama Nation currently releases smolts that are ready to migrate. Reducing residualism reduces the potential for competition with and predation on other species.

Competition

Supplementation and conservation efforts, such as the Yakama Nation's ongoing Yakima Basin Coho reintroduction program, could result in competition for previously occupied habitat and resources. This may lead to displacement and reduced survival or abundance of one or both of the competitors (Glova 1984). Competition between and among fish species occurs when two or more individuals use the same resources, particularly when the resource is limited. In the Yakima Basin, reintroduced Coho released as fry may compete with other fish species for rearing habitat and feeding opportunities. Juvenile Coho salmon are thought to be more aggressive relative to other juvenile salmonids; thus, they may compete with other hatchery or naturally-produced salmonids under certain conditions. However, Groot and Margolis (1991) suggest there is little habitat overlap between Coho and other salmonids, and that this habitat segregation provides a possible mechanism for reducing ecological interactions between the species.

Several studies have evaluated the existing growth and abundance of nontarget fish species (i.e., non-Coho) following years of ongoing juvenile Coho releases in the Yakima Basin. Coho and Rainbow Trout/steelhead occupy similar habitats in the Yakima River and its tributaries (Pearsons and Temple 2007). Dunnigan (1999) found no evidence that ongoing Coho fry releases influenced the abundance or growth of Rainbow or Cutthroat Trout in the Naches River watershed. The researchers acknowledged that low sample size could have biased the results, but speculated that spatial segregation, resource partitioning, and differences in diet minimize the potential for competition between Coho and trout. Pearsons and Temple (2007) observed some reduction in the mean size of Rainbow Trout and steelhead since the start of Coho reintroduction (and spring Chinook supplementation), but further analysis determined that this trend was not related to Coho reintroduction activities. Further, Pearsons and Temple (2007) found that the current level of salmon supplementation in the basin has not impacted steelhead in the upper Yakima Basin beyond "acceptable limits." Acceptable levels of impact on nontarget fish of concern (e.g., ESA-listed steelhead) were defined as a significant change in abundance, size structure, and distribution of nontarget fish when compared to pre-supplementation conditions (Pearsons 1998; Temple and Pearsons 2012). In the *Biological Opinion for the Yakima River Spring Chinook Salmon, Summer/Fall Chinook Salmon, and Coho Salmon Hatchery Programs*, NMFS (2013) recognized that these "acceptable limits" provide a sufficient means to measure the impact of Coho reintroduction on ESA-listed steelhead.

The MCR steelhead recovery plan (NMFS 2009) does not identify the reintroduction of Coho salmon as a factor limiting the productivity of the Yakima River MCR steelhead (NMFS 2009). The Yakima Recovery Plan (YBFWRB 2004) supported the continued reintroduction of Coho salmon in the Yakima River Basin, and indicated that such programs could potentially increase the flow of marine-derived nutrients into salmon and steelhead rearing areas (NMFS 2013). Further, NMFS (2013) states that "the presence of hatchery fish and the progeny of naturally-spawning hatchery fish in the juvenile steelhead rearing areas is likely to result in competition between rebuilding Coho salmon and ESA-listed steelhead, but this competition is expected to have a low effect on ESA-listed steelhead."

Temple et al. (2014) evaluated ecological interactions between naturally produced Coho and rearing juvenile rainbow/steelhead trout following 5 years of Coho reintroduction in Taneum Creek in the Yakima Basin. During the study, they observed Coho and trout rearing together in all habitats sampled (e.g., pool, riffle, and glide), which confirmed that both species occupy similar habitats and therefore may compete for resources. By comparing rainbow/steelhead trout data from decades of previous study to post-Coho reintroduction data, they found that increased natural Coho production did not reduce Rainbow Trout abundance, size, condition, or growth. These findings suggest that ongoing reestablishment of natural Coho densities has not resulted in negative ecological interactions for rainbow/steelhead trout. Further, Temple et al. (2014) did not detect impacts on Rainbow Trout abundance where adult Coho were stocked during studies conducted in Taneum Creek.

Temple et al. (2011) reported that reintroduced Coho rarely occupy habitat that overlaps with Cutthroat Trout in tributaries, though some overlap occurs in higher elevations of the mainstem. Study findings indicate that considerable overlap between Coho and Rainbow Trout currently occurs in tributaries and the mainstem. Coho also appear to overlap with mountain whitefish and sucker species in the mainstem, and dace and sculpin species in tributaries. However, other studies in the Yakima and nearby basins (Dunnigan et al. 1999; Spaulding et al. 1989 as cited in BPA et al. 2012) suggest that ongoing competition between Coho and other species may not be significant. Although mountain whitefish are ubiquitous in the upper Yakima and Naches systems, they use different habitat than Coho (BPA 2007).

Spawning Coho adults are spatially separated from Bull Trout, which spawn in higher elevation tributaries than Coho. Ongoing releases of juvenile Coho downstream of the upper Yakima River reaches are far downstream of areas where Bull Trout spawn and rear and therefore do not likely affect Bull Trout (USFWS 2007a). However, the expansion of Coho release sites further upstream in the upper Yakima Basin may result in some level of interactions. Several years of ecological interactions studies conducted in the Yakima Basin have not detected adverse effects on Bull Trout (Pearsons et al. 2006).

The proposed integrated Coho program would release more parr and fewer smolts than the current program. Because parr spend more time in freshwater than smolts, and therefore more time interacting with nontarget fish, it is assumed that releasing parr poses more competitive risk than releasing smolts (Pearsons and Temple 2007). Therefore, an increase in parr releases would have the potential to increase competitive interactions between Coho and nontarget species compared to baseline conditions. The potential for this impact is moderate.

However, as described in Section 3.7.1.3, Dunnigan (1999) found no evidence that released Coho fry (smaller than parr) influenced the abundance or growth of steelhead/Rainbow Trout or Cutthroat Trout in the Naches River watershed and that spatial segregation, resource partitioning, and differences in diet minimize the potential for competition between Coho and trout. Further, Coho parr releases have and would continue to focus on tributaries where steelhead are not present, or are present in low abundance (NMFS 2013). Similarly, Coho parr releases have and would continue to focus on tributaries where Bull Trout are not present, or are present in low abundance (NMFS 2013). As described in Chapter 2, as part of the ongoing MR&E program, the Yakama Nation and WDFW would continue to monitor competitive interactions between released Coho juveniles and nontarget fish species.

Predation

Predation by hatchery fish on wild fish can occur anywhere the two stocks exist in the same space and time, and risks to wild fish are increased when hatchery fish, particularly larger smolts, are released during periods when vulnerable newly emergent fry are present. In the Yakima Basin, hatchery-released Coho smolts have been shown to prey on several species of salmonids (including spring Chinook fry) at very low frequencies. Because most salmonid fry emerge in mid-summer after Coho smolts migrate, the risk of predation on other fish species by parr and by second generation Coho spawned in the wild is low. For example, steelhead fry do not emerge from the gravel until after the majority of the hatchery Coho smolts have out-migrated from the Yakima Basin, thus reducing the potential for predation. This is also the case for predation on resident juveniles due to spatial and temporal separation between Coho and other salmonid species. Pearsons and Temple (2007) evaluated the impacts of Coho salmon reintroduction in the Yakima Basin on several trout species, including Bull Trout. They found very little if any spatial overlap of Coho and Bull Trout in Yakima River tributaries, including those in the upper Yakima River (e.g., North Fork Teanaway River at Jack Creek). Further, they did not capture any Coho (or Chinook salmon) during electrofishing of areas where Bull Trout were present (Pearsons and Temple 2007).

In an effort to establish a baseline for the ecological risk of re-establishing Coho in the Yakima Basin, the Yakama Nation conducted a number of field studies as part of Phase 1 and Phase 2 of the Coho reintroduction program. Dunnigan (1999) conducted a 2-year Coho smolt predation study investigating the predation of newly emergent spring Chinook fry in the upper Yakima Basin (Dunnigan 1999). The study reported that of nearly 1,100 Coho smolts trapped in 1998, only 5 had consumed fish, and of those fish, only 1 individual had consumed an anadromous salmon (spring Chinook). The study concluded that ongoing hatchery Coho smolt releases had no significant impact on the wild spring Chinook population. Similarly, in 1999, only 2 Coho out of 993 collected smolts had consumed fish, and none of them were salmonids. Researchers investigating Coho smolt predation on fall Chinook salmon found that the two most abundant fish species in Coho stomachs were carp and sculpin, and the Coho smolt diet consisted overwhelmingly of invertebrates. Based on these results, researchers estimated that Coho predation on fall Chinook salmon was no higher than 0.1 percent and was likely much lower (McMichael and Pearsons 1998; Dunnigan et al. 2002).

Under the proposed program, up to 500,000 parr would replace 500,000 current smolt releases into various tributaries throughout the Yakima Basin. Compared to baseline conditions, the shift to more parr releases into more tributaries could initially reduce the potential for Coho predation on nontarget fish because parr are small and primarily consume invertebrates. The risk of predation on other fish species by parr and by second generation Coho spawned in the wild is low, also due to spatial and temporal separation between them and other salmonid species (BPA 2007). Further, in their freshwater stage, Coho primarily feed on plankton and insects (NMFS 2016b), including terrestrial drift and benthic aquatic invertebrates (Gonzales 2006; Dill et al. 1981; Johnson and Ringler 1980). However, as parr eventually grow and mature into smolts, the potential for predation of nontarget fish by Coho smolts would be similar to baseline conditions.

Genetic Interactions

Yakima River Coho were extirpated from the basin in the early 1980s. Reintroduction efforts began in 1983 using broodstock from the Little White Salmon Hatchery. In 1996, the program began using broodstock from the Eagle Creek National Fish Hatchery. Thus, there are no differences between the hatchery and natural Coho populations in the Yakima Basin because the natural population was extirpated and the current hatchery population is being used to develop the natural stock.

Disease Transmission

As described in the *Yakima Basin Coho Hatchery and Genetic Management Plan* (Yakama Nation 2010) that covers the proposed MRS Hatchery, the USFWS would screen adult broodstock for routine bacteria and viruses at the time of spawning. All life stages would be monitored for disease, and Integrated Hatchery Operations Team fish health guidelines would be followed to prevent disease transmission between fish on site and disease transmission or amplification to or within the watershed. The juvenile rearing density and loading guidelines used at the facility would be based on standardized agency guidelines. Juveniles would be screened monthly for routine bacteria, viruses, and parasites by USFWS. All fish would be examined for the presence of “reportable pathogens” as defined in the Pacific Northwest Fish Health Protection Committee disease control guidelines, within 3 weeks prior to release by USFWS pathologist under contract. Fish transfers into the basin have been inspected and accompanied by notifications as described in Integrated Hatchery Operations Team and Pacific Northwest Fish Health Protection Committee guidelines. Using these protocols, the potential for disease transmission from the proposed MRS Hatchery into the Yakima River is highly unlikely and therefore discountable.

Beneficial Effects

While the YN acknowledges that there are risks involved with any particular restoration action, it is also important to acknowledge benefits. Indigenous people have long understood and taught the importance of the ‘interconnection’ of all things. This philosophy and approach, more commonly referred to as ‘ecosystem restoration’ in the Western science context, is a fundamental part of the NPCC’s Fish and Wildlife Program, the ESA, and conservation literature. Similarly, the National Research Council (1996) concluded that, “… a goal of management should be to increase the size and maintain the diversity of spawning populations and to re-establish ecosystem processes.”

Programs that restore keystone species such as the reintroduction of wolves to Yellowstone National Park provide evidence for how species-rich communities can produce more temporally stable ecosystem services because of the complementary or independent dynamics among species (e.g., Ripple et al. 2014). Hatchery-origin as well as natural-origin fish contribute marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems (Bilby et al. 1996). Another positive benefit may come from the disturbance of gravels by spawning adult Coho (and other salmonids), which removes fine materials from the riverbed and increases flow exchange (NMFS 2013; Montgomery et al. 1996). The act of gravel churning by spawning Coho salmon, the last spawners of the year in the Yakima Basin, may also bring macroinvertebrates to the surface and thereby increase the availability of this juvenile salmonid food source. Finally, in areas where they overlap, juvenile Coho might also provide another prey source for larger trout and sculpin (BPA 2007).

Thus, it is likely that YN Coho reintroduction efforts will increase the stability and function of ecosystems in the Yakima and upper Columbia Basins consistent with the ISAB’s revised principles, the NPCC 2014 Fish and Wildlife Program’s overall vision and ecosystem function strategy, and the ESA’s primary purpose “to protect and recover imperiled species and the ecosystems upon which they depend”.

The Yakama Nation is also investing heavily in habitat improvements throughout the basin (summarized in Table 7-4). These actions are expected to increase the productivity of the naturally-spawning Coho population. As natural Coho abundance increases, reliance on hatchery production to meet harvest goals will decrease.

2. ***Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.***

The Coho program has already gone through two phases wherein the risks and benefits of the program have been evaluated. Studies on Coho predation and competition with other species have been conducted, and the impacts of the Coho program on other species are considered acceptable. Biologists have shown that hatchery-origin Coho will successfully spawn and produce offspring, and these offspring contribute to fisheries in large numbers. Returning hatchery-origin adults readily find and use spawning habitat located throughout the basin.

An adaptive management plan is a fundamental component of the proposed program (Section 5). It uses performance triggers to determine when certain management strategies are implemented. An intensive monitoring and evaluation plan is already in place in the basin and will be used to evaluate program success.

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.***

The Yakama Nation recognizes that factors outside the Tribe's control have a large impact on program success. For example, harvests in ocean and Columbia River fisheries may remove more than 30 percent of program adults on an annual basis. Also, the selective nature of these fisheries may result in more than 50 percent of all adipose-clipped hatchery-origin fish being harvested prior to entering the Yakima River. Variable ocean conditions also affect the number of hatchery- and natural-origin adults produced each year. The proposed program accounts for this variability by setting minimum spawning escapement targets and adjusting brood collection and sources as needed to achieve these targets.

Global climate change may cause stream temperatures in the Yakima River system to increase over time. These changes may be sufficient to overwhelm the beneficial actions being undertaken to improve habitat conditions in the basin. If habitat quality does not increase, then it is unlikely that harvest benefits can be obtained from what will be limited natural Coho production. Under this scenario, the need for hatchery production to achieve harvest goals will be even higher. Hatchery facilities are designed with sufficient rearing space to meet goals under such a future scenario.

4. ***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.***

The morphological, demographic and behavioral characteristics of hatchery Coho will be constantly compared to the natural population to detect changes in these attributes over time. To reduce the chance of divergence in physical and genetic traits between the two components of the population, the Upper Yakima integrated Coho program will incorporate naturally produced Coho into broodstock at ever increasing rates as the natural run size increases.

Because the segregated program will not include natural-origin Coho as broodstock, the program will enforce strict controls on the proportion of hatchery fish spawning naturally (pHOS) upstream of Prosser Dam. pHOS will be limited to less than five percent.

Coho jacks will be incorporated into the broodstock at rates similar to those observed in the natural population. Scale samples will be taken on naturally produced fish to determine size and age relationships for returning fish. This action will establish the size criterion separating adult and jack Coho.

Coho will be released as either parr, where they will overwinter in tributaries and emigrate volitionally to the ocean as smolts, or as smolts (15-20 fpp). This size range is similar to what has been observed for naturally produced smolts arriving at Roza Dam and the Chandler Facility.

5. ***The entities authorizing or managing an 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.***

The primary goal of the integrated and segregated Coho hatchery programs is to provide fish for harvest pursuant to *U.S. v Oregon*. A secondary goal is to meet cultural objectives. The integrated program is also designed to produce sufficient Coho to restore naturally-spawning populations above Prosser Dam. Because of degraded habitat conditions, the Tribe recognizes that attaining this goal may not be met for decades.

6. ***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.***

Hatchery Coho production in the Yakima River Basin is required under *U.S. v Oregon* (2008) to achieve tribal fishing rights as defined in law. Annual releases from the program have been coordinated with, and agreed to, by federal, state and tribal fisheries managers. Coho reintroduction is also outlined in the Yakima Subbasin Plan (http://www.nwcouncil.org/fw/subbasinplanning/yakima/plan/).

7. ***Appropriate risk management needs to be maintained in using the tool of artificial propagation.***

Since its inception, the Coho program has strived to quantify and mitigate the risks the program may have on other aquatic species. Competition and predation studies were undertaken in Phase 1 and Phase 2 to ensure that impacts to Chinook and steelhead were at acceptable levels. These studies will be repeated in the future as natural Coho production increases. The results of these studies will be used to determine the need for changes in program release locations or numbers. An adaptive management plan has been put in place for Phase 3 and Phase 4 that sets triggers to determine when program changes should be made. Triggers are used to set escapement levels, determine the proportion of natural-origin returns used in broodstock (pNOB), and control the proportion of hatchery fish spawning naturally (pHOS). The programs will be operated consistent with HSRG recommendations (HSRG 2009a, HSRG 2014) to reduce genetic and ecological risks that the hatchery programs may pose to natural populations.

8. ***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.***

Harvest rates on Yakima River Coho are set by the terms of *U.S. v Oregon* and are intended to provide sufficient fish to meet treaty rights while at the same time protecting ESA listed Coho in the lower Columbia River. Because Yakima River Coho are captured in the same fisheries as naturally produced Coho from the lower Columbia, harvest rates are deemed protective. The implementation of mark-selective fisheries for Coho in the ocean and mainstem Columbia River (below McNary) will decrease harvest rates on naturally produced adults while at the same time allowing higher harvest rates on marked hatchery fish.

9. ***Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.***

The program is required to meet tribal treaty rights. The size of the program has been agreed to by the parties to *U.S. v Oregon*. All other relevant legal mandates for fish protection, mitigation and enhancement will be incorporated into the program.

2.10 HATCHERY AND GENETIC MANAGEMENT PLAN

A draft HGMP for the existing Coho hatchery program is attached as Appendix A. If the programs described in the Master Plan are implemented, the HGMP would be revised to incorporate the new programs and facilities.

3.0 PROPOSED HATCHERY PROGRAMS FOR YAKIMA SUMMER AND FALL-RUN CHINOOK AND YAKIMA UPRIVER BRIGHT CHINOOK

3.1 POPULATION STATUS

The Yakima Basin historically supported an abundance of Chinook salmon with broad temporal and spatial diversity (Figure 3-1). Early arriving, spring Chinook spawned in the upper reaches and tributaries of the Yakima and Naches rivers. Summer-fall Chinook spawned from the mouth of the Yakima upstream past the middle river, where the city of Yakima is now located. As a result of past land and water development and fisheries management practices, the naturally-reproducing population has been severely reduced in abundance, run-timing, and spawner distribution. By 1970, the early component of the summer-fall Chinook population that once spawned high in the watershed was completely eliminated, leaving a large portion of the Yakima Basin with no Chinook salmon (Figure 3-2).

Before the 1850s, the Yakama tribe could rely on Chinook salmon for a continuous supply of fish for subsistence, cultural and ceremonial purposes from spring through fall of each year. These opportunities no longer exist. As discussed below (Section 3.4.2), the primary objectives of the proposed Chinook hatchery program are to restore harvest opportunities, meet cultural objectives, and reestablish a locally-adapted Yakima Basin summer/fall Chinook population. Figure 3-3 illustrates the potential summer/fall and URB Chinook spawning distribution that would be re-established by the proposed hatchery program.

Upper Columbia summer-run Chinook and URB fall Chinook are part of the Upper Columbia River summer/fall Chinook Evolutionarily Significant Unit (ESU), which is not listed under the ESA. Existing hatchery and naturally-spawning fall Chinook in the Yakima Basin are part of this ESU. The URB fall Chinook currently present in the lower Yakima River are either of hatchery origin (from Priest Rapids stock) or are recent descendants of hatchery-origin fish. What remains is essentially a hatchery population that is sustained by and genetically linked to the Hanford Reach URB fall Chinook population. In addition to providing increased harvest opportunities for Chinook salmon, the proposed program would reestablish a locally-adapted summer/fall Chinook population in the Yakima River Basin. This population would also be part of the existing Upper Columbia River summer/fall Chinook ESU.

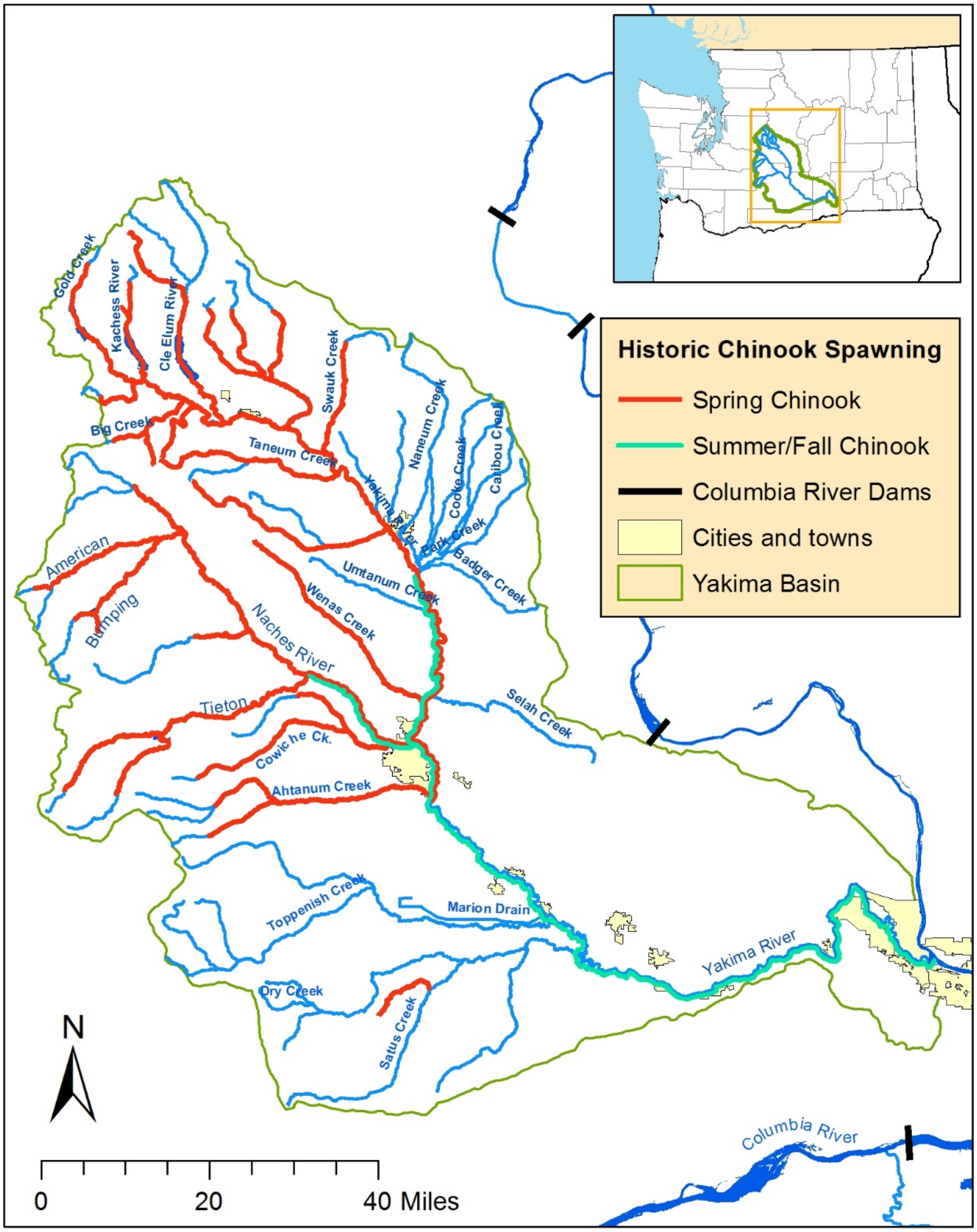


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Figure 3-1. Historical Yakima Basin spawning reaches used by Chinook salmon.

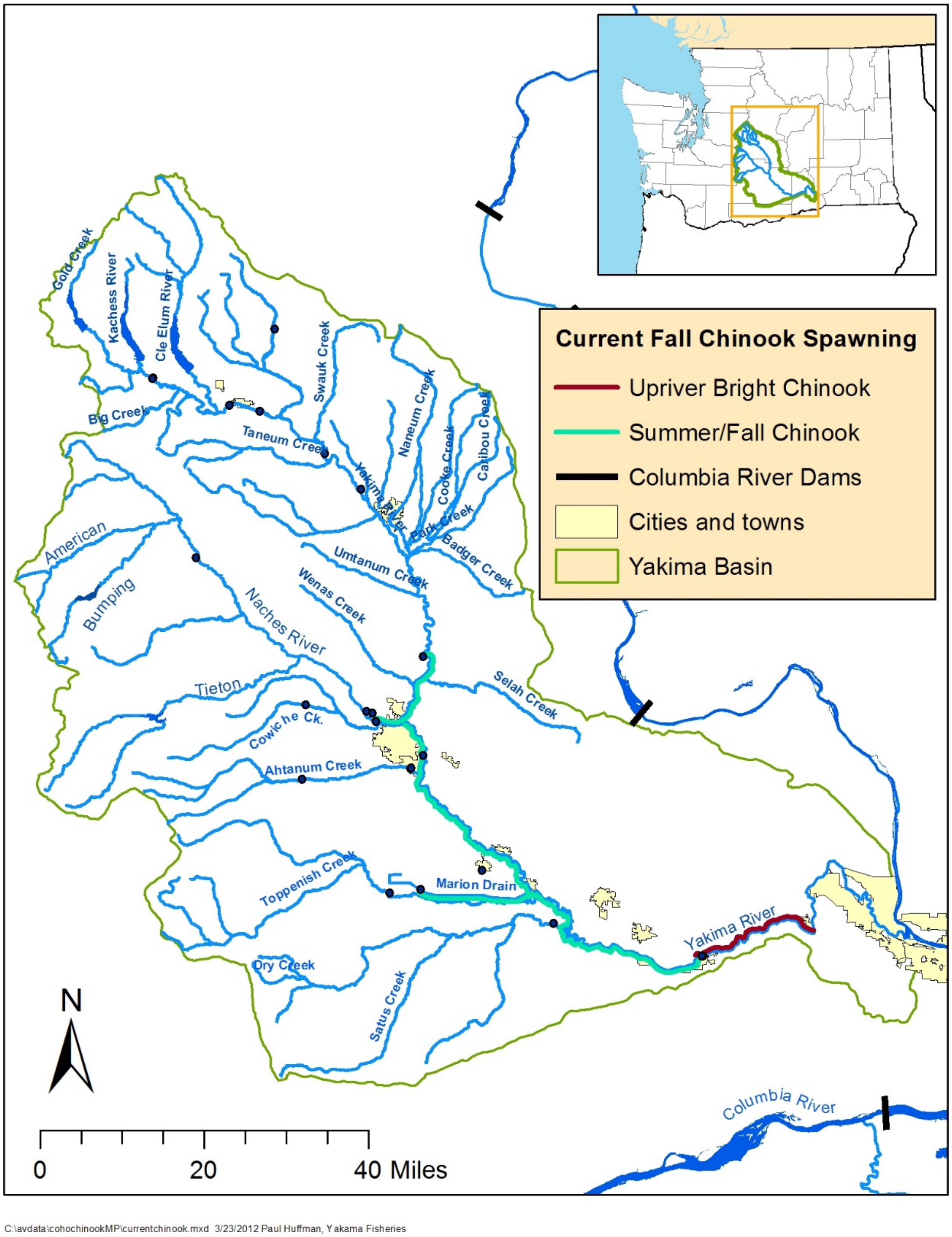

Figure 3-2. Current spawning distribution of Yakima Basin summer/fall and URB fall Chinook.

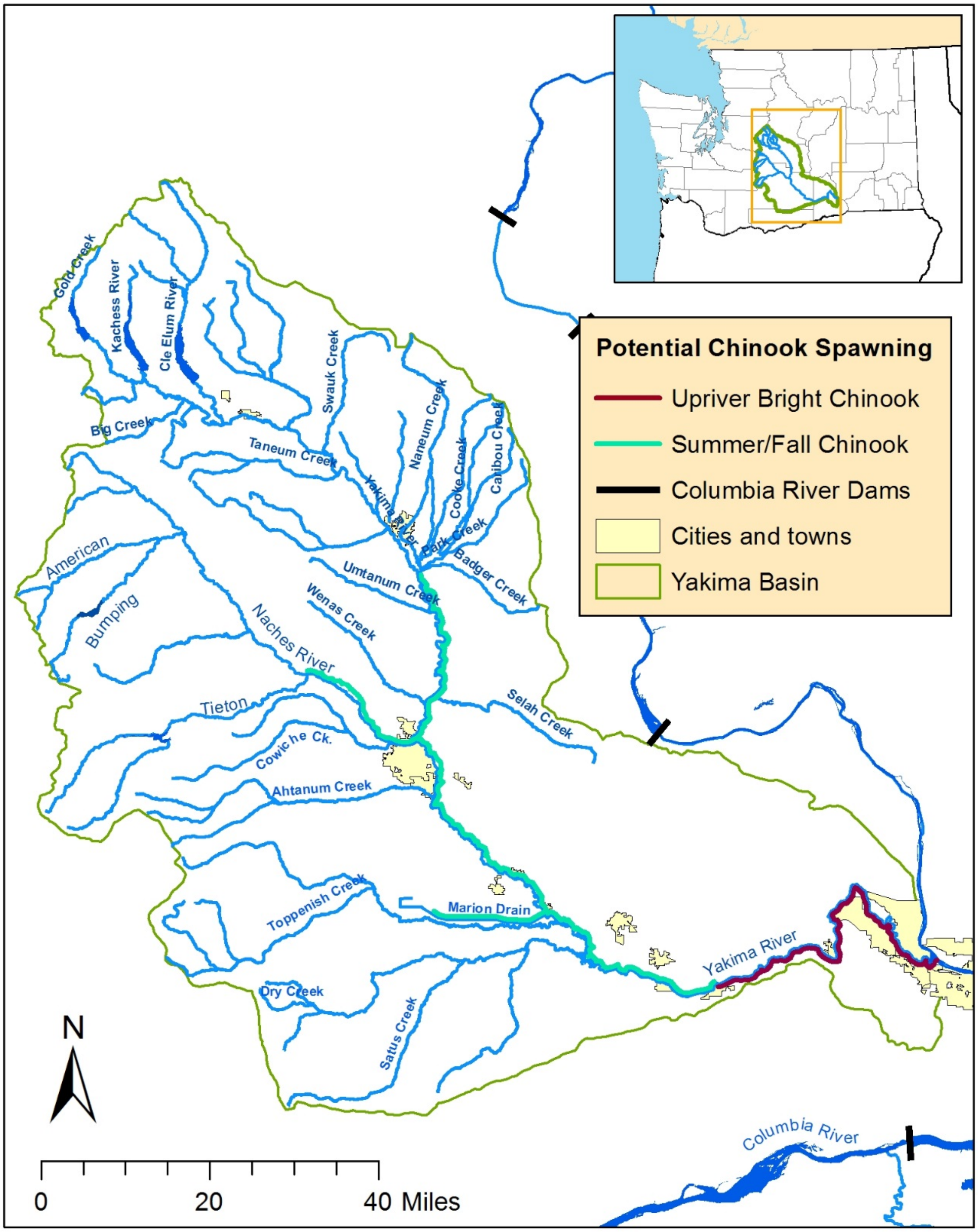

Figure 3-3. Potential spawning distribution of Yakima Basin summer/fall and URB fall Chinook with implementation of the proposed program.

3.2 HABITAT CONTEXT

To be successful, hatchery programs must be part of an integrated, "all H" (Hatchery, Habitat, Harvest, and Hydro) strategy. Protecting existing high-quality stream habitat and restoring degraded habitat is essential to restoring sustainable fisheries. The Yakima Subbasin and Recovery Plans identify major habitat factors limiting fish production and propose strategies and actions to improve habitat quality and quantity. These habitat strategies are expected to provide benefits to all resident and anadromous fish species in the Basin.

Habitat actions have been identified and/or are being implemented as part of subbasin planning (YRBSRB 2004), the YKFP, the Yakima River Basin Integrated Water Resource Management Plan Draft Programmatic EIS (USDI and WDOE 2011), and through other basin activities. A recovery strategy proposed for Chinook (and other species) is documented in the subbasin plan, and a good summary of the limiting factors and types of actions proposed to address each can be found in Appendix I of that document (YRBSRB 2004). For summer- and fall-run Chinook, in-basin actions are focused on reducing stream temperatures and better mimicking historical flow pattern in the mid- to lower Yakima River Basin. Major factors inhibiting Yakima River summer- and fall-run Chinook production are as follows:

- Sub-lethal to lethal water temperatures are typically present by June below Prosser Dam (RM 47)
- Low flow conditions (especially in poor water years) between Prosser Dam and the Chandler power-plant outfall
- Predation by birds (especially in poor water years), and both native and introduced piscivorous fish (particularly smallmouth bass)
- Loss of structurally complex rearing habitat
- Excessive sediments from irrigation drains (although this has been slowly improving in recent years) in major spawning areas
- Smolt mortality associated with predation in the vicinity of bypass outfalls at Wapato, Sunnyside and Prosser dams, and a number of smaller Yakima Basin dams (e.g., Marion Drain re-use diversion, Columbia and Richland Ditches at Horn Rapids Dam)
- Adult mortality associated with mainstem Columbia dams
- Smolt mortalities associated with traversing mainstem Columbia dams and impoundments

As described in Section 2.2, a comprehensive approach to address water resource and ecosystem issues affecting fish passage, habitat and human water requirements is being developed through the Yakima River Basin Integrated Water Resource Management Plan, which is described in the Final Programmatic EIS (USDI and WDOE 2012). The Plan includes seven elements: reservoir fish passage, structural and operational changes to existing facilities, surface water storage, groundwater storage, habitat/watershed protection, enhanced water conservation and market reallocation.

The analysis in the Final EIS for the Integrated Plan evaluated potential changes in summer- and fall-run Chinook production under different habitat restoration scenarios. The analysis was performed by the Bureau of Reclamation using both AHA and EDT modeling and evaluated three scenarios:

- Future Without Integrated Plan (FWIP) – Represents fish population increases from habitat improvements that would continue under current programs and funding levels

- Restoration – Represents fish population increases from habitat improvements that would result from implementing the Integrated Plan's fish habitat enhancement program. The actions identified in the Yakima Steelhead Recovery Plan were used as a surrogate in the modeling effort to characterize these habitat improvements.

- Restoration with Fish Passage (Integrated Plan) – Represents fish population increases from the habitat restoration scenario plus providing fish passage at Cle Elum, Keechelus, Kachess, Bumping, and Tieton dams.

For summer- and fall-run Chinook, the analysis concluded[5]:

- **Summer Chinook** – The baseline run size of summer Chinook at the mouth of Columbia was 3,308 fish. The summer Chinook run under the FWIP (3,694 fish at the mouth of the Columbia) increased under the Restoration and Restoration with Passage scenarios to 7,390 fish, more than doubling the average run size. There was no difference in the average run size under the Restoration and Restoration + Passage scenarios. This is because summer Chinook complete their entire freshwater life cycle downstream of the five BOR storage dams and are not affected by the provision of fish passage, which is the only difference between these scenarios.

- **Fall Chinook** – The baseline run size of fall Chinook at the mouth of Columbia was 8,385 fish. Fall Chinook runs under the FWIP scenario (8,724 fish at the mouth of the Columbia) increased under both the Restoration and Restoration with Passage scenarios to 13,170 fish. There was no difference in the average run size under the Restoration and Restoration + Passage scenarios. This is because fall Chinook complete their entire freshwater life cycle downstream of the five BOR storage dams and are not affected by the provision of fish passage, which is the only difference between these scenarios.

This Master Plan assumes the Integrated Plan would be implemented and that habitat would improve as assumed in modeling[6]. The EDT productivity and capacity assumptions for this scenario (USDI and WDOE 2012) were incorporated into this Master Plan (see Section 3.5.2).

More detail on the habitat strategy in place in the Yakima Basin is described in Sections 7.3 and 7.4.2 of this Master Plan.

As a result of recent and on-going efforts to restore habitat, there is reason to be optimistic that the middle reaches of Yakima Basin will once again be able to support naturally-spawning Chinook. The

[5] The percent increase for each scenario was calculated from data found in Table 5-6, page 5-45 of the Final EIS and is based on escapement to the mouth of the Columbia River (i.e., after ocean harvest but before freshwater harvest).
[6] Note that the FWIP will be implemented regardless of the outcome of the Integrated Plan.

Yakama Nation believes the time is now right to begin the process of reestablishing the lost summer/fall Chinook life history to the Yakima River.

3.3 CURRENT HATCHERY PROGRAM

The Yakima URB fall Chinook program currently releases approximately 2.0 million URB fall Chinook smolts annually from the Prosser and Marion Drain hatcheries (Table 3-1). A portion of the production is derived from broodstock collected in the vicinity of Prosser Dam, while the remainder is from Priest Rapids stock reared at Little White Salmon National Fish Hatchery and moved to Prosser Hatchery for final rearing and release.

The Yakima URB fall Chinook program began in 1983 using Priest Rapids origin fish. In the early years of the program, releases consisted of direct stream and/or acclimated releases transferred from out-of-basin facilities. Local hatchery operations began at Prosser Hatchery in 1994 and at Marion Drain in 1997.

The Yakama Nation also has a goal of re-establishing a locally-adapted population of summer-run Chinook, which were extirpated from the Yakima Basin by 1970. Pursuant to this goal the tribe began releases of Wells Hatchery summer-run Chinook in the Yakima River Basin in 2009 (Table 3-2).

In-hatchery data for fall Chinook produced from local brood collected at Prosser Dam are summarized in Table 3-3. These smolts were incubated and reared at Prosser Hatchery. Prespawning survival is generally greater than 95% as brood are spawned soon after they are collected.

3.3.1 Hatchery Releases

Table 3-1. Total releases of Yakima Basin upriver bright fall-run Chinook by release year and site.

Release Year	Prosser On-Station Release				Billy's Pond[2]	Stiles Pond[2]	Marion Drain	Total Release
	LWH[1]	PRH[1]	Subyrl[2]	Yrling[2]				
1997	1,694,861							1,694,861
1998	1,695,399							1,695,399
1999	1,690,000		192,000					1,882,000
2000	1,695,037		306,000				16,000	2,017,037
2001	1,699,136		427,753				12,000	2,138,889
2002	1,704,348		286,158				4,000	1,994,506
2003	1,771,129		365,409				18,000	2,154,538
2004	1,748,200		561,385				52,223	2,361,808
2005	1,700,000		466,000		75,000[3]	38,890	41,000	2,320,890
2006	1,683,664		130,002			118,835	2,000	1,934,501
2007	1,700,000[4]		50,000		5,000	75,000	15,731	1,845,731
2008	789,993		519,486[5]	1,833	11,308	72,296	5,253	1,400,169
2009	1,647,275		299,574	7,516			24,245	1,978,610
2010	1,680,045		290,282	12,167			22,945	2,005,439
2011	1,699,944	503,772	620,952	22,857				2,847,525

Release Year	Prosser On-Station Release				Billy's Pond[2]	Stiles Pond[2]	Marion Drain	Total Release
	LWH[1]	PRH[1]	Subyrl[2]	Yrling[2]				
2012	1,200,000	405,000	269,633	19,432			72,258	1,966,323
2013	1,506,725		184,949	22,735				1,714,409
2014	1,542,702	379,970	445,347					2,368,019
2015	1,653,495	479,078	584,397					2,716,970
2016	1,593,090		562,472					2,155,562
2017	1,789,400		423,920	159,470				2,213,320
2018	1,638,300		328,620	208,660				1,966,920

1 Transfers from LWH=Little White Salmon NFH; PRH=Priest Rapids Hatchery.
2 Releases from local brood source adults collected at Prosser Dam or Hatchery.
3 Released from Edler Pond (approximately 2 miles downstream from Billy's Pond).
4 Of which approximately 500,000 were reared on-station at Prosser under accelerated growth conditions.
5 Of which approximately 5,400 were released from SKOV pond.

Table 3-2. Total releases[1] of summer-run Chinook by release year and release site.

Release Year	Prosser	Stiles Pond		Nelson Springs	Wapatox	Roza	Total Release
		Subyearling	Yearling				
2009		180,911					180,911
2010		200,747					200,747
2011			176,364	39,406			215,770
2012	98,300			98,803			197,103
2013				88,208		48,355	136,563
2014				179,901		74,980	254,881
2015	55,000			99,600		122,848	277,448
2016						37,000	37,000
2017	169,499					75,000	244,499
2018					44,000	30,000	74,000

1 All fish released as subyearlings unless otherwise noted.

Table 3-3. In hatchery data for fall Chinook juveniles released in the Yakima Basin from local broodstock collected at Prosser Dam or Hatchery.

Brood Year	Females Spawned[1]	Males Spawned[1]	Total eggs	Average Fecundity	Eyed eggs	Smolts Released	Smolt Size (fish/lb)	Egg to Subyearling Survival[2]
2010	250	260	992,461	3,970	963,894	620,952	85.4	62.6%
2011	97	92	345,217	3,559	329,749	269,633	82.4	78.1%
2012	108	120	360,139	3,334	345,496	184,949	91.1	51.4%
2013	164	178	596,653	3,638	583,982	445,347	97.8	74.6%
2014	164	182	657,441	3,573	631,143	584,347	82.4	88.9%
2015	188	201	597,177	3,176	562,472	562,397	84.9	94.2%
2016	139	145	480,748	3,458	430,276	423,920	87.6	88.2%
2017	120	131	361,943	3,016	349,359	328,620	88.7	90.8%
Average	*154*	*164*	*548,972*	*3,466*	*524,546*	*427,521*	*87.5*	*90.5% (average 2014-2017)* [3]

[1] Observed prespawn survival has been greater than 98% as fish are typically spawned within one week of collection.
[2] Infrastructure deficiencies (e.g., wells, pumps, chillers) caused poor survival in some years.
[3] Well water was used starting in 2014, improving survival rates.

3.3.2 Natural Production

Adult fall Chinook returning to the Yakima Basin consist of hatchery-origin returns from releases at and above Prosser Dam and natural-origin returns from fish spawning naturally in the Yakima River. Due to physical and logistical constraints at Prosser Hatchery it is not possible to mark all hatchery releases of summer/fall run Chinook without jeopardizing fish health and survival, but these issues are being addressed through this Master Planning process. Thus, enumeration of hatchery- and natural-origin summer/fall run Chinook adult returns is not presently possible but will be in the future.

Total returns of summer- and fall-run Chinook to the mouth of the Yakima River are shown in Figure 3-4. Annual returns increased from a 1983-1999 average of just over 1,000 fish to a 2000-2018 average of more than 6,000 fish (Figure 3-4). While this increase coincides with improved ocean conditions, some of the increase may also be due to improved passage in the mainstem Columbia River, changes in the lower Yakima River that are making fish seek more amenable spawning areas further upriver[7], and improvements in hatchery spawning and rearing protocols.

Escapement estimates above and below Prosser Dam are reported in Table 3-4. Adult salmon populations in the Yakima River Basin are enumerated at Prosser Dam using video equipment installed in all three adult fish ladders. This provides the above Prosser escapement estimate (before broodstock collection). Although adult passage over spillways is believed to occur when flows are favorable, Prosser Dam counts are generally considered by Yakama Nation biologists to be within +/- 5% of actual fish passage. WDFW redd survey data and non-tribal fishery harvest estimates below Prosser Dam allow the run to be reconstructed to the Yakima River mouth. This information is used to estimate escapement below Prosser Dam.

[7] For example, increased aquatic vegetation like stargrass (*Heterantera dubia*) in the lower Yakima River (Wise et al. 2009).

Returns from the summer-run Chinook releases began in 2012. By re-establishing the summer-run population component, the YN seeks to increase the temporal (Figure 3-5) and spatial distribution of summer/fall run Chinook in the Yakima River Subbasin. Approximately 440 summer-run Chinook were estimated to pass above Prosser Dam in 2018 (Figure 3-5).

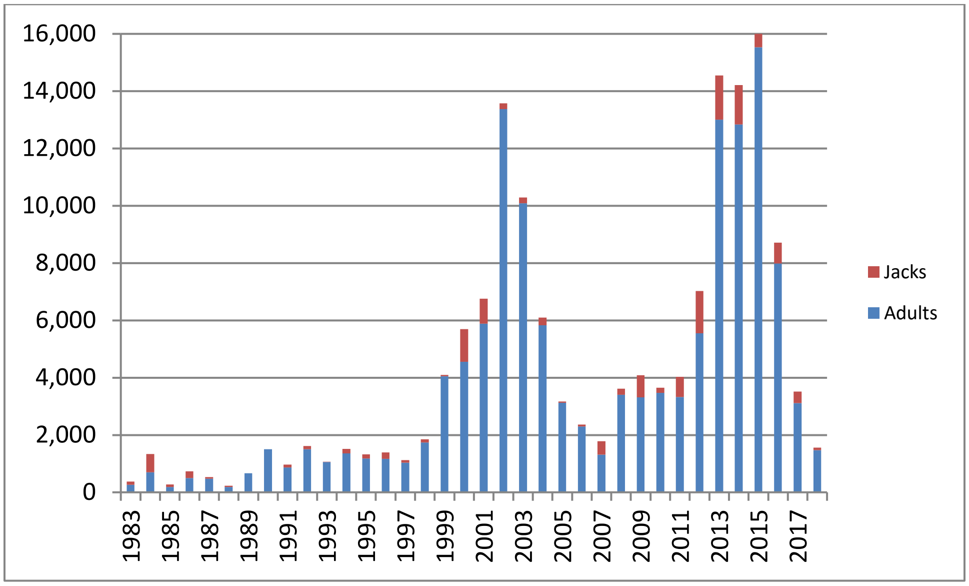

Figure 3-4. Estimated returns of adult and jack summer- and fall-run Chinook to the Yakima River mouth, 1983-2018.

Table 3-4. Estimated summer/fall Chinook returns and escapement in the Yakima River, 1998-2018.

Return Year	Total Returns[1]		Escapement			
			Above Prosser		Below Prosser	
	Adult	Jack	Adult	Jack	Adult	Jack
1998	1,743	106	1,064	84	645	22
1999	4,056	43	1,876	20	2,046	23
2000	4,557	1,138	1,371	922	2,931	194
2001	5,886	869	3,651	660	1,293	151
2002	13,369	211	6,146	95	4,923	116
2003	10,092	193	4,796	79	3,874	73
2004	5,825	354	2,862	85	2,231	223
2005	3,121	45	1,920	22	491	7
2006	2,299	67	1,499	29	363	10
2007	1,318	460	892	240	194	26
2008	3,403	208	2,739	124	137	17
2009	3,315	772	2,381	591	424	106
2010	3,474	176	2,763	125	270	12
2011	3,325	705	2,318	400	470	81
2012	5,553	1,468	3,751	963	1098	211
2013	13,005	1,541	8,537	995	1936	194
2014	12,839	1,371	8,302	1,003	2,969	302

Return Year	Total Returns[1]		Escapement			
			Above Prosser		Below Prosser	
	Adult	Jack	Adult	Jack	Adult	Jack
2015	15,533	769	8,644	559	5,224	156
2016	7,982	735	5,688	585	1,372	119
2017	3,116	399	1,927	278	719	105
2018	1,465	99	937	53	323	21
Average	*5,966*	*559*	*3,527*	*377*	*1,616*	*103*

1 Total returns include escapement (above and below Prosser) and recreational harvest. See Table 3-8 for recreational harvest.

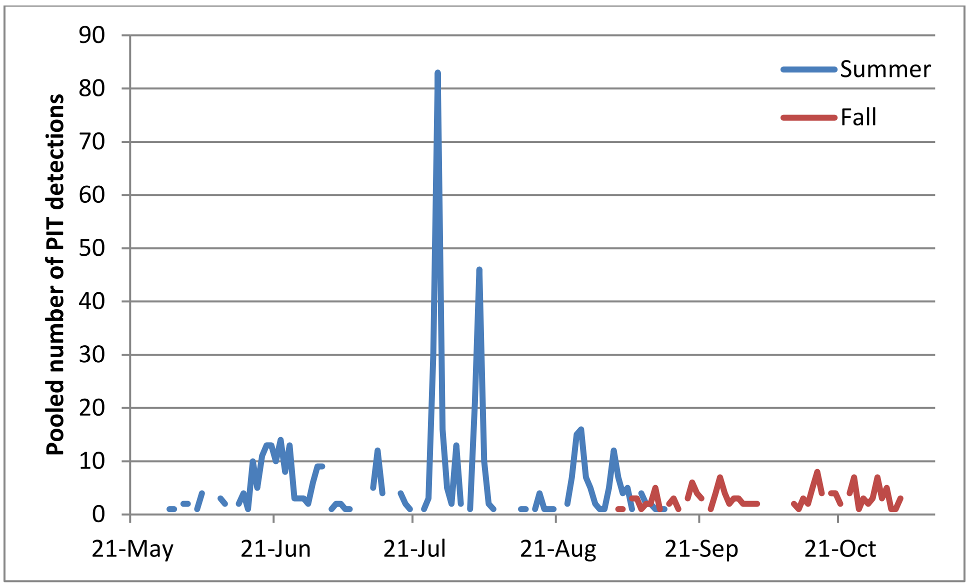

Figure 3-5. Adult return timing at Prosser Dam of PIT-tagged summer- and fall-run Chinook reared at the Marion Drain and Prosser Hatcheries and released as subyearlings, pooled for return years 2009-2018.

Fall Chinook redd distribution in the Yakima River Basin appears to be experiencing a major transition in recent years. Historical redd survey data indicates that a substantial number of fall Chinook spawned below Prosser Dam in the lower Yakima River. However, from 2003-2018, an average of approximately 80 percent (range 62 to 90 percent) of fall Chinook redds were located above Prosser Dam (Figure 3-6). Biologists and habitat experts in the subbasin at least partially attribute this change in spawning distribution to the invasion of water stargrass (see Wise et al. 2009) in the lower 43 miles of the Yakima River. Water stargrass may eliminate spawning habitat and impede fish passage.

With the reintroduction of summer run Chinook in 2009, the Yakama Nation is expanding the distribution of summer/fall run Chinook spawners into the middle reaches of the Yakima Basin and to Roza Dam in the Upper Yakima subbasin. Summer Chinook are now spawning in intended areas above Prosser Dam (Figure 3-7). Spawners observed in 2017 were primarily age-4 fish returning from 2014 subyearling releases. This was the fifth year of substantial natural summer-run Chinook spawning in these habitats in over 40 years of surveys.

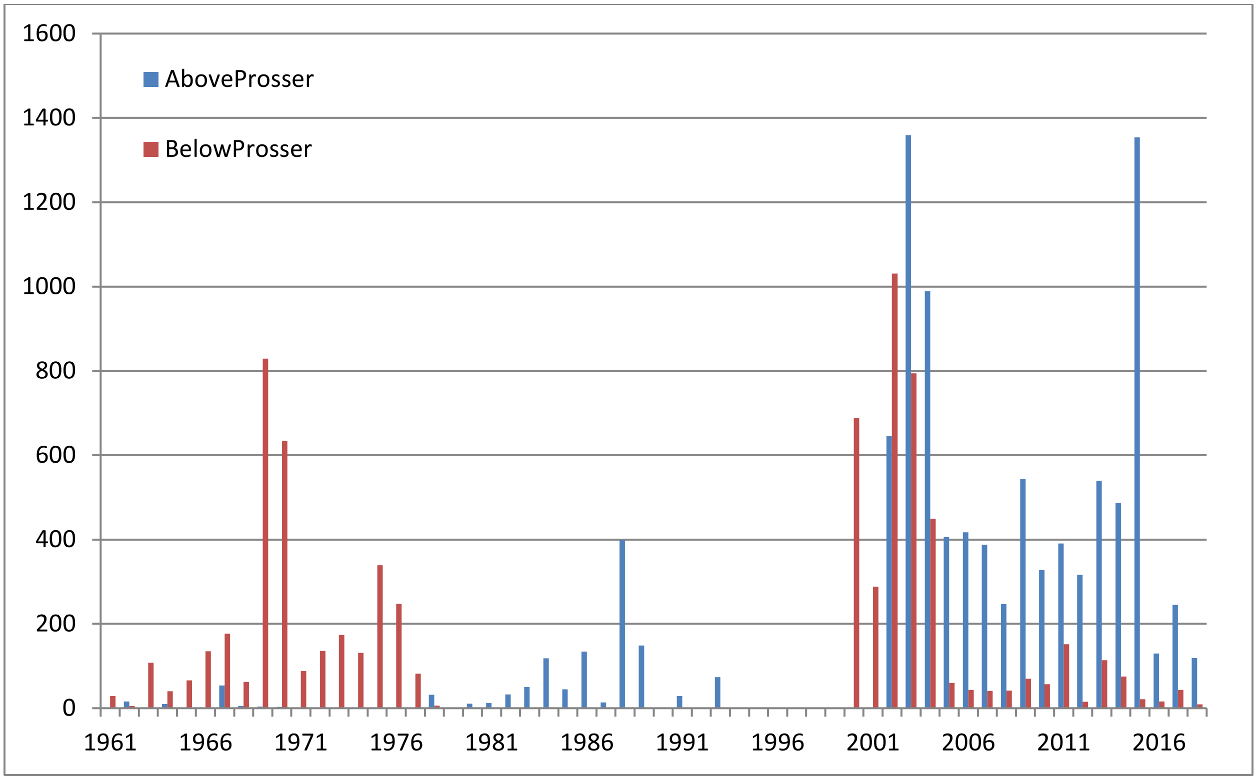

Figure 3-6. Fall Chinook redd counts above and below Prosser Dam, 1961-2018, for years in which surveys were conducted and data are available. Data from YN, WDFW, and Pacific Northwest National Laboratory files. Note that survey completeness is highly variable due to annual flow and turbidity conditions; survey data are partial or incomplete for most years prior to 2000.

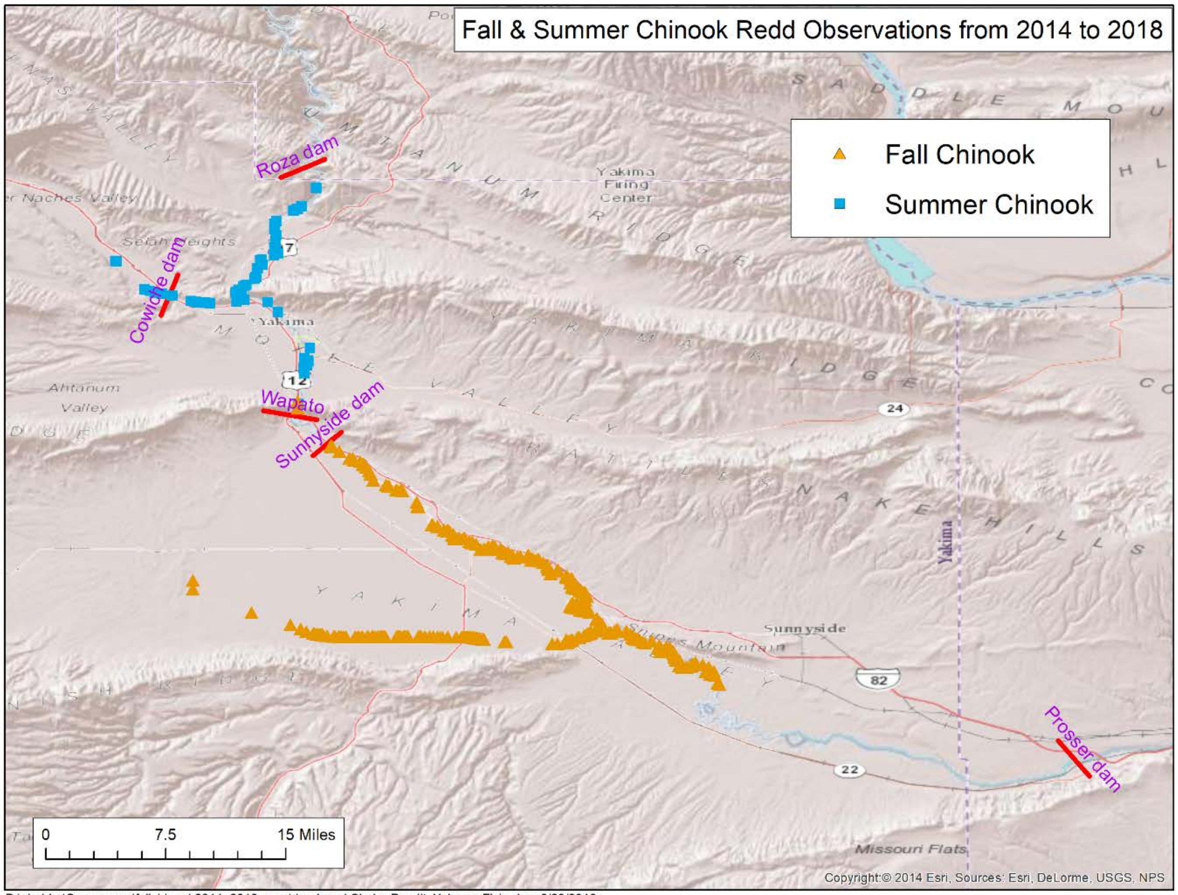

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Figure 3-7. Distribution of summer and fall run Chinook redds in the Yakima River Basin (above Prosser Dam), 2014-2018.

Table 3-5. McNary Dam smolt to Bonneville Dam adult SAR indices for PIT-tagged summer- and fall-run Chinook released in the Yakima River Basin by brood year and life stage at release, 2006-2015 (PTAGIS query run May 6, 2019).

Brood Year	Subyearlings		Yearlings	
	Summer	Fall	Summer	Fall
2006		0.0%		8.5%
2007		2.3%		1.2%
2008	2.1%	0.5%		3.0%
2009	2.0%	1.1%		0.7%
2010	3.8%	0.0%	1.9%	1.6%
2011	1.7%	1.2%		1.6%
2012	1.3%	0.9%		
2013	1.1%	0.4%		
2014	0.0%	0.0%		
2015	0.2%	0.4%		

Brood Year	Subyearlings		Yearlings	
	Summer	Fall	Summer	Fall
Pooled	*1.8%*	*1.1%*	*1.9%*	*1.7%*
Mean	*1.5%*	*0.7%*		*2.8%*
Geomean	*1.4%*	*0.8%*		*2.0%*

Beginning with the hatchery-origin subyearling and yearling release data presented in Tables 3-1 and 3-2, we estimated post-harvest hatchery-origin release to Bonneville adult return survival (SAR) indices (Table 3-6) using the following steps.

1) Apply average estimates for smolt survival from release to McNary Dam reported in Neeley 2019 (subyearlings) and Neeley 2017 (fall-run yearlings) to the Yakima and Naches subyearling and yearling release estimates.

2) Apply PIT-based McNary Dam smolt to Bonneville Dam adult return survival estimates (Table 3-6) to the resulting Yakima and Naches release by life stage to McNary smolt survival estimates from step 1.

Table 3-6. Estimated release to Bonneville Dam (adult) survival (SAR) for summer- and fall-run Chinook released as subyearlings or yearlings in the Yakima and Naches Basins, brood years 2006-2014.

	Subyearlings		Yearlings	
	Summer-run	Fall-run	Summer-run	Fall-run
2006		0.0%		4.0%
2007		0.9%		1.0%
2008	0.0%	0.1%		1.8%
2009	0.4%	0.3%	0.7%	0.5%
2010	1.7%	0.0%		0.9%
2011	0.5%	0.3%		0.8%
2012	0.3%	0.3%		
2013	0.1%	0.1%		
2014	0.0%	0.0%		
Release to Bonneville Dam Mean (post-harvest)	*0.43%*	*0.22%*	*0.70%*	*1.50%*
Release to Bonneville Dam Geomean (post-harvest) [1]	*0.40%*	*0.25%*	*0.70%*	*1.17%*
Release to Yakima Basin Mean (pre-harvest)[2]	*0.76%*	*0.32%*	*1.24%*	*2.17%*
Release to Yakima Basin Geomean (pre-harvest)[1,2]	*0.71%*	*0.36%*	*1.24%*	*1.80%*

1 Geomean excludes zeroes.
2 Assumes ocean and lower Columbia River fisheries exploitation rate is 48% for summer Chinook and 36.5% for fall Chinook; see Table 3-20. Assumes adult fish passage survival from Bonneville through McNary Dams is 92% (FCRPS BiOp).

We also used the PIT detection data for returning adults at Bonneville Dam to estimate age composition of returning summer and fall-run Chinook (Table 3-7). Subyearling releases of summer and fall-run Chinook return mostly as 3- and 4-year old adults. Yearling releases of fall-run Chinook have had a substantially higher proportion of Age-2 returns than subyearling releases.

Table 3-7. Age composition of returning hatchery-origin PIT-tagged summer and fall-run Chinook released in the Yakima subbasin as subyearlings or yearlings (data from PTAGIS query run May 1, 2019).

Brood Year	Age at Return				
	2	3	4	5	6
	Summer Chinook Subyearlings				
2008	12.5%	12.5%	50.0%	25.0%	0.0%
2009	5.4%	16.3%	63.6%	14.7%	0.0%
2010	0.2%	27.5%	61.4%	10.6%	0.2%
2011	0.0%	12.1%	67.5%	20.4%	0.0%
2012	1.0%	50.0%	40.8%	8.2%	0.0%
2013	5.6%	11.1%	77.8%	5.6%	0.0%
Mean	4.1%	21.6%	60.2%	14.1%	0.0%
	Fall Chinook Subyearlings				
2007	9.7%	47.9%	35.8%	6.6%	
2008	13.3%	53.3%	33.3%	0.0%	
2009	18.9%	40.5%	32.4%	8.1%	
2010	0.0%	66.7%	16.7%	16.7%	
2011	11.6%	34.9%	50.0%	3.5%	
2012	9.7%	61.1%	26.4%	2.8%	
Mean	10.6%	50.7%	32.4%	6.3%	
	Summer Chinook Yearlings				
2010[1]	13.6%	31.2%	44.2%	3.9%	0.6%
	Fall Chinook Yearlings				
2006	96.4%	0.0%	3.6%	0.0%	0.0%
2007	63.8%	15.9%	8.7%	11.6%	0.0%
2008	31.3%	36.1%	26.9%	5.8%	0.0%
2009	26.1%	18.0%	37.8%	18.0%	0.0%
2010	40.3%	26.4%	27.4%	6.0%	0.0%
2011	11.0%	15.9%	54.3%	14.0%	4.9%
Mean	44.8%	18.7%	26.4%	9.2%	0.8%

[1] Ten of 154 (6.5%) detections occurred about 90 days post-release in adult ladders at Bonneville Dam and were assumed to be age-1 returns. However, only 2 of these 10 were confirmed as upstream detections based on later detections at dams upstream of Bonneville. The other 8 detections at Bonneville could have been late-migrating juveniles.

3.3.3 Harvest

Yakima Basin summer/fall Chinook are harvested in marine fisheries from Alaska to southern Oregon and in Columbia River fisheries from the mouth to the Hanford Reach. Approximately 71% of harvest recoveries from Yakima Basin summer/fall Chinook releases for brood years 1997-2007 occurred in marine (44%) and mainstem Columbia River (27%) fisheries (Figure 3-8). Out-of-basin harvest rates have not been estimated specifically for Yakima Basin summer/fall run Chinook, but the average ocean fisheries exploitation rate for mid-Columbia River summer/fall Chinook was 39% for brood years 1982-89, with a total exploitation rate of 68% estimated for the same years (PSC 1994). Chapman et al. (1994) estimated that the mean exploitation rate for brood year 1975-87 fall Chinook released from Priest Rapids Hatchery was 64%. Total exploitation rates for Okanogan River summer/fall Chinook from 2014-2018 averaged 58% for NORs and 70% for HORs (DJWA 2019). Harvest rates of these stocks in U.S. fisheries have been reduced since the mid-1990s due to Endangered Species Act (ESA) management concerns as they are intermixed with ESA-listed Snake River fall Chinook populations (NMFS 1999a-d and 2000a-c). The total exploitation rate of Yakima River summer/fall run Chinook is likely similar to that of other mid-Columbia River summer/fall Chinook stocks.

Mainstem Columbia River summer Chinook fisheries occurring from June 16 through July 31 are managed in accordance with an abundance-based harvest schedule. Upriver summer Chinook escapement goals include 20,000 adult summer Chinook (natural and hatchery) above Priest Rapids Dam.

Similarly, fall season Chinook fisheries in the Columbia River Basin below the confluence of the Snake River are managed according to an abundance-based harvest rate schedule. The total harvest rate increases as the expected run size of URBs at the mouth of the Columbia River increases. The goal of this management strategy is to meet minimum adult escapement goals. Upriver fall Chinook escapement goals include 60,000 adult URB fall Chinook (natural and hatchery) above McNary Dam.

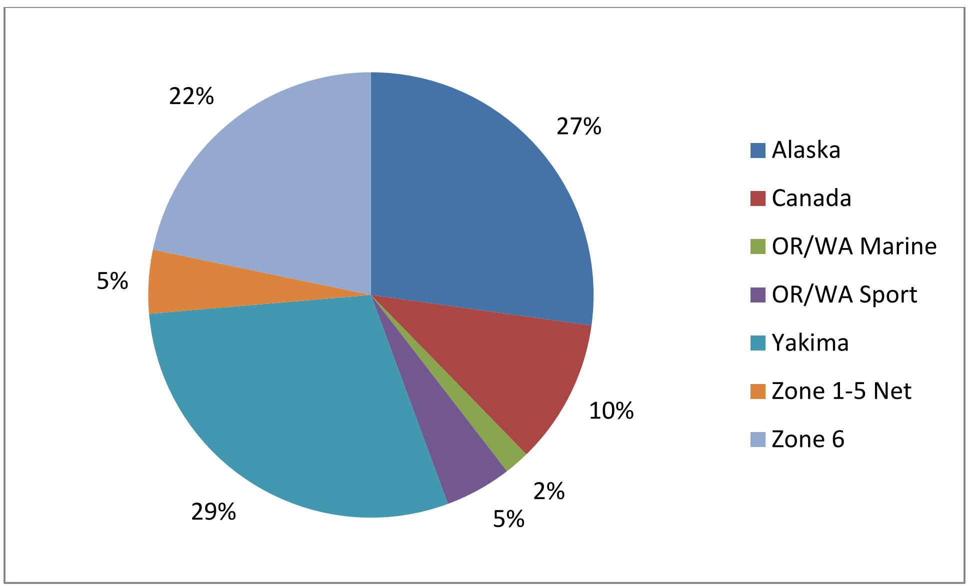


Figure 3-8. Distribution of coded-wire tag recoveries of Yakima Basin summer/fall run Chinook releases in marine, mainstem Columbia River, and Yakima Basin fisheries. Data retrieved from the regional mark information system (RMIS) for brood year 1997-2007 recoveries.

Recreational fishers enjoy a successful annual fall Chinook fishery situated primarily near the mouth of the Yakima River (Table 3-8). Recreational anglers harvest about 14 percent of the annual summer/fall Chinook returns to the basin each year. The majority of this harvest is comprised of fall-run Chinook, because the terminal fishery typically does not open until Sept. 1 annually. Tribal fishers harvest a substantial, but unquantified number of Yakima Basin-destined fall Chinook (Figure 3-8) in commercial gillnet fisheries in the Zone 6 fishing area. Because of the quantity and relatively higher quality of fall Chinook available to tribal fishers in Zone 6 Columbia and Klickitat River fisheries, Yakima River tribal harvest is typically at or near zero even though regulations allowing fall season fisheries in the Yakima River are propagated annually by the Yakama Nation.

Table 3-8. Estimated summer/fall Chinook returns and recreational harvest in the Yakima River, 1998-2018.

Return Year	Yakima River Total Returns[1]		WA Recreational Harvest		
	Adult	Jack	Adult	Jack	Rate
1998	1,743	106	34	0	1.8%
1999	4,056	43	134	0	3.3%
2000	4,557	1,138	255	22	4.9%
2001	5,886	869	942	58	14.8%
2002	13,369	211	2,300	0	16.9%
2003	10,092	193	1,422	41	14.2%
2004	5,825	354	732	46	12.6%
2005	3,121	45	710	16	22.9%
2006	2,299	67	437	28	19.7%
2007	1,318	460	232	194	24.0%
2008	3,403	208	527	67	16.4%
2009	3,315	772	510	75	14.3%
2010	3,474	176	441	39	13.2%
2011	3,325	705	537	224	18.9%
2012	5,553	1,468	704	294	14.2%
2013	13,005	1,541	2,532	352	19.8%
2014	12,839	1,371	1,568	66	11.5%
2015	15,533	769	1,665	54	10.5%
2016	7,982	735	922	31	10.9%
2017	3,116	399	470	16	13.8%
2018	1,465	99	205	25	14.7%
Average	*5,966*	*559*	*823*	*78*	*14.0%*

1 Total returns to the Yakima River include escapement (above and below Prosser) and recreational harvest.

3.4 PROPOSED HATCHERY PROGRAM

This Master Plan proposes two hatchery programs for Yakima summer/fall Chinook and Yakima URB Chinook: (1) a locally-adapted integrated harvest program upstream of Prosser Dam using facilities at Prosser Hatchery (in the long-term phase a new facility is proposed in the upper Basin to support the summer-run component), and (2) a segregated URB harvest program downstream of Prosser Dam using facilities at Prosser Hatchery. The first program will be referred to as the **Yakima Integrated**

Summer/Fall Chinook Program and second program as the **Yakima Segregated URB Harvest Program**. The integrated summer/fall Chinook program will be implemented in two phases, a transition and a long-term phase. An overview of the two programs is presented in Table 3-9. The remainder of section 3.4 presents details on the proposed programs.

Table 3-9. Overview of Proposed Yakima Integrated Summer/Fall Chinook and Segregated Upriver Bright Chinook Programs

	Yakima Integrated Summer/Fall Chinook Program	Yakima Segregated Upriver Bright Program
Associated Natural Population	Yakima River Summer-Fall Chinook (extirpated)	Hanford/Priest Rapids URB Fall Chinook
ESU	Upper Columbia Summer/Fall Chinook ESU	Upper Columbia Summer/Fall Chinook ESU
ESA Status	Not Listed	Not Listed
Spawning Area	Yakima River, upstream of Prosser Dam	Lower Yakima River, downstream of Prosser Dam
Hatchery Program Purpose	Harvest and reestablishment of a naturally-spawning, locally-adapted bimodal summer-fall Chinook population spawning above Prosser Dam	Harvest
Harvest Goals	Temporally and spatially expand fishing season in the Yakima River to historic patterns Transition: contribute >15,000 adults to all fisheries Long term: contribute >20,000 adults to all fisheries	
Yakama Nation Cultural Goals	• Natural spawning of Chinook salmon over historic range and time periods in the Yakima River • Meet ceremonial and subsistence requirements	Meet treaty harvest entitlements as confirmed and specified in U.S. v. Oregon agreements
Conservation Goals for Natural Population	Transition: >5,500 total spawners (NOR+HOR) Long term: >4,000 natural-origin (NOR) spawners	Contribute toward U.S. v. Oregon combined escapement target at McNary Dam
Broodstock origin	Summer-run Transition: Upper Columbia summer-fall Chinook via Wells Hatchery or local returns to Prosser Summer-run Long-term: Upper Columbia summer-fall Chinook via local returns to Roza Dam or Naches weir(s)	Hanford Reach fall Chinook via Priest Rapids Hatchery

	Yakima Integrated Summer/Fall Chinook Program	Yakima Segregated Upriver Bright Program
	Fall-run Component: Hanford Reach fall Chinook via local returns to Prosser	
Broodstock Management	Transition to an **integrated** program over time as local, natural-origin returns become available for broodstock.	This program will be managed as a **segregated** hatchery population relative to the Yakima River summer-fall population.
Broodstock Collection Locations	Prosser Dam Summer-run Long-term: local returns to Roza Dam or Naches weir(s)	Prosser Dam, Little White Salmon NFH, Priest Rapids Hatchery, Priest Rapids Dam
Hatchery Program Size	Summer-run: 1 million subyearlings Fall-run: 500,000 subyearlings	1.7 million subyearlings 210,000 yearlings
Hatchery Facility	Prosser Hatchery Summer-run Long-term: TBD site upstream of Naches/Yakima R confluence	Prosser Hatchery
Marking/Tagging	100% CWT	100% ad clipped, 10% CWT
Release Locations	Summer-run - Transition: 50% of available subyearlings at Prosser Hatchery; remaining fish from temporary acclimation sites in Yakima River above confluence of Naches and Yakima Rivers Summer-run - Long-term: 50% of available subyearlings each from acclimation sites in Yakima River above confluence of Naches and Yakima Rivers	Prosser Hatchery

3.4.1 Program Need and Justification

The Yakama Nation was guaranteed fishing rights by the Treaty of 1855. These rights were confirmed by a federal court in *U.S. v Oregon* in 1969. Since 1977, the parties to *U.S. v Oregon* have been involved in negotiating a series of plans for fisheries management in the Columbia River Basin. These plans have been adopted by the orders of the U.S. District Court for the District of Oregon. The planning process is the principal forum for addressing issues related to anadromous fish harvest, stock restoration, and hatchery production. The 2008-2017 Accords identify a short-term (< 25 years) production goal of 1.7 million fall Chinook to be released in the Yakima River Basin. The 2008-2017 Accords have been reauthorized through 2022.

Historically, Yakama Tribal members fished for Chinook, Coho, steelhead and other species in the Yakima River and throughout the Columbia River Basin. By the 1970s, habitat conditions were degraded to the point that sustainable runs of early and late run Chinook had been extirpated from the basin.

Given current habitat conditions and fishery exploitation rates (> 60 percent), the Yakima Basin cannot sustain natural production of summer/fall Chinook without significant habitat improvements. Harvest levels are not expected to decrease in the short term, and the habitat improvements needed to increase population productivity to a level that can withstand this harvest rate are not expected in the near term.

Therefore, to meet treaty obligations, a hatchery program is needed that will increase tribal harvest and restore natural production of summer and fall-run Chinook salmon in the Yakima Basin. In addition to the long-established 1.7 million *U.S. v Oregon* URB harvest program, this will require operating the integrated summer/fall Chinook program at a sustained level of 1.5 million annually over the short term (< 25 years) to recolonize spawning habitat above Prosser Dam. The long-term strategy (> 25 years) for meeting treaty obligations is to implement actions that will improve critical habitat throughout the basin and in the Columbia River migration corridor. Because decades of work may be required before basin habitat is able to sustain natural summer/fall Chinook production at sufficient levels to meet harvest and natural spawning goals, hatchery production will help meet these goals in the interim.

3.4.2 Program Goals and Objectives

The proposed programs for Yakima summer/fall Chinook and URB fall Chinook have distinct objectives.

- **Yakima Integrated Summer/Fall Chinook Program:** The primary objective of the integrated summer/fall Chinook program is to expand harvest opportunities temporally and spatially within the Yakima Basin. The integrated program is also expected to increase the number of fish spawning naturally in the Yakima River basin, which will contribute to the Yakama Nation's cultural objective of seeing Chinook salmon complete their life cycle in the wild. In addition, the integrated program is designed to reestablish a locally-adapted summer/fall Chinook population between Prosser Dam and Roza Dam in the Yakima River and up to the mouth of the Tieton River in the Naches River subbasin and increase the spatial and temporal diversity of the naturally-spawning population.

- **Yakima Segregated URB Harvest Program:** The primary objective of the segregated program is to increase harvest of URB fall Chinook in the Zone 6 and Yakima River basin fisheries consistent with *U.S. v Oregon* agreements.

3.4.3 Yakima Integrated Summer/Fall Chinook Hatchery Program

The Yakima Integrated Summer/Fall Chinook Program will release fish into the Yakima and Naches Rivers upstream of Prosser Dam. To reestablish the historic bi-modal summer/fall run-timing, brood for this program will initially come from two sources: summer-run from Upper Columbia (Wells Hatchery or Entiat Hatchery) and summer/fall-run from local returns to Prosser Dam. The concept is to introduce diverse life histories and let the habitat drive the combined population toward local adaptation over time. The hatchery program will be operated to maintain run-time diversity, but also to incorporate local, natural-origin adults in the hatchery broodstock in sufficient proportion to allow the natural environment to drive adaptation of the integrated population.

The early, summer-run component of the program has a long-term release goal of 1.0 million subyearling Chinook. From 2009-2018, releases averaged 182,000 subyearlings annually (Table 3-2) with eggs imported from Wells or Entiat Hatcheries in the Upper Columbia. With implementation of this Master Plan, the primary objective during the transition phase will be to establish a locally returning hatchery-origin population from which to draw broodstock. From available eggs (regardless of brood source), the priority will be to rear and release 50% or more of available subyearlings from Prosser Hatchery. This will allow maximum opportunity for fish to imprint on this water source and home to the hatchery “swim-in” denil ladder upon adult return. Additional eggs beyond this priority need will be split 50/50 and targeted for release in acclimation sites in the Upper Yakima and Naches Rivers above their confluence in Yakima, WA. As a local program is established over time and additional broodstock become available, the long-term goal will be to increase the number of fish acclimated and released from upriver locations and to incorporate natural-origin broodstock into the program from trap (e.g., Roza Dam) or weir locations upriver.

Incorporating locally returning hatchery- and natural-origin returns into the broodstock is expected to reestablish a locally-adapted summer-fall Chinook population and increase its productivity and fitness (YKFP 2010, HSRG 2014). The broodstock strategy is also designed to increase the spatial and temporal diversity of the population. The summer-run fish are expected to return as adults earlier in the year (Figure 3-5) and spawn higher in the basin than the later arriving fall-run population component (Figure 3-9). Once local broodstock are available, broodstock collection will be stratified based on run-timing of the early and late returning components of the population. Local broodstock (NORs and HORs returning from the integrated program) will be collected at Prosser Dam. A critical part of the long-term plan is to construct a hatchery facility at a site to be determined above the confluence of the Yakima and Naches Rivers. This will allow fish to imprint to preferred habitats from the earliest stages of their life cycle.

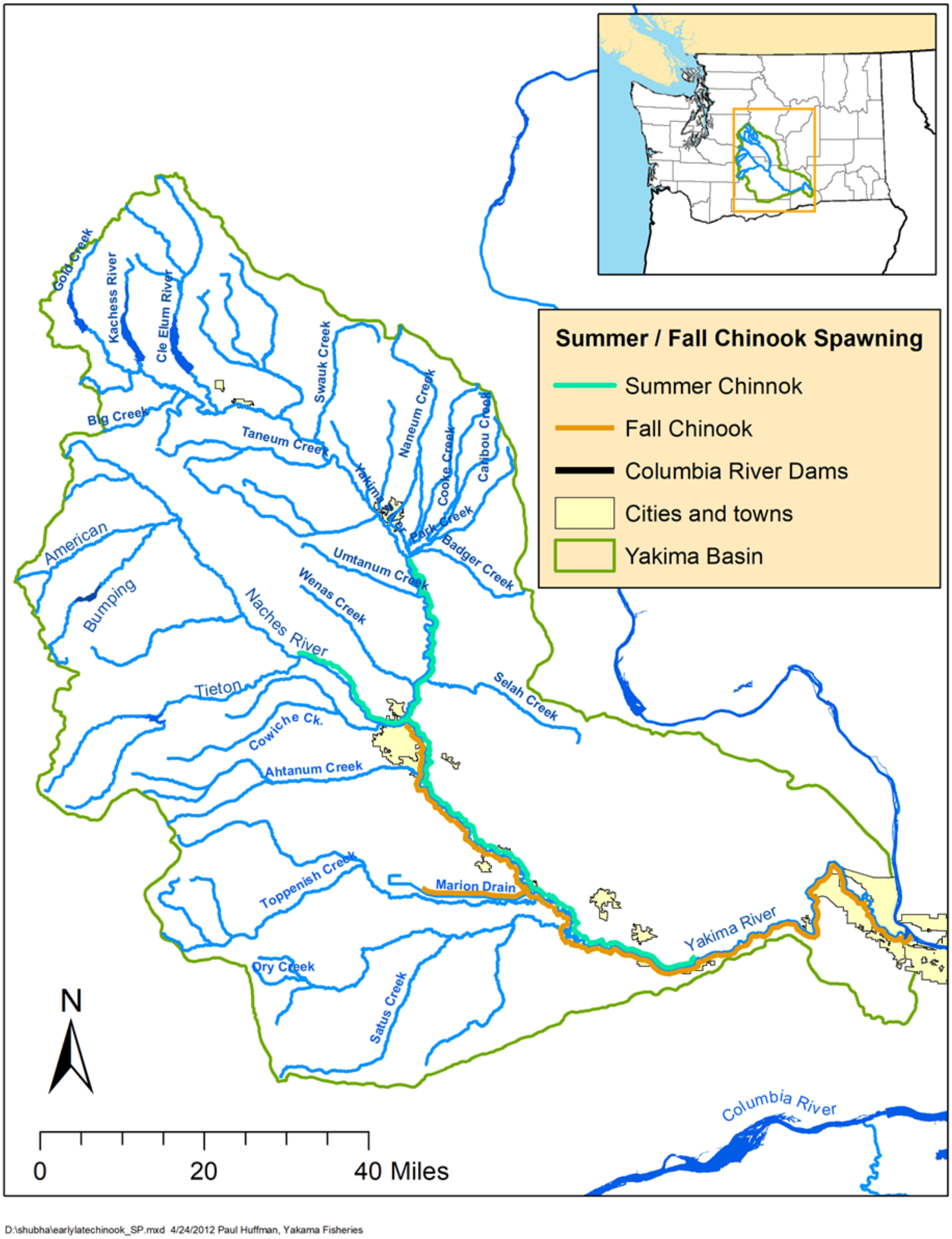


Figure 3-9. Spawning areas used by summer- and fall-run Chinook in the Yakima River.

The 500,000 subyearling fall-run Chinook will also be reared at Prosser Hatchery. Juveniles from the two programs will be differentially marked so that returning summer- and fall-run hatchery-origin adults may be distinguished during broodstock collection. Summer-run hatchery releases will be 100% coded-wire tagged and will not be ad-clipped. Fall-run releases will be 100% ad-clipped; 10% will also receive CWTs to provide harvest data. It will not be possible to distinguish summer- from fall-run adipose-present/no internal tags NOR returns. However, NOR fish are expected to show different spatial distribution on the spawning grounds with summer-run fish distributing more into the mid-Yakima at spawn-time and fall-run fish remaining lower in the Basin.

The program will have two phases: a **transition phase** and a **long-term phase**. Release goals for the two phases and run components are shown in Table 3-10.

Table 3-10. Release goals and broodstock management strategy for the Yakima integrated summer/fall Chinook program.

Program Goal	Integrated Summer-run Chinook			Integrated Fall-run Chinook	
	Current	Transition[1]	Long-term[2]	Current	Transition/ Long-term[1]
Hatchery-origin brood (HOB)	100%	620	310	100%	155
Natural-origin brood (NOB)	0%	0	310	0%	155
Subyearlings released	~180,000	1,000,000	1,000,000	0	500,000
pNOB	0%	0-30%	30-50%	0%	30-50%

[1] Prosser Hatchery upgrades implemented; assumes 95% pre-spawn survival, 4,000 fecundity, and 85% egg-smolt survival.
[2] New facility constructed in Upper Yakima or Naches.

Transition Phase

During the transition phase, both the summer- and fall-run Chinook programs will reside at Prosser Hatchery. Initially, broodstock for the summer-run component will be obtained from summer-run adults returning to Wells or Entiat Hatcheries, and broodstock for the fall-run component will be obtained from the Prosser segregated program. During the transition phase, the program will begin to incorporate locally returning hatchery-origin fish into the broodstock. Importing brood from out-of-basin sources will be terminated as soon as sufficient numbers of local broodstock become available. Initially, broodstock will be acquired from the following sources, in order of priority:

1) Hatchery-origin returns (from this program) to Prosser Dam or Hatchery
2) Imported broodstock from Wells or Entiat Hatcheries (summer Chinook) or the in-basin segregated program (fall Chinook).

The annual release goal for summer-run Chinook during the transition phase is to consistently release 1,000,000 subyearlings total from the combined sites of Prosser Dam and the upriver acclimation sites. Release locations of summer-run Chinook during the transition phase will depend on the number of releases, with the emphasis shifting to upper subbasin release locations when total release numbers exceed 500,000 (Table 3-11). Maintaining a high release number will maximize the opportunity to collect locally returning hatchery adults and thus, transition away from the out-of-basin broodstock source as quickly as possible. It is likely that in the early stages of the transition phase, both local adults and imported eggs will be required to meet the annual release goal.

Later in the transition phase, as sufficient NORs return, the goal is to begin incorporating natural-origin broodstock into both the summer brood. For the summer-run program, the goal is to use up to 30% NORs as broodstock during the transition phase. The number of NORs used for brood will be determined based on the NOR run size (Table 3-12).

Table 3-11. Release location rules for Integrated Summer-run Chinook during the Transition Phase.

Total Release Size	Release Location		
	Prosser	Upper Yakima	Naches
< 250,000	60%	40%	0%
250,000-500,000	60%	20%	20%
>500,000	50%	25%	25%

The annual release goal for the fall-run program is 500,000 subyearlings during both the transition and long-term phases. Initially, as with the summer-run program, the goal during the transition phase is to shift to using 100% local broodstock. As sufficient NORs return, the goal is to use up to 50% NORs as broodstock. The number of NORs used for brood will be determined based on the NOR run size (Table 3-13).

Long-term Phase

During the long-term phase, the summer-run program will move to the new facility constructed in the upper Yakima or Naches subbasins. In addition, the program will begin using a higher proportion of NOR adults (30-50%) in the broodstock. The fall-run program is expected to operate the same during the transition and long-term phases (Table 3-10).

For the summer-run program, the trigger for transitioning to the long-term phase will be based on the total run size of NOR adults enumerated at Prosser Dam. NOR adults will not be taken for broodstock until the natural-origin return meets an annual minimum return size of 400 adults for a 5-year consecutive period (Table 3-12). Broodstock collection practices will target a pNOB of 20% when NOR run sizes are between 400 and 600 adults, which would remove a maximum of 30% of the NOR run for broodstock (Table 3-12). In years where NOR run sizes exceed 600 adults, a greater number of NORs will be incorporated into the program using a sliding scale as outlined in Table 3-12 below. It is expected that as habitat improves over time, the naturally-spawning population above Prosser will have an increasing influence on the life history composition of the integrated population because NORs will comprise a larger proportion of the population and will be increasingly used as broodstock as more become available. When the new summer-run facility is built, juveniles derived from the NOR x NOR crosses will be prioritized for the acclimation sites in the Naches and upper Yakima Rivers where natural production is expected to increase with implementation of this Master Plan.

Similarly, fall-run NOR adults will not be taken for broodstock until the NOR run size reaches 400 adults based on a 5-year running average (Table 3-13). The sliding scale broodstock collection table illustrates how NORs will be allocated to broodstock, escapement, and terminal harvest. In practice, achieving the target pNOB levels for both the summer- and fall-run programs would require collecting 1 in 3 NORs for a pNOB of 30%, for example. This would ensure the broodstock are collected at random and are representative of the entire run timing.

Table 3-12. Sliding scale broodstock collection table for the transition and long-term phases of the Yakima integrated summer-run Chinook program (assumes 620 broodstock are needed for a full program).

NOR Run Size	NOB	HOB	pNOB	Percent of NOR Run Size Collected for Brood	NOR Terminal Harvest	Approx. NOR Escapement
150	0	620	0%	0	0	150
250	0	620	0%	0	0	250
300	0	620	0%	0	0	300
400	120	500	20%	30%	0	280
500	120	500	20%	24%	50	330
600	180	440	30%	30%	50	370
800	180	440	30%	23%	50	570
1,000	310	310	50%	31%	100	590
1,200	310	310	50%	26%	100	790

Table 3-13. Sliding scale broodstock collection table for the transition/long-term phase of the Yakima integrated fall-run Chinook program (assumes 310 broodstock are needed for a full program).

NOR Run Size	NOB	HOB	pNOB	Percent of NOR Run Size Collected for Brood	NOR Terminal Harvest	Approx. NOR Escapement
150	0	310	0%	0	0	150
250	0	310	0%	0	0	250
300	0	310	0%	0	0	300
400	60	250	20%	15%	0	340
500	60	250	20%	12%	50	390
600	90	220	30%	15%	50	460
800	90	200	30%	11%	50	660
1,000	155	155	50%	16%	100	745
1,200	155	155	50%	13%	100	945

3.4.4 Yakima Segregated URB Fall Chinook Harvest Program

The current Yakima URB fall Chinook harvest program releases approximately 2.0 million subyearling Chinook annually (Table 3-1). The eggs or juveniles needed for the program are currently imported from the Little White Salmon Hatchery. Juveniles are reared at and released from Prosser Hatchery.

The program proposed in this Master Plan will continue to release approximately 1.9 million URB fall Chinook juveniles (1.7 million subyearlings and 210,000 yearlings) from Prosser Hatchery (Table 3-14).

The program will obtain broodstock from either returning adults produced by the program (identified by adipose fin clips), or when needed, from the Little White Salmon NFH, Priest Rapids Hatchery, or Priest Rapids Dam (OLAFT facility) as prescribed in *U.S. v Oregon* management agreements. The priority will be to collect returning adults produced by the program. All juveniles will be adipose fin-clipped before release. In addition, 10% of released juveniles will receive coded-wire tags. Juveniles from the URB program will be differentially marked from those produced by the Yakima integrated summer/fall Chinook program, which will be 100% CWT, but not adipose fin-clipped. Juveniles from the segregated program will continue to be released at Prosser Hatchery.

Table 3-14. Release goals and broodstock management strategy for the Yakima segregated URB fall Chinook program.

Program Goal	Segregated Fall-run Chinook	
	Current	Transition/Long-term
Brood source	Local + imported	Local + imported
Hatchery-origin brood (HOB)	1,200	1,200
Subyearlings released	1.7 million	1.7 million
Yearlings released	210,000	210,000

3.4.5 Summary of Proposed Chinook Programs

In summary, the proposed programs would result in the following changes to ongoing Chinook hatchery programs currently being conducted in the Yakima Basin:

- **Increase in the number of summer- and fall-run Chinook releases.** The proposed programs would increase the number of summer-run Chinook subyearlings released from 200,000 up to 1,000,000 annually. The integrated fall-run Chinook program is new and would release up to 500,000 subyearlings. The segregated URB fall Chinook program would continue to release up to 1.9 million juveniles (1.7 million subyearlings and 210,000 yearlings[8]). As a result, the total release of summer-run and fall-run Chinook juveniles will be up to 3.4 million fish. This is an increase from current juvenile releases, which have averaged 1.9 million.

- **Transition to using local broodstock and integration of natural-origin returns into broodstock.** Both the integrated and segregated summer/fall run Chinook programs will transition to using 100% local broodstock. In addition, the integrated summer- and fall-run programs will incorporate natural-origin broodstock (30% in Phase 3 and 50% in Phase 4) based on the natural-origin run sizes at Prosser Dam.

3.5 SCIENTIFIC FRAMEWORK

[8] These releases were designed to meet the Total Adult Production goal for the John Day Mitigation Program funded by the U.S. Army Corp of Engineers.

3.5.1 Biological Objectives

Biological objectives for each phase (transition and long-term) are identified in Table 3-15. Substantial habitat improvements will be required to meet the long-term natural-origin escapement goals of the integrated summer- and fall-run Chinook program.

Table 3-15. Biological Objectives for the Integrated Summer- and Fall-run Chinook Program

Objective	Transition Phase		Long-Term Phase	
	Yakima Summer/Fall Chinook Program	Yakima URB Harvest Program	Yakima Summer/Fall Chinook Program	Yakima URB Harvest Program
Escapement	5,500 natural- and hatchery-origin adults	Meet *U.S. v Oregon* combined URB fall Chinook escapement targets to McNary Dam	4,000 natural-origin adults	Meet *U.S. v Oregon* combined URB fall Chinook escapement targets to McNary Dam
Harvest	Average >15,000 adult contribution to all fisheries from both programs combined		Average >20,000 adult contribution to all fisheries from both programs combined	
	Average of >4,000 adults harvested in Zone 6 and terminal fishery from both programs combined		Average of >5,500 adults harvested in Zone 6 and terminal fishery from both programs combined	
pNOB	30%	NA[2]	50%	NA[2]
pHOS	NA[1]	< 5% stray rate	< 50%	< 5% stray rate
PNI	NA[1]	NA[2]	> 0.50	NA[2]

1 No PNI or pHOS goals during recolonization (transition) phase.
2 No pNOB or PNI objectives for segregated program.

3.5.2 Key Assumptions

The key assumptions for natural and hatchery production in the transition and long-term phases are identified below (Tables 3-16 through 3-23). These assumptions were incorporated into the AHA tool to forecast the harvest and conservation benefits of the programs, which are presented in section 3.5.3. The key assumptions will be reviewed annually and modified as appropriate based on research, monitoring and evaluation results.

3.5.2.1 Natural Production

The natural production assumptions used in the AHA model are shown in Table 3-16. The productivity and capacity assumptions are based on EDT modeling results and are adjusted to included fitness loss (i.e., fitness loss is applied as a multiplier). Fitness assumptions are discussed below. Transition phase productivity and capacity assumptions are the baseline or current assumptions about the system. Long-term phase assumptions are adjusted to account for 1) habitat restoration actions (ongoing and proposed) under the Integrated Plan, described in Section 3.2, and 2) fitness improvements as the program becomes fully integrated and the population becomes locally adapted.

The smolt-to-adult survival (SAR) assumption for natural-origin summer- and fall-run Chinook is based on PIT tag data for subyearling summer- and fall-run Prosser Hatchery releases (brood years 2006-2014). This is the best available data for the Yakima River summer/fall Chinook population, because Prosser Hatchery releases are not externally marked or coded-wire tagged to allow hatchery and natural-origin returns to be distinguished. The AHA model uses the pre-harvest SAR (i.e., survival before harvest removals) from Bonneville (smolt) to Bonneville (adult return), then applies assumptions about juvenile and adult fish passage survival through the mainstem Columbia River from the FCRPS Biological Opinion. The post-harvest Bonneville to Bonneville SAR for Prosser releases (BY 2006-2014) was 0.83% for summer-run subyearlings and 0.86% for fall-run subyearlings. The pre-harvest SARs (1.59% for summer-run and 1.35% for fall-run) were then calculated by adjusting the post-harvest SARs by the exploitation rate in the ocean and lower Columbia River fisheries below Bonneville Dam (48% for summer-run and 36.5% for fall-run Chinook; Table 3-21). Juvenile fish passage survival for subyearlings from McNary through Bonneville is assumed to be 75% (95% per project); adult fish passage survival is assumed to be 92% (98% per project).

These SAR assumptions are similar to those estimated for Little White Salmon (LWS) Hatchery subyearling fall Chinook, which is one of the brood sources for the Yakima fall Chinook program. The LWS subyearling fall Chinook post-harvest BON to BON SAR for juvenile migration years 2008-2015 was 1.4% (arithmetic mean) or 0.69% (geomean), including only adult returns; the SAR estimate including jacks is slightly higher.

Table 3-16. Natural production assumptions for Yakima integrated summer/fall Chinook by phase.

	Transition Phase		Long-Term Phase	
	Summer-run Component	Fall-run Component	Summer-run Component	Fall-run Component
Productivity (Smolts/Spawner)[1]	114	120	225	174
Capacity (Smolts)	838,396	515,880	1,916,558	1,092,134
Fitness	0.50		0.68	
Post-harvest BON-to-BON SAR[2]	0.83%	0.86%	0.83%	0.86%
Pre-harvest BON-to-BON SAR[3]	1.59%	1.35%	1.59%	1.35%
Juvenile Fish Passage Survival	0.75	0.75	0.75	0.75
Adult Fish Passage Survival	0.92	0.92	0.92	0.92

1 Productivity and capacity values including fitness loss.
2 Based on PIT tag data for Prosser Hatchery subyearling summer- and fall-run Chinook releases.
3 Adjusted to account for harvest in the ocean and lower Columbia River (below Bonneville Dam) fisheries.

Fitness

In the past, hatchery releases of Chinook consisted of fish originating outside of the Yakima River Basin (i.e., not locally adapted). Although the current hatchery program is beginning to use local broodstock, the majority of releases in most years are still from out-of-basin brood. This Master Plan assumes that out-of-basin hatchery fish have a fitness factor 50 percent that of a locally-adapted Yakima River population[9]. It is then assumed that by following an integrated hatchery strategy (as defined by the HSRG), population fitness can be improved over time.

The HSRG defines an integrated program as follows:

> *A hatchery program is an **Integrated Type** if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild*. (HSRG et al. 2004). *For a natural/hatchery composite population at equilibrium (Ford 2002), the influence of the hatchery and natural environments on the adaptation of the composite population is determined by the proportion of natural-origin broodstock in the hatchery (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). The larger the ratio pNOB/ (pHOS+pNOB), the greater the strength of selection in the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, this ratio must exceed 0.5.*

This ratio is referred to as the proportionate natural influence (PNI). The Master Plan sets broodstock management (pNOB and PHOS) targets such that a PNI greater than 0.50 is achieved in Phase 4. AHA modeling shows that if this PNI value is achieved, the relative fitness of the integrated population will be increased to approximately 68 percent.

3.5.2.2 Hatchery Production

Estimates of the number of broodstock required for each program are based on in-hatchery data for the Prosser program (Tables 3-17 and 3-18). Pre-spawning mortality is minimal because adults are spawned soon after being collected.

Additional hatchery assumptions are shown in Tables 3-19 and 3-20. The smolt-to-adult survival (SAR) assumptions for hatchery-origin returns are based on PIT tag data for subyearling and yearling summer- and fall-run Prosser Hatchery releases (brood years 2006-2014). For hatchery-origin fish, the AHA model uses the pre-harvest release to Prosser SAR (i.e., survival before harvest removals). The pre-harvest release to Prosser SAR was 0.71% for summer-run subyearlings and 0.36% for fall-run subyearlings (geomean for BY 2006-2014; Table 3-6). This was calculated by adjusting the release to Bonneville (adult returns) post-harvest SARs by the exploitation rate in the ocean and lower Columbia River fisheries (below Bonneville Dam; 48% for summer-run and 36.5% for fall-run Chinook; Table 3-21 and 3-22) and expected adult fish passage survival through from Bonneville to McNary Dams (92%; FCRPS BiOp).

These post-harvest SAR assumptions are similar to the post-harvest release to Bonneville (adult returns) SAR estimated for Little White Salmon (LWS) Hatchery subyearling fall Chinook, which is one of the brood sources for the Yakima fall Chinook program. The LWS subyearling fall Chinook post-harvest release to Bonneville (adult returns) SAR for juvenile migration years 2008-2015 was 0.91% (arithmetic mean) or 0.46% (geomean). The LWS estimate includes adult returns only.

[9] Note that the historical Yakima River Coho population has been extirpated. The focus of the Master Plan is to create a locally-adapted Coho population in the Yakima River. The 50 percent fitness assumption is the standard value used by the HSRG in AHA modeling.

Table 3-17. In-hatchery production requirements and performance metrics for Yakima River integrated summer/fall Chinook.

Parameter	Integrated Summer Chinook	Integrated Summer Chinook	Integrated Fall Chinook
	Transition	Long-term	Transition/Long-term
Brood Source	Local + imported	Local	Local + imported
Brood Number[1]	620	620	310
Pre-spawn Mortality	<5.0%	<5.0%	<5.0%
Fecundity	4,000	4,000	4,000
Eggs	1,178,000	1,178,000	589,000
Egg-to-Subyearling Survival	85.0%	85.0%	85.0%
Subyearlings Released	1,001,300	1,001,300	500,650

1 Estimates of the number of broodstock required for each program are based on in-hatchery data for the Prosser program (Tables 3-17 and 3-18).

Table 3-18. In-hatchery production requirements and performance metrics for Yakima River segregated URB fall Chinook.

Parameter	Current	Lower Yakima URB Segregated Chinook	Lower Yakima URB Segregated Chinook
		Transition	Long-term
Brood Source	Local + Imported	Local + Imported	Local
Brood Number[1]	1,200	1,200	1,200
Pre-spawn Mortality	5.0%	5.0%	5.0%
Fecundity	4,000	4,000	4,000
Eggs	2,280,000	2,280,000	2,280,000
Egg-to-Subyearling Survival	85.0%	85.0%	85.0%
Subs/yearlings Released	1,938,000	1,938,000	1,938,000

1 Estimates of the number of broodstock required for each program are based on in-hatchery data for the Prosser program (Tables 3-17 and 3-18).

Table 3-19. Hatchery production assumptions for the Yakima integrated summer/fall Chinook program by phase.

	Yakima Integrated Summer/Fall Program			
	Transition Phase		Long-Term Phase	
	Summer-run	Fall-run	Summer-run	Fall-run
pNOB	0-30%	30-50%	30-50%	30-50%
Post-harvest SAR (Release to BOA)[1]	0.40%	0.25%	0.40%	0.25%
Pre-harvest SAR (Release to Prosser)[2]	0.71%	0.36%	0.71%	0.36%

1 Based on PIT tag survival estimates from tagging to Bonneville (adult returns) for subyearling summer and fall-run releases from Prosser Hatchery.
2 Adjusted to remove pre-Bonneville harvest (ocean and lower Columbia River fisheries) and account for adult fish passage survival from BON to MCN dams.

Table 3-20. Hatchery production assumptions for the Yakima URB Chinook harvest program by phase.

	Yakima URB Segregated Harvest Program	
	Transition Phase	Long-Term Phase
Subyearlings - Post-harvest SAR (Release to BOA) [1]	0.25%	0.25%
Subyearlings - Pre-harvest SAR (Prosser to Prosser) [2]	0.36%	0.36%
Yearlings - Post-harvest SAR (Release to BOA) [1]	1.17%	1.17%
Yearlings - Pre-harvest SAR (Release to Prosser) [2]	1.80%	1.80%

1 Based on PIT tag survival estimates from tagging to Bonneville (adult returns) for subyearling or yearling summer and fall-run releases from Prosser Hatchery.
2 Adjusted to remove pre-Bonneville harvest (ocean and lower Columbia River fisheries) and account for adult fish passage survival from BON to MCN dams.

3.5.2.3 Harvest

Harvest rate assumptions for Yakima summer/fall and URB Chinook are based on CWT recoveries from the Yakima summer/fall Chinook hatchery program and harvest rate data for other mid- and upper-Columbia River summer/fall Chinook populations. For example, the Okanogan River summer/fall Chinook population has a total exploitation rate of 58% for NORs and 70% for HORs, which are adipose fin-clipped (DJWA 2019). The difference in the total exploitation rate for Okanogan HORs and NORs is primarily due to selectivity in the terminal fishery (6% harvest rate for NORs and 33% for HORs). The 2018 PFMC Ocean Salmon Fisheries report (PFMC 2019) provides total exploitation rates for summer- and fall-run upper Columbia River Chinook salmon, which include both ocean and freshwater fisheries. The average total exploitation rate for the most recent 5 years is approximately 65% for summer-run and 50% for fall-run Chinook (PFMC 2019). The 2018 Joint Staff Reports (WDFW and ODFW 2018a and 2018b) report summer- and fall-run Chinook harvest data for the lower Columbia (Zones 1-5) and upper Columbia (Zone 6, above Bonneville Dam). These data, along with the total exploitation rates in PFMC (2019) and Yakima River terminal harvest rate data (Table 3-8) were used to estimate harvest rates in the ocean, lower Columbia, Upper Columbia, and terminal fisheries (Table 3-21 and 3-22). Currently, the terminal harvest rate for summer/fall Chinook is 14%, but the fishery is not open during the summer run and primarily harvests fall-run Chinook; therefore, the AHA analysis assumes the current/transition phase terminal harvest rate for summer-run Chinook is 3% to allow summer-run Chinook to recolonize the habitat. During the long-term phase, the AHA analysis assumes the summer-run Chinook terminal harvest rate would be similar to the fall-run terminal harvest rate.

Harvest rate assumptions for Yakima integrated program HORs are identical to those for NORs (Table 3-21), because integrated HORs will be coded-wire tagged, but will not be adipose fin-clipped, and thus will not be subject to additional harvest in selective fisheries. Harvest rate assumptions for the URB segregated harvest program (Table 3-22) are identical to those for integrated fall-run Chinook because URB releases will not be adipose fin-clipped.

Table 3-21. Harvest rate assumptions for the Yakima integrated summer/fall Chinook harvest program by phase.

	NORs				Integrated HORs			
	Transition		Long-term		Transition		Long-term	
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Ocean Harvest Rate	43%	31%	43%	31%	43%	31%	43%	31%
Lower Columbia Harvest Rate	9%	8%	9%	8%	9%	8%	9%	8%
Upper Columbia Harvest Rate	20%	16%	30%	16%	20%	16%	30%	16%
Terminal Harvest Rate	3%	14%	14%	14%	3%	14%	14%	14%
Total Exploitation Rate	60%	54%	64%	54%	60%	54%	64%	54%

Table 3-22. Harvest rate assumptions for the Yakima segregated URB fall Chinook harvest program by phase.

	Segregated HORs	
	Transition	Long-term
Ocean Harvest Rate	31%	31%
Lower Columbia Harvest Rate	8%	8%
Upper Columbia Harvest Rate	16%	16%
Terminal Harvest Rate	14%	14%
Total Exploitation Rate	54%	54%

3.5.3 Expected Outcomes by Phase based on AHA Modeling

The expected outcomes of the hatchery program in each phase were calculated using the All-H Analyzer (AHA) model based on the proposed hatchery strategies and key assumptions about in-basin and out-of-basin conditions. Expected outcomes for the current summer- and fall-run Chinook program and the proposed integrated and segregated programs are shown in Tables 3-23 and 3-24. Total outcomes (from the summer-run, fall-run and URB Chinook programs combined) are summarized in Table 3-23 for the current programs and projected Transition and Long-term Phase outcomes. These are the average long-term outcomes based on AHA modeling using the key assumptions about habitat, fish passage, harvest, and SARs described in section 3.5.2. As noted previously, documentation for the AHA model is provided in HSRG (2009b), found at: http://hatcheryreform.us/wp-content/uploads/2016/05/4_appendix_c_analytical_methods_and_info_sources.pdf.

There is substantial uncertainty associated with the SAR assumptions for NORs and HORs used in AHA. This uncertainty has an impact on the program's ability to achieve its harvest and conservation goals.

Table 3-23. Expected outcomes for the current and proposed Yakima Summer/Fall Chinook programs based on All-H Analyzer modeling.

	Current (all releases)	Integrated Summer Chinook – Transition	Integrated Fall Chinook – Transition	Integrated Summer Chinook – Long Term	Integrated Fall Chinook – Long Term	Lower Yakima River Segregated
Hatchery Yearlings	210,000	0	0	0	0	210,000
Hatchery Subyearlings	1,900,000	1,000,000	500,000	1,000,000	500,000	1,700,000
Natural-origin Smolts	84,431	278,146	163,860	697,619	292,096	0
Ocean Harvest	4,742	5,268	1,264	7,697	1,731	3,618
Lower Columbia Harvest	778	629	225	918	308	644
Zone 6 Harvest	1,461	1,290	414	1,885	567	1,186
Terminal Harvest	831	140	280	953	383	802
Total Harvest	7,813	7,327	2,183	11,453	2,990	6,250
Natural-origin Returns to Basin (brood + escapement)	403	1,357	810	3,050	1,445	0
Hatchery-origin Returns to Basin (brood + escapement + hatchery surplus)	5,116	3,175	1,415	2,804	1,370	4,875
Total Adult Returns to Yakima Basin	5,519	4,532	2,225	5,855	2,815	4,875
Imported Broodstock (HOR)	1,310	-	-	-	-	-
Local Broodstock (NOR)	-	186	93	310	155	-
Local Broodstock (HOR)	-	434	217	310	155	1,200
Natural-origin Escapement	403	1,171	717	2,740	1,290	0
Hatchery-origin Escapement (includes in-basin strays from seg. program)	3,772	2,530	1,170	2,243	1,170	492
Total Escapement	4,175	3,701	1,887	4,983	2,460	492
In-basin Strays from segregated program	3,323	-	443	-	443	443

	Current (all releases)	Integrated Summer Chinook – Transition	Integrated Fall Chinook – Transition	Integrated Summer Chinook – Long Term	Integrated Fall Chinook – Long Term	Lower Yakima River Segregated
Out-of-basin Strays (segregated fish straying to other basins)	369					49
Hatchery Surplus	1,344	211	28	251	45	3,232
pNOB	0%	30%	30%	50%	50%	NA
Effective pHOS*	47%	63%	57%	40%	42%	NA
PNI	-	0.32	0.35	0.56	0.54	NA
Total Run Size (harvest + returns to Basin; includes in-basin and out-of-basin strays from seg. program)	13,701	11,859	4,408	17,307	5,805	11,174

*Assumes HORs have 80% relative reproductive success compared to NORs; i.e., effective pHOS = (HORs*80%)/(HORs*80% + NORs).

Table 3-24. Combined outcomes (by program phase) for the current and proposed Yakima Summer/Fall Chinook programs based on All-H Analyzer modeling.

	Current (includes all releases)	Transition – Integrated and Segregated Programs Combined	Long Term – Integrated and Segregated Programs Combined
Hatchery Yearlings	210,000	210,000	210,000
Hatchery Subyearlings	1.9 million	3,200,000	3,200,000
Natural-origin Smolts	84,431	442,006	989,715
Ocean Harvest	4,742	10,151	13,046
Lower Columbia Harvest	778	1,498	1,871
Zone 6 Harvest	1,461	2,890	3,637
Terminal Harvest	831	1,221	2,138
Total Harvest	7,813	15,759	20,692
Natural-origin Returns to Basin (brood + escapement)	403	2,167	4,496
Hatchery-origin Returns to Basin (brood + escapement + hatchery surplus)	5,116	9,465	9,049
Total Adult Returns to Basin	5,519	11,632	13,545

	Current (includes all releases)	Transition – Integrated and Segregated Programs Combined	Long Term – Integrated and Segregated Programs Combined
Imported Broodstock (HOR)	1,310	0	0
Local Broodstock (NOR)	-	279	465
Local Broodstock (HOR)	-	1,851	1,665
Natural-origin Escapement	403	1,888	4,031
Hatchery-origin Escapement (includes in-basin strays from seg. program)	3,772	3,700	3,413
Total Escapement	4,175	5,588	7,443
In-basin Strays from segregated program	3,323	443	443
Out-of-basin Strays (segregated fish straying to other basins)	369	49	49
Hatchery Surplus	1,344	3,471	3,529
Total Run Size (harvest + returns to Basin; includes in-basin and out-of-basin strays from seg. program)	13,701	27,441	34,287

3.6 OTHER ALTERNATIVES CONSIDERED

The proposed Chinook programs achieve the harvest goals described in *U.S. v Oregon*, meet treaty obligations, and achieve Yakama Nation cultural objectives. In addition, the integrated summer/fall Chinook program meets the conservation objectives of increasing the number of naturally-spawning summer/fall Chinook above Prosser Dam and increasing the spatial and temporal diversity of the population.

Other alternatives were considered but rejected because they either failed to achieve the identified goals in a timely manner consistent with legal agreements or were not scientifically sound. A brief description of the alternatives not carried forward, along with the rationale for this decision, is presented below.

Alternative A would keep the existing program as described in Section 3.3. This alternative was not carried forward for the following reasons:

- The current program uses mostly of out-of-basin broodstock. In separate reviews of this program, the HSRG (2009a) and USFWS Columbia Basin Hatchery Review Team (USFWS 2007b) recommended that this practice be discontinued and the program shift to local broodstock.

- The current program does not meet the Tribe's long-term harvest goals.
- The current program emphasizes the fall component of the summer/fall Chinook population and does not address the Tribe's goals for increasing spatial and temporal diversity of the population.

Under **Alternative B**, all hatchery releases of Chinook would be discontinued. The program would rely on habitat improvement actions and natural colonization by other stocks (e.g., Hanford Reach URBs) to produce the fish needed to achieve identified goals. Because the primary program goal of harvest would not be achieved for many decades under this alternative, it was eliminated from further consideration.

Finally, under **Alternative C**, the HSRG's recommendations for the fall-run Chinook program would be adopted (HSRG 2009a). The HSRG's recommendation to collect local broodstock will be adopted as part of the proposed program. However, the HSRG's recommendations do not address the summer-run component of the summer/fall Chinook population and would not achieve the Tribe's spatial and temporal diversity goals. The HSRG's analysis would also not meet the Tribe's long-term harvest goals. Therefore, this alternative was eliminated from further consideration.

3.7 CONSISTENCY WITH NPCC SCIENTIFIC PRINCIPLES

The Yakama Nation has made every effort to design the proposed Chinook programs to conform to the NPCC's eight scientific principles and major project review requirements. This section presents the principles and discusses how the proposed Chinook programs are consistent with each.

3.7.1 Principle 1: The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems

Language from the NPCC Fish and Wildlife Program further amplifies this principle:

> *"The physical and biological components of ecosystems together produce the diversity, abundance and productivity of plant and animal species, including humans. The combination of suitable habitats and necessary ecological functions forms the ecosystem structure and conditions needed to provide the desired abundance and productivity of specific species."*

The aquatic and terrestrial habitats present within and outside of the Yakima Basin determine the abundance, productivity, and diversity of the basin's fish populations. The quality and quantity of this habitat has been evaluated through field surveys and modeling efforts that have identified habitat factors likely limiting fish production in the basin. The primary limiting factors for summer- and fall-run Chinook salmon are high stream temperatures and changes in stream flow volumes, magnitude and timing. Strategies and actions to address these limiting factors were developed and incorporated into the Yakima Subbasin Plan (YSFWPB 2004). These actions are being implemented annually as funds allow and their effectiveness is being tracked over time through monitoring and evaluation efforts.

The biological objectives for the summer/fall Chinook program are based on Ecosystem Diagnosis and Treatment (EDT) and AHA modeling of the entire life cycle and ecosystem used by summer/fall Chinook (see Section 2.5.3), including the Yakima River Basin, Columbia River, Columbia River estuary and the Pacific Ocean. The analysis estimated potential summer/fall Chinook production in the basin over both the short term (transition phase; < 25 years) and long term (> 25 years). It showed that factors outside the basin will play an important role in determining whether the program will be successful. For example, summer/fall Chinook exploitation rates in ocean and freshwater fisheries are greater than 60 percent in most years. This level of harvest, combined with poor in-basin habitat quality, creates a situation where the naturally-spawning population is not sustainable under current habitat conditions without hatchery supplementation. Habitat actions proposed over the long term are expected to improve habitat quality and quantity to levels that will produce a sustainable population.

This Master Plan recognizes that humans also rely on the productivity of the ecosystem to provide societal needs, and that many of these needs are in direct conflict with the needs of other species. Treaties and legal agreements dictate that certain actions, for example fish harvest, will continue despite the negative effect fisheries may have on fish abundance. Agriculture in the basin requires large amounts of river water to grow the crops which produce hundreds of millions of dollars in revenue to farmers each year. Much of this water comes at the expense of aquatic species such as summer/fall Chinook that rely on it for all phases of their life-cycle.

Basin stakeholders have been working cooperatively to balance the needs of humans and fish. This balance is being improved by exploring selective fisheries, setting instream flows, guaranteeing water rights to farmers, screening diversions, implementing upland and riparian habitat actions designed to protect the riverine environment, and implementing projects such as this one in a well thought-out and scientifically justifiable manner.

3.7.2 Principle 2: Ecosystems are dynamic, resilient and develop over time

The NPCC Fish and Wildlife Program expands upon this principle by stating:

> *"Although ecosystems have definable structures and characteristics, their behavior is highly dynamic, changing in response to internal and external factors. The system we see today is the product of its biological, human and geological legacy. Natural disturbance and change are normal ecological processes and are essential to the structure and maintenance of habitats."*

Habitat conditions in the Yakima Basin have been degraded over time primarily due to human actions such as logging, agriculture, and urban development (YSFWPB 2004). These activities have contributed to the decline of habitat quality, quantity and fish abundance and influence what is biologically possible to achieve in the short and long term.

The Yakima Subbasin Plan (YSFWPB 2004) identifies limiting factors resulting from habitat degradation and proposes a number of strategies to restore habitat conditions closer to pre-development conditions. Implementing these strategies will help protect fish populations from catastrophic events as well as smaller scale disruptions. Habitat protection and restoration activities that take into account natural processes as well as human-caused changes require a long-term commitment.

Although the short-term goal of the program is focused on providing fish for harvest, in the long term, it is expected that habitat actions will increase natural fish population productivity, abundance and diversity to the point where the natural population will be self-sustaining. The program anticipates and relies on improvements in habitat to achieve long-term program goals. If achieved, this may allow a substantial portion of the hatchery program to be reduced or eliminated.

3.7.3 Principle 3: Biological systems operate on various spatial and time scales that can be organized hierarchically

The NPCC Fish and Wildlife Program language elaborates on this concept as follows:

> *"Ecosystems, landscapes, communities and populations are usefully described as hierarchies of nested components distinguished by their appropriate spatial and time scales. Higher-level ecological patterns and processes constrain, and in turn reflect, localized patterns and processes. There is no single, intrinsically correct description of an ecosystem, only one that is useful to management or scientific research. The hierarchy should clarify the higher-level constraints as well as the localized mechanisms behind the problem."*

The proposed URB harvest program and the summer/fall Chinook program would operate in separate areas in the Yakima River basin. The portion of the basin below Prosser Dam (RM 47) would be managed to maximize harvest of the Yakima River URB population. The upper portion of the basin above Prosser Dam would be managed to restore a locally-adapted Yakima summer/fall Chinook population, which would have both harvest and conservation objectives.

The major constraints limiting goal attainment in the basin result from legal agreements, high harvest rates, mainstem Columbia River hydropower development, and human use of basin water and land resources. All of these factors have been taken into consideration in program development. The use of artificial production to achieve identified goals is an indication that these constraints will not soon be eliminated. Humans will always need water, land and power to support an ever increasing population. The challenge is to develop a strategy that balances the needs of both humans and fish.

This Master Plan focuses on implementing actions that are within the control of the Tribe (and basin partners) to meet the harvest and long-term conservation objectives for the summer/fall Chinook program. Actions are designed to protect the population through each of the phases of their life-cycle that occur in the basin. Habitat improvement actions benefitting summer/fall Chinook are targeting conditions in the mainstem Yakima River, the area where summer/fall Chinook complete all freshwater life stages.

Water is at a premium in the Yakima Basin for both agriculture and municipal purposes, particularly in the summer. Such demands are the primary factors constraining production of most species of anadromous fish. Downstream improvement actions are focused on providing sufficient flows with the proper temperature regime to produce large numbers of healthy smolts and ensure the survival of adult migrants. Water diversions are being screened and the quality of irrigation returns improved to enhance aquatic ecosystem health.

Until habitat quality improves, Treaty harvest rights need to be met through artificial production. Long term, as habitat improves, it may be possible to rely more on natural Chinook production to achieve program objectives. When this occurs, hatchery production may be reduced or eliminated. However, the scale of habitat improvements will be tempered by the growing human population that will continue to place demands on natural resources such as water and land. It is likely that the Tribe will have to rely on artificial production to meet Treaty rights for many decades.

3.7.4 Principle 4: Habitats develop, and are maintained, by physical and biological processes

Elaborating on this, the NPCC Fish and Wildlife Program adds:

> *"Habitats are created, altered and maintained by processes that operate over a range of scales. Locally observed conditions often reflect more expansive or non-local processes and influences, including human actions. The presence of essential habitat features created by these processes determines the abundance, productivity and diversity of species and communities. Habitat restoration actions are most effective when undertaken with an understanding and appreciation of the underlying habitat-forming processes."*

Habitat conditions observed in a particular reach may signal that impacts are occurring elsewhere in the subbasin or at a larger scale. For example, changes in the amount and/or timing of stream flow or sediment input to a channel may be the result of human activity or natural processes in adjacent upland areas or stream reaches. Habitat actions and strategies proposed in the Yakima Subbasin Plan (YSFWBP 2004) emphasize actions at the watershed (subbasin) level rather than at the habitat unit scale. Strategies include:

- Protecting stream corridor structure and function
- Restoring passage and connectivity between habitat areas
- Restoring floodplain function and channel migration processes
- Restoring riparian condition
- Restoring normative flow regimes
- Restoring degraded water quality, including water temperature

The Subbasin Plan proposes a variety of actions to implement these strategies, taking into account the limited usefulness of some types of habitat actions as well as the acceptability of some actions to members of the public. The Tribe's proposed Chinook programs will not impede efforts to achieve these habitat goals.

3.7.5 Principle 5: Species play key roles in developing and maintaining ecological conditions

The NPCC Fish and Wildlife Program adds that:

> *"Each species has one or more ecological functions that may be key to the development and maintenance of ecological conditions. Species, in effect, have a distinct job or occupation that is essential to the structure, sustainability and productivity of the ecosystem over time. The existence, productivity and abundance of specific species depend on these functions. In turn, loss of species and their functions lessens the ability of the ecosystem to withstand disturbance and change."*

Anadromous fish returning to the Yakima River deliver marine-derived nutrients as their carcasses decompose after spawning in the basin. These nutrients increase stream productivity and provide a food source for both terrestrial and aquatic species (Cederholm et al. 2000).

Past salmon harvest management in the ocean and Columbia River and habitat degradation have contributed to decreased abundance of some species in the Yakima Basin which has, in turn, reduced the amount of nutrients being delivered. Release of hatchery summer/fall Chinook pursuant to *U.S. v Oregon* agreements helps mitigate for the loss of marine-derived nutrients in the mainstem Yakima River. Actions proposed in this Master Plan would improve delivery of marine-derived nutrients to the basin from both natural-origin and hatchery summer/fall Chinook salmon. It is expected that summer/fall Chinook abundance, diversity and spatial distribution would increase, helping to restore some lost functionality and increasing the resilience of the overall ecosystem.

The eggs, fry and juveniles produced by hatchery fish spawning naturally will provide food for other species such Mountain Whitefish, Cutthroat Trout and Rainbow Trout. An increase in food supply may increase the abundance, diversity and spatial structure of these native species.

3.7.6 Principle 6: Biological diversity allows ecosystems to persist in the face of environmental variation

Specific language from the NPCC Fish and Wildlife Program states:

> *"The diversity of species, traits and life histories within biological communities contributes to ecological stability in the face of disturbance and environmental change. Loss of species and their ecological functions can decrease ecological stability and resilience. It is not simply that more diversity is always good; introduction of non-native species, for example, can increase diversity but disrupt ecological structure. Diversity within a species presents a greater range of possible solutions to environmental variation and change. Maintaining the ability of the ecosystem to express its own species composition and diversity allows the system to remain productive in the face of environmental variation."*

The diversity of fish populations will be ensured primarily through habitat improvement and protection actions across the Yakima Basin and by re-establishing the summer component of the summer/fall Chinook population (YSFWBP 2004).

Habitat actions implemented throughout the historical range of these summer/fall Chinook will allow the development of spawning aggregates adapted to current environmental conditions. Spawning aggregates are expected to occur in the lower Naches River, middle Yakima River, Marion Drain, mouths of major tributaries and possibly below Prosser Dam.

3.7.7 Principle 7: Ecological management is adaptive and experimental

Elaborating on the seventh principle, the NPCC Fish and Wildlife Program states:

> *"The dynamic nature, diversity, and complexity of ecological systems routinely disable attempts to command and control the environment. Adaptive management — the use of management experiments to investigate biological problems and to test the efficacy of management programs — provides a model for experimental management of ecosystems. Experimental management does not mean passive "learning by doing," but rather a directed program aimed at understanding key ecosystem dynamics and the impacts of human actions using scientific experimentation and inquiry."*

This Master Plan includes a monitoring and evaluation program to track key Chinook performance metrics over time (e.g., in-hatchery metrics, HOR and NOR returns, Zone 6 and terminal harvest).

3.7.8 Principle 8: Ecosystem function, habitat structure and biological performance are affected by human actions

The NPCC Fish and Wildlife Program further explains that:

> *"As humans, we often view ourselves as separate and distinct from the natural world. However, we are integral parts of ecosystems. Our actions have a pervasive impact on the structure and function of ecosystems, while at the same time, our health and well-being are tied to these conditions. These actions must be managed in ways that protect and restore ecosystem structures and conditions necessary for the survival and recovery of fish and wildlife in the basin. Success depends on the extent to which we choose to control our impacts so as to balance the various services potentially provided by the Columbia River Basin."*

The common thread running through all eight scientific principles is the effect of human actions on anadromous fish and their habitats. This Master Plan, in concert with the Yakima Subbasin Plan (YSFWBP 2004), is designed to address both human-caused degradation of Yakima salmon stocks and the cultural, economic, commercial, and recreational importance of those stocks by restoring and increasing naturally-spawning populations and accommodating treaty harvest rights.

Habitat strategies in the Yakima Subbasin Plan address human degradation of stream habitat. It should be noted that this Plan does not account for, or assume, any improvements in habitat conditions in the mainstem Columbia or estuary. Subbasin strategies and actions are designed to target the key habitat factors limiting fish abundance, productivity, spatial structure, and life history diversity. A prioritization strategy has been developed to guide the action selection and implementation process.

Strategies under this Master Plan do not target habitat improvements; rather the programs attempt to balance the harvest rights of the Tribe with the impacts the hatchery programs and fisheries have on native fish communities.

Harvest will be monitored and in-season adjustments will be made when necessary. Selective sport fisheries that require anglers to release unmarked fish will be maintained throughout the basin. Tribal fisheries will be regulated using traditional time, area, and gear restrictions. The WDFW and other parties are investigating the use of selective fisheries in the ocean and lower Columbia River to reduce harvest impacts on summer/fall Chinook.

To further reduce human impacts to the ecosystem, these programs propose to:

- Convert to a locally-adapted broodstock
- Operate consistent with HSRG guidelines for segregated and integrated harvest programs when adult returns and natural production allow.
- Implement an adaptive management plan that uses attainment of performance indicators to drive hatchery operations and decisions.
- Reduce hatchery production over time as natural summer- and fall-run Chinook production is capable of achieving biological and legal objectives

3.8 SUBBASIN-WIDE RISK ASSESSMENT

The summer component of the Yakima summer/fall Chinook population has been extirpated, and the fall component has been dramatically reduced in abundance and influenced by releases from out-of-basin hatcheries. Therefore, the risks of using artificial production to increase the abundance of the summer- and fall-run components are deemed low. The fish that remain in the Yakima River basin are of recent hatchery origin. Domestication risks will be reduced by transitioning to local broodstock and eventually by transitioning the summer/fall Chinook program to an integrated population.

A potential program risk is straying of hatchery fish outside of the target basin. Straying may decrease the productivity of the natural populations inhabiting these areas. Hatchery strays will be minimized by transitioning to locally-adapted broodstock. To address the remaining risk, all hatchery fish will be marked with a coded wire-tag. The tag will allow hatchery fish to be identified if harvested or collected during carcass surveys or operations at other hatcheries. Additionally, groups of juveniles will be PIT-tagged prior to release so that upon return as adults, they may be detected as they pass through the FCRPS. If straying exceeds five percent, hatchery operations may be altered in an attempt to improve adult homing.

3.9 CONSISTENCY WITH NPCC ARTIFICIAL PRODUCTION PRINCIPLES

The Yakima Coho programs have been designed to be consistent with the NPCC artificial production principles, as described below.

1. ***The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.***

The Yakima summer/fall Chinook and URB fall Chinook programs are designed to provide harvest to meet tribal treaty rights established in law. Artificial production is appropriate for Yakima River summer/fall and URB Chinook because current habitat conditions and harvest rates are such that natural production cannot meet legal obligations or biological objectives.

The Yakama Nation is also investing heavily in habitat improvements throughout the basin. These actions are expected to increase the productivity of naturally produced summer/fall Chinook and other species. As natural fish abundance increases, reliance on hatchery production to meet harvest goals will decrease. However, the task of improving habitat conditions over time will be complicated due to the increasing need humans have for power, water and land resources. It will require a significant effort to simply maintain status quo habitat conditions in the Yakima Basin. Because of this, it is likely that artificial production will be needed for the foreseeable future.

2. ***Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.***

An adaptive management plan is a fundamental component of this program. It uses performance triggers to select when certain management strategies are implemented. An intensive monitoring and evaluation plan is already in place in the basin and will be used to track and determine the causes of program success or failure.

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.***

The program recognizes that factors outside of the Tribe's control may have a large effect on program success. Harvest levels in ocean and freshwater fisheries may take more than 60 percent of program adults on an annual basis. In addition, summer/fall Chinook migrating to and from the basin are lost in large numbers as they pass through the FCRPS dams. The effects of these external factors on fish survival are a major reason a 2.7 million fish hatchery program is required to achieve program goals.

Variable ocean conditions will also affect the number of hatchery- and natural-origin adults produced each year. The program accounts for this variability by setting minimum spawning escapement targets and adjusting in-basin harvest rates as needed to achieve these targets. Global climate change may cause stream temperatures in the Yakima River system to increase over time (Section 7.4.6). This change may be sufficient to overwhelm the beneficial actions being undertaken to improve habitat conditions in the basin.

If habitat quality does not increase, it is unlikely harvest benefits can be obtained from what will be limited natural Chinook production. Under this scenario, the need for hatchery production to achieve harvest goals will be even greater. Hatchery facilities are designed with sufficient infrastructure expansion capabilities to meet goals under such a future scenario.

4. ***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.***

The morphological, demographic and behavioral characteristics of hatchery summer/fall Chinook will be tracked and compared to the natural population to detect changes in these attributes over time. To reduce the chance of divergence in physical and genetic traits between the two components of the population, naturally produced Chinook will be incorporated into the integrated program broodstock at ever increasing rates as the natural run size increases. The segregated program will prioritize the use of local-origin adults as broodstock to produce fish with traits that have the highest survival potential possible.

The URB fall Chinook program in the lower Yakima will be managed as part of the Hanford Reach/Priest Rapids population. It will be segregated from the Yakima summer/fall Chinook population spawning upstream of Prosser. The contribution of URB spawners to the summer/fall escapement will be limited to less than five percent. Hatchery operations (such as acclimation) or program size will be altered if the target is not achieved.

Jacks will be incorporated into the integrated broodstock of the summer/fall Chinook program at rates similar to those observed in the natural population. Scale samples will be taken on naturally produced fish to determine size and age relationships for returning fish. This action will establish the size criterion separating adult and jack Chinook.

Summer/fall Chinook smolts will be released at between 70 and 90 fpp. This size range is similar to what has been observed for naturally produced smolts arriving at monitoring facilities in the lower Yakima River.

5. ***The entities authorizing or managing an 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.***

The Yakima URB fall Chinook program downstream of Prosser is strictly a harvest augmentation program. The primary goal of the summer/fall Chinook hatchery program is to provide fish for harvest pursuant to *U.S. v Oregon*. The secondary, more long-term goal is to produce sufficient adults to restore them to self-sustaining levels throughout the basin. Because of degraded habitat conditions, the Tribe recognizes that in all likelihood, this goal will not be met for decades. Thus, the purpose of summer/fall Chinook program is both harvest augmentation and conservation/re-colonization.

6. ***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.***

Hatchery production of URB fall and summer/fall Chinook in the Yakima River Basin is required under *U.S. v Oregon* to achieve tribal fishing rights as defined in law. The *U.S. v Oregon* Columbia River Fish Management Plan (1988) identified a short-term production goal for the Yakima Basin to release 1.7 million URB fall Chinook from the Little White Salmon Hatchery. The long-term production goal for the basin included construction of a Yakima hatchery with capacity to produce 3.0 million URB fall Chinook. The Columbia River Fish Management Plan also supported establishment of a new program under which the production of 200,000 URB fall Chinook would be converted to summer Chinook and identified the construction of a Yakima hatchery for regional (summer Chinook) supplementation as a long-term goal. The URB Chinook program downstream of Prosser is part of these agreements. Annual releases from the existing program have been coordinated with, and agreed to by federal, state and tribal fisheries managers. Summer/fall Chinook reintroduction is also outlined in the Yakima Subbasin Plan that was adopted by the NPCC (http://www.nwcouncil.org/fw/subbasinplanning/yakima/plan/). The reestablishment of extirpated salmon populations is an integral part of the basin planning process.

7. ***Appropriate risk management needs to be maintained in using the tool of artificial propagation.***

An adaptive management plan has been developed that sets triggers to determine when program changes should be made. For example, NOR run size is used to determine when to incorporate NORs into the broodstock. The programs will be operated consistent with HSRG (2009, 2014) recommendations to reduce genetic and ecological risks that the hatchery may pose to natural populations as conditions allow.

8. ***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.***

Harvest rates on Columbia River summer and fall Chinook are set by the terms of *U.S. v Oregon*. Harvest rates are intended to provide sufficient fish to meet treaty rights while at the same time protecting ESA listed salmonids in the Columbia River. Because Yakima River summer and fall Chinook are captured in the same fisheries as naturally produced fish from the Columbia River, harvest rates are similar. These rates are not meant to protect the naturally produced Yakima summer Chinook population. Since this population was extirpated around 1970, pre-terminal fisheries protection of this population as it is reestablished has not yet been a high management priority. The harvest rates are therefore not conducive for the recovery of the low productivity (recruit per spawner < 1.0) Yakima River summer/fall Chinook stock. Harvest rates may need to change in the future if it appears that a self-sustaining population can be established in the basin. The need for such change will be discussed in future updates of the *U.S. v Oregon* management plan.

9. ***Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.***

The Chinook program is required to meet tribal treaty rights. The size of the current program has been agreed to by the parties to *U.S. v Oregon*. The size of the programs proposed in this Master Plan will be sent to the pertinent parties for approval as well. All other relevant legal mandates for fish protection, mitigation and enhancement will be incorporated into the program.

3.10 HATCHERY AND GENETIC MANAGEMENT PLAN

A draft HGMP for the existing summer/fall and URB fall Chinook hatchery programs is attached as Appendix B. If the programs described in the Master Plan are implemented, the HGMP would be revised to incorporate the new programs and facilities.

4.0 SUMMARY OF STEELHEAD KELT PROGRAM

4.1 POPULATION STATUS

The Yakima River Basin once supported abundant and diverse runs of salmon and steelhead that now return in just a fraction of their historical numbers (ICTRT 2007). The Yakima River steelhead major population group (MPG) is part of the Middle Columbia River Steelhead distinct population segment (DPS), which is listed as threatened under the Endangered Species Act (ESA). Fish from the Yakima River Steelhead Kelt Reconditioning Program are considered part of the ESA-listed DPS.

The Yakima River MPG is believed to consist of four individual, genetically unique populations spawning in the following areas: the Upper Yakima River, including the mainstem and all tributaries above the confluence with the Naches River; the Naches River system including Ahtanum Creek and Yakima Mainstem extending from the confluence of the Naches down to Toppenish Creek; Toppenish Creek; and Satus Creek (Figure 1).

Adult population and productivity metrics for the Yakima River steelhead MPG are trending upwards (Table 4-3). For the most recent five run years (June 30, 2014 to July 1, 2019) mean annual abundance was 2,634 wild steelhead for the MPG and 291 wild steelhead for the portion of the Upper Yakima population spawning above Roza Dam. This compares to average annual abundance estimates of about 1,400 steelhead for the MPG and fewer than 25 steelhead for the Upper Yakima population (proportion spawning above Roza Dam) in the 1980s and 1990s. Freshwater and marine environmental conditions have changed and the past three run years (June 30, 2016 to July 1, 2019) have been below the 1991-2010 average.

Yakama Nation Fisheries is collaborating with a number of agencies including the Columbia River Inter-Tribal Fish Commission and the Yakima Subbasin Fish and Wildlife Recovery Board to recover ESA-listed steelhead populations in the Yakima River Basin. The Tribe is using a combination of habitat actions and wild steelhead kelt reconditioning to achieve restoration goals. In recent years, Yakima River steelhead have comprised an increasing proportion of the Bonneville Dam count. Yakima River steelhead may be experiencing greater productivity and survival than other steelhead populations above Bonneville Dam due to improved freshwater rearing conditions within the Yakima basin. Habitat restoration actions in the Yakima River Basin, the Yakima kelt reconditioning program, and ongoing efforts to improve fish passage and limiting factors in the Yakima Subbasin may have contributed to this trend.

The recovery plan (NMFS 2009) did not identify the release of spring Chinook salmon, fall Chinook salmon, or Coho salmon as a factor limiting the productivity of the Yakima River MCR steelhead populations. The Yakima Recovery Plan (YBFWRB 2009) supported the continued reintroduction of Coho salmon, Sockeye salmon, and summer Chinook salmon identifying these actions as potentially increasing the flow of marine-derived nutrients into salmon and steelhead rearing areas in the Yakima River Basin.

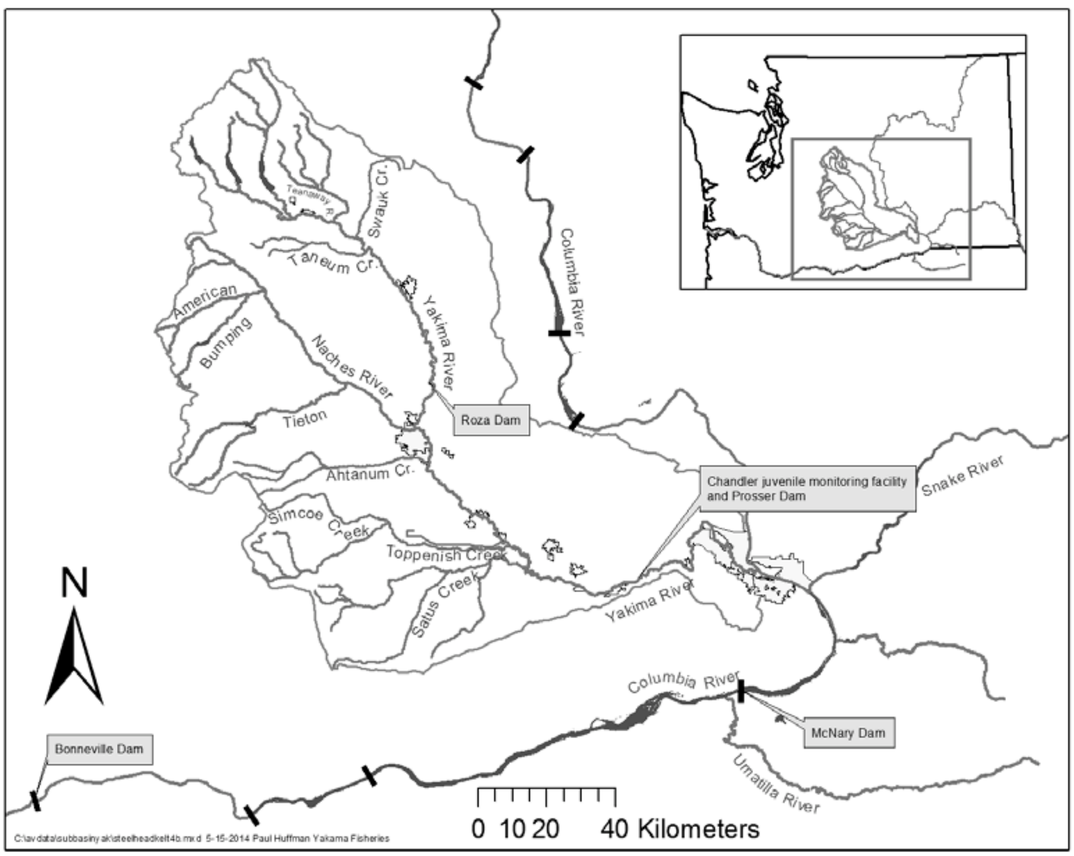


Figure 4-1. Yakima River Basin showing major steelhead streams and monitoring locations (map courtesy of Paul Huffman).

4.2 HABITAT CONTEXT

Many factors affect the abundance, productivity, spatial structure, and diversity of the Yakima River MPG steelhead populations. Habitat modifications in the Yakima River Basin, including flow regulation, irrigation activities, and development in floodplain, riparian, and upland areas, have had the most deleterious effects on steelhead. The Yakima Recovery Plan (YBFWRB 2009) identified 5 major in-basin factors for decline:

1) Alteration of stream flows due to development of irrigation systems, including both the dewatering of lower reaches in many tributaries and the high and low flows in the mainstem Yakima and Naches rivers associated with water storage and delivery from upstream reservoirs.

2) Creation of passage barriers associated with both small and large diversion dams, road crossings, and Bureau of Reclamation (BOR) storage dams.

3) Reduction in floodplain function due to diking, channel simplification, and floodplain development for agricultural and urban uses.

4) Impacts on riparian areas and upland hydrology due to past and, to a lesser extent current, grazing and forestry practices.

5) Changes in ecological dynamics, including reduction in beaver populations, reductions in delivery of oceanic nutrients to headwaters by salmon, introduction of exotic species, and increased predation by native species.

There are many restoration and passage improvement projects in the Yakima River Basin overseen by the YBFWRB and funded through the Salmon Restoration Funding Board (SRFB). Examples of restoration actions in the action area include improved fish passage in Cowiche Creek and in Taneum Creek that will also restore channel complexity, refuge areas, and riparian habitats. In 2011, land was purchased to protect and restore fish habitat adjacent to the Naches River, Reecer Creek, and along the Yakima River in Ellensburg, Washington (YBFWRB 2009). Similarly, numerous projects funded by BPA have occurred within the Yakima River Basin, including bank stabilization, levee set-back, riparian plantings and fencing, barrier removal, and side-channel restoration (YRWP 2012).

More details about ongoing and recently completed habitat restoration projects are in Table 7-4 and Section 7.3.

4.3 CURRENT STEELHEAD KELT PROGRAM

4.3.1 Kelt Reconditioning Program

The Yakima Kelt Reconditioning program collects steelhead kelts (post-spawned adult steelhead) to recondition them so that they can be released into the Yakima River to spawn again. Steelhead kelt reconditioning is the practice of capturing, holding, and feeding post-spawned steelhead in an artificial rearing environment for the purpose of regeneration of gonads for repeat spawning. After 6 months, the reconditioned kelts are released back into the river.

From 2001 to 2018, a total of 9,589 out-migrating kelts were collected at the Chandler Juvenile Monitoring Facility (Table 4-1). All captured fish were PIT tagged for individual re-identification during reconditioning and following release. Kelts were held at Prosser Hatchery. The average survival rate of kelts to release was 48%. On average, 532 kelts were collected and 234 were released. The majority (>92%) of kelts were female (Hatch et al. 2019).

Reconditioned kelts were released upstream of Prosser Dam from 2001 to 2007 and a few kilometers downstream of Prosser Dam from 2008 to present. Reconditioned kelts are released into the river from mid-October to early December when the majority of the natural run is returning from the ocean. Reconditioned fish mingle with the natural run and proceed to overwintering locations and on to the spawning grounds in spring. The release location was selected to allow reconditioned kelts to migrate upstream volitionally and choose their spawning location. Spawning in the Yakima River basin generally peaks from early March to early May, depending on the elevation of the stream. The timing of upstream migration by reconditioned kelts in 2008-present was determined based on PIT tag detections at Prosser Dam.

Table 4-1. Yakima Basin steelhead kelts reconditioned at Prosser Hatchery, number of kelts released, and survival rate to release, 2001 to 2018. Source: Yakama Nation.

Year	Number of Kelts Collected	Number of Reconditioned Kelts Released	Survival to Release
2001	508	108	21.3%
2002	420	142	33.8%
2003	482	301	62.4%
2004	694	288	41.5%
2005	427	86	20.1%
2006	279	85	30.5%
2007	422	221	52.4%
2008	472	266	56.4%
2009	510	141	27.6%
2010	1,100	426	38.7%
2011	680	223	32.8%
2012	572	333	58.2%
2013	575	308	53.6%
2014	481	316	74.4%
2015	1,098	435	43.4%
2016	525	341	73.0%
2017	117	84	71.8%
2018	227	152	67.0%
Total	*9,589*	*4,214*	*43.9% (pooled)*
Average	*532*	*234*	*47.7%*

The Tribe's research has found that kelts captured at the Chandler Juvenile Monitoring Facility (CJMF) survive well through the long-term reconditioning process at Prosser Hatchery. From 2000-2018, 9,589 kelts were collected at the CJMF and 4,214 survived through the first fall of the collection period (43.9% pooled survival rate; Yakama Nation). During the past five years (2014-2018), survival has averaged

66%. Post-release upstream migratory patterns of reconditioned kelt steelhead mimic those of upstream pre-spawn steelhead migrants (Hatch et al. 2013).

Table 4-2 gives the count of upstream migrating ocean-returning steelhead, reconditioned kelts released that were subsequently detected migrating upstream[10], and the combined total steelhead run year count at Prosser Dam for the most recent 11 return years. The percentage of the total return that consisted of actively migrating reconditioned kelts averaged 4.0% over these 11 years. Since we know reconditioned kelts are predominantly female, these data demonstrate a substantial and measurable contribution to overall population demographics in comparison to no intervention. Based on average survival to release (~50%; Table 4-1) and release to spawning ground migration (~50%; Table 4-2), approximately 25% of kelts collected for reconditioning are expected to migrate to the spawning grounds.

Table 4-2. Contribution to steelhead run from reconditioned kelts released in the Yakima basin.

Run Year	Ocean Return	Reconditioned Kelts[1]	Total	Reconditioned Kelts
2008-09	3,378	91	3,469	2.6%
2009-10	6,750	46	6,796	0.7%
2010-11	6,043	153	6,196	2.5%
2011-12	6,301	58	6,359	0.9%
2012-13	4,556	231	4,787	4.8%
2013-14	4,039	104	4,143	2.5%
2014-15	5,096	116	5,212	2.2%
2015-16	3,737	216	3,953	5.5%
2016-17	1,462	155	1,617	9.6%
2017-18	1,335	53	1,388	3.8%
2018-19	998	95	1,093	8.7%

1 Kelts detected migrating upstream (natural and hatchery-origin).

The reproductive success of long-term reconditioned kelts is being explored to assess the net benefit of the kelt reconditioning program (for the latest results see Hatch et al. 2019). Specific questions regarding the success of artificially reconditioning kelt steelhead include: 1) Do reconditioned kelts produce viable offspring that contribute to recruitment, 2) How does artificially reconditioned kelt reproductive success compare with natural repeat spawner success, and 3) How does artificially reconditioned kelt reproductive success compare with first time spawner success?

Here is a short summary of results from each objective:

1) Do reconditioned kelts produce viable offspring that contribute to recruitment, and 3) How does artificially reconditioned kelt reproductive success compare with first time spawner success?

We found that reconditioned kelts had greater mass, length, and mass at length than did maiden spawners. When standardized for size, skip spawners had greater total, individual, and dry egg mass than maiden and consecutive spawners; consecutive spawners had lower individual egg mass than

[10] Based on detection at Prosser or Roza Dams or any of the instream PIT tag arrays.

maiden spawners but higher fecundity. Increases in fecundity and egg size suggest that reconditioned kelts released to spawn naturally may be more productive than maiden spawners (Jenkins et al. 2018).

2) How does artificially reconditioned kelt reproductive success compare with natural repeat spawner success.

This is unknown. Repeat spawners make up an extremely small portion of the run, and finding them, tracking them to the spawning grounds, and capturing their progeny is nearly impossible with current technology.

Beginning in 2013, the Tribe genotyped representative first time spawners, kelts following spawning, and reconditioned kelts for use in parentage analysis. This information is being used to generate relative reproductive success (RRS) and lifetime reproductive success (LRS) estimates to determine the effects of the program. The lifetime relative reproductive success (RRS) of kelts compared to maiden (first time) spawners was 3.27 for males and 2.36 for females[11] (Hatch et al. 2019). This is similar to findings by Seamons and Quinn (2010). While relative reproductive success of female reconditioned kelts following reconditioning (i.e., reproductive success at the second spawning) is slightly lower (average RRS = 0.94) than reproductive success at the first spawning (1.42), any spawning by a reconditioned kelt is additive to the population and demonstrates the potential to boost numbers (Hatch et al. 2019).

Overall, the Tribe's research has demonstrated that steelhead kelt reconditioning increases repeat spawner abundance and provides recovery benefits in river systems that have experienced substantial losses in natural productivity due to loss of habitat and habitat connectivity.

4.3.2 Escapement

Summer-run steelhead in the Yakima River Basin are enumerated at Prosser and Roza Dams (Rkm 75.6 and Rkm 205.8 respectively) using video equipment installed in adult fish ladders. Fish are denoted as hatchery- or natural-origin based on presence or absence, respectively, of observed external or internal marks. For the most recent 10 return years, both the aggregate MPG and the Upper Yakima population returns have averaged greater than 98% wild with some hatchery-origin strays from other Columbia River Basin tributaries (Table 4-3).

Trends in annual abundance of Yakima River MPG steelhead (Prosser Dam) and Upper Yakima steelhead (Roza Dam) are increasing (Table 4-3). For the most recent five run years (June 30, 2014 to July 1, 2019) mean annual abundance was 2,634 wild steelhead for the MPG and 291 wild steelhead for the portion of the Upper Yakima population spawning above Roza Dam. This compares to average annual abundance estimates of about 1,400 steelhead for the MPG and fewer than 25 steelhead for the Upper Yakima population (proportion spawning above Roza Dam) in the 1980s and 1990s.

Steelhead counts at Prosser Dam represent total adult escapement for the Yakima River MPG. The large geographic distribution of steelhead in the Yakima Basin results in diverse pre-spawning migration and holding patterns that influence the proportion of fish that survives to spawn. Historically, there have been no reliable means of estimating population-specific spawner abundances due to limited methods, enumeration points, and unknown pre-spawn mortality rates. The YN conducted a 3 year radio

[11] Lifetime reproductive success of female kelts included reproductive success at the first spawning (1.42) and second spawning (0.94), which sums to 2.36.

telemetry study that estimated spawner escapement for the Yakima River steelhead populations including the Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River populations (Frederiksen et al. 2015). In addition to estimating spawner escapement for 3 consecutive years, data from the study will be used to assess potential long-term monitoring methods including the use of GSI and PIT-tagging techniques for apportioning the total run at Prosser Dam.

Adult productivity indices for Yakima River MPG steelhead are presently trending upward (Figures 4-2 and 4-3). Figure 4-3 indicates that Yakima River MPG steelhead are experiencing higher survival relative to other steelhead populations above Bonneville Dam.

Table 4-3. Yakima Basin steelhead counts at Prosser and Roza Dams, 1983-2019.

Run Year[1]	Prosser Dam			Roza Dam		
	Wild	Hatchery[2]	Total	Wild	Hatchery[2]	Total
1983-84	911	229	1,140	15	0	15
1984-85	1,975	219	2,194	6	0	6
1985-86	2,012	223	2,235	3	0	3
1986-87	1,984	481	2,465	0	0	0
1987-88	2,470	370	2,840	0	0	0
1988-89	1,020	142	1,162	0	0	0
1989-90	686	128	814	0	0	0
1990-91	730	104	834	0	0	0
1991-92	2,012	251	2,263	107	9	116
1992-93	1,104	80	1,184	15	0	15
1993-94	540	14	554	28	0	28
1994-95	838	87	925	22	1	23
1995-96	451	54	505	90	2	92
1996-97	961	145	1,106	22	0	22
1997-98	948	165	1,113	51	0	51
1998-99	1,018	52	1,070	14	0	14
1999-00	1,571	40	1,611	14	0	14
2000-01	3,032	57	3,089	133	7	140
2001-02	4,491	34	4,525	232	5	237
2002-03	2,190	45	2,235	128	6	134
2003-04	2,739	16	2,755	212	2	214
2004-05	3,377	74	3,451	224	3	227
2005-06	1,995	10	2,005	120	2	122
2006-07	1,523	14	1,537	59	0	59
2007-08	3,025	285	3,310	171	5	176
2008-09	3,444	25	3,469	206	0	206
2009-10	6,602	194	6,796	311	15	326
2010-11	6,064	132	6,196	336	10	346
2011-12	6,206	153	6,359	398	6	404
2012-13	4,516	271	4,787	280	18	298
2013-14	4,083	60	4,143	372	4	376
2014-15	5,181	31	5,212	470	5	475

Run Year[1]	Prosser Dam			Roza Dam		
	Wild	Hatchery[2]	Total	Wild	Hatchery[2]	Total
2015-16	3,938	15	3,953	470	3	473
2016-17	1,604	13	1,617	245	2	247
2017-18	1,372	16	1,388	150	0	150
2018-19	1,075	18	1,093	119	3	122
						Means:
1983-19	*2,436*	*118*	*2,554*	*140*	*4*	*143*
2009-19	*4,064*	*90*	*4,154*	*315*	*7*	*322*
2014-19	*2,634*	*19*	*2,653*	*291*	*3*	*293*

1 July 1 to June 30 run year.

2 WDFW Skamania-stock hatchery plants were discontinued in the early 1990s; observed adipose clipped steelhead at Prosser and Roza Dams are out-of-basin strays. The hatchery count does not include reconditioned kelts. Reconditioned kelts are counted as wild fish and are also included in the total column.

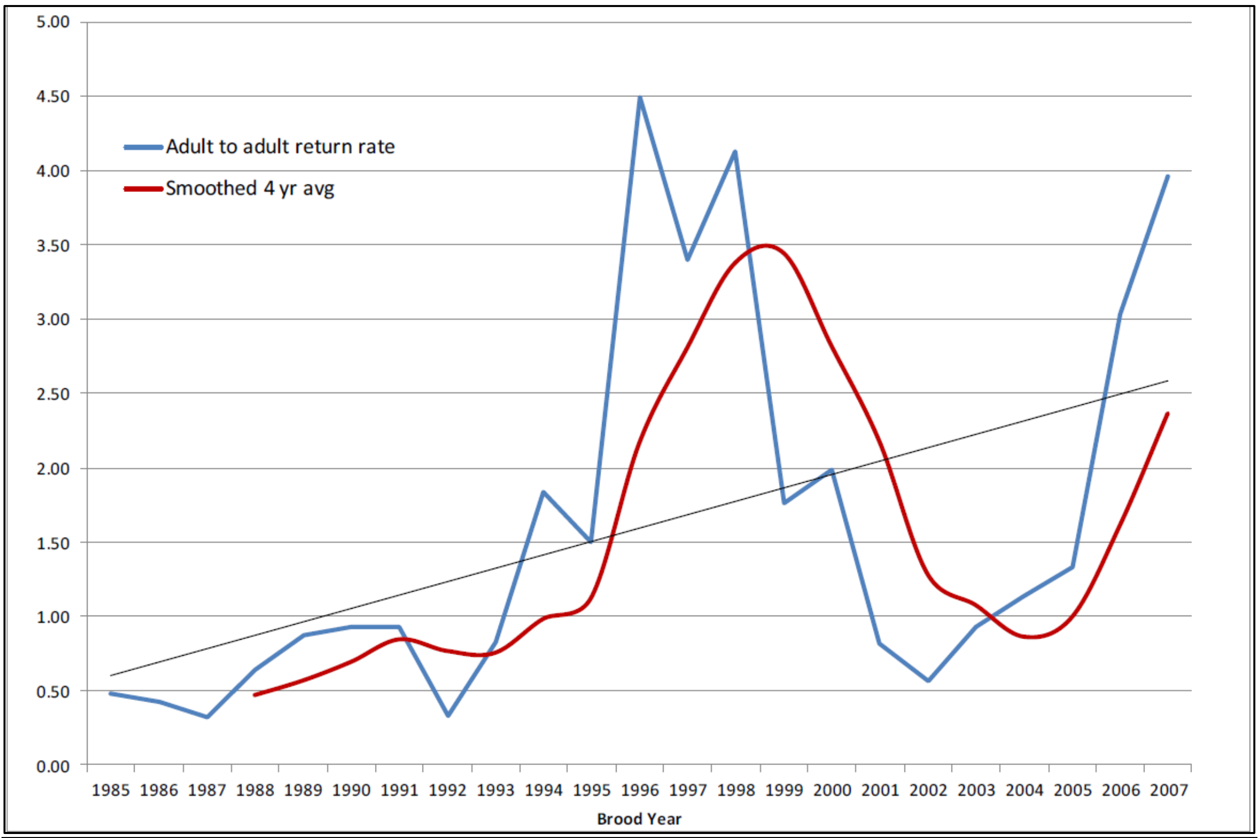


Figure 4-2. Adult-to-adult return indices for Yakima River MPG steelhead. The smoothed line represents a four-year running average.

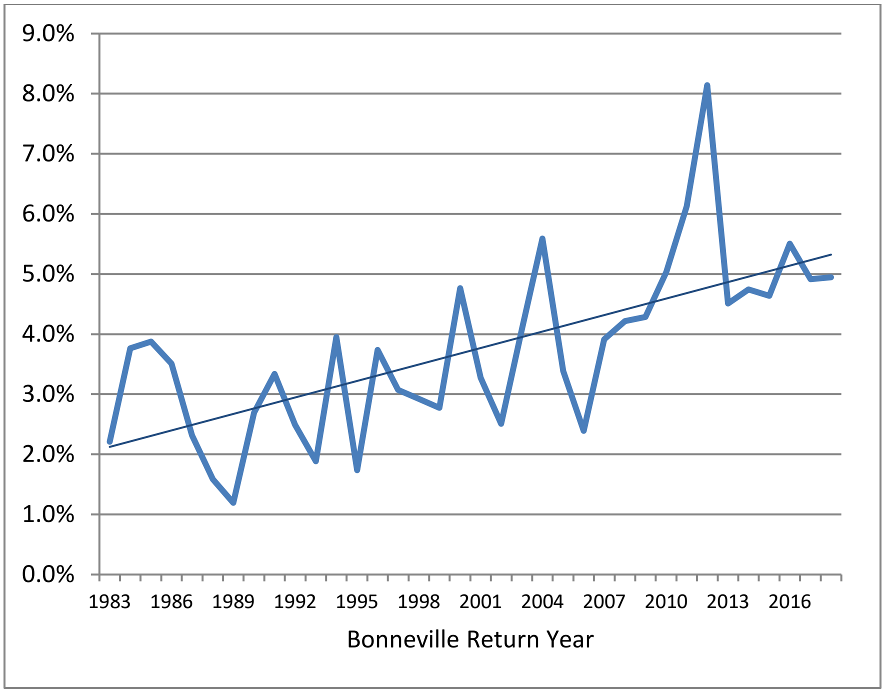


Figure 4-3. Yakima River MPG steelhead (Prosser wild abundance) as a percentage of Bonneville Dam wild Group A steelhead abundance, 1983 to 2018.

4.3.3 Juvenile Abundance

Steelhead smolts entrained into the Chandler Canal at Prosser Dam and representing the entire Yakima steelhead MPG are counted throughout the outmigration period each year (generally late winter through early summer). Smolt counts can be expanded to total downstream passage if the flow-dependent entrainment rate and the survival rate from the diversion headgate to the counting facility can be reliably estimated. On average, approximately 50,000 outmigrating smolts have been detected at Prosser (Table 4-4). The post-harvest SAR index has averaged about 6% (geomean 4%).

Table 4-4. Yakima River MPG natural-origin steelhead smolt (estimates at Prosser) by brood year and outmigration year. Returning natural-origin adults counted at Prosser 2 years after that smolt migration, and surrogate smolt-to-adult return (SAR) index, 1988-2012. Note these data are preliminary and subject to change. DO NOT CITE.

Year	Steelhead Smolts[1]		Adults[2]		SARs	
	Brood Year	Outmigrant Year	Produced by Brood Year	Produced by Outmigrant Year	Brood Year Cohort	Outmigrant Year Cohort
1985	93,477	83,461	1,001	1,700	1.07%	1.89%
1986	86,944	96,639	917	1,877	1.05%	1.81%
1987	49,194	89,657	786	917	1.60%	0.95%
1988	41,009	61,338	1,672	879	4.08%	1.33%
1989	38,058	38,536	927	1,004	2.44%	2.42%
1990	45,864	31,206	673	1,549	1.47%	4.62%

Year	Steelhead Smolts[1]		Adults[2]		SARs	
	Brood Year	Outmigrant Year	Produced by Brood Year	Produced by Outmigrant Year	Brood Year Cohort	Outmigrant Year Cohort
1991	30,238	29,933	679	875	2.25%	2.72%
1992	25,875	50,104	667	624	2.58%	1.16%
1993	31,837	24,529	907	687	2.85%	2.60%
1994	47,003	26,748	993	625	2.11%	2.17%
1995	86,760	26,331	1,261	932	1.45%	3.29%
1996	102,951	69,454	2,021	962	1.96%	1.29%
1997	72,490	117,771	3,263	1,229	4.50%	0.97%
1998	36,602	70,297	3,914	1,994	10.69%	2.64%
1999	47,597	36,293	1,809	2,641	3.80%	6.77%
2000	33,168	45,127	3,191	4,661	9.62%	9.60%
2001	46,122	31,391	2,473	1,099	5.36%	3.26%
2002	39,044	42,522	2,544	3,570	6.52%	7.81%
2003	46,343	32,599	2,136	3,052	4.61%	8.71%
2004	43,427	37,915	3,163	1,806	7.28%	4.43%
2005	26,113	50,550	4,527	2,040	17.34%	3.75%
2006	22,083	18,265	6,054	3,175	27.41%	16.85%
2007	28,527	30,650	5,977	4,489	20.95%	14.07%
2008	45,380	26,251	N/A	6,227	N/A	23.65%
2009	68,098	28,754	N/A	5,908	N/A	20.55%
2010	N/A	57,948	N/A	N/A	N/A	N/A
2011	N/A	76,000	N/A	N/A	N/A	N/A
2012	N/A	83,000	N/A	N/A	N/A	N/A
Mean	*49,368*	*50,474*	*2,242*	*2,181*	*6.22%*	*5.97%*
Geomean	*45,138*	*44,758*	*1,752*	*1,701*	*3.95%*	*3.77%*

1 Juvenile age data available from 1985-2007. 2008-09 used average age structures from prior years.

2 Adult age data available 1986-87, 1990-92, 2002-2005. All other years used averages from available years.

4.3.4 Run Timing, Sex Ratio, and Size of Kelts

Steelhead residing in the Yakima Basin are classified as summer-run based on their July-September run timing at Bonneville Dam. Adult run timing in the Yakima Basin typically begins in late August or early September and extends into May of the following year. After crossing Prosser Dam, the majority of fall migrants overwinter in mainstem areas near the mouths of Satus and Toppenish Creeks. Part of the run continues upstream and overwinters in mainstem areas extending up to and above Roza Dam. Steelhead will typically move upriver into tributaries when spawning begins the following spring. Post-spawned (kelt) and juvenile steelhead downstream passage at Prosser Dam is similar, generally occurring from March-June.

Adult steelhead migrants to the Yakima River Basin are predominantly female, with mean annual percentage female rates ranging from 62-83% (mean 70.3%) at Prosser Dam and from 67-84% (mean 74.5%) at Roza Dam. Downstream migrating kelt steelhead in the Yakima River Basin are even more skewed towards females, with mean annual percentage female rates ranging from 82-95% (mean 89.6%) at the CJMF (Table 4-5). Post-spawn survival in steelhead has been reported to be higher for females than for males (Keefer et al. 2008; Seamons and Quinn 2010; Hatch et al. 2013).

The vast majority (about 95%) of MPG steelhead returning to the Yakima River Basin are in the "Group A" size management range (< 78cm fork length) which is used for fishery management purposes in the Columbia River Basin. Mean annual fork lengths of downstream migrating kelt steelhead sampled at the CJMF from Jan. 1, 2001 to June 30, 2015 ranged from about 58-69 centimeters (cm) and averaged 63.9 cm for females and 60.2 cm for males (Table 4-6).

Table 4-5. Sex ratio of downstream migrating kelt steelhead sampled at the Chandler juvenile fish monitoring facility, Jan. 1, 2001-June 30, 2018.

Year	Females	Males	Percent Female	First Date Observed	Last Date Observed
2001	525	29	94.8%	03/12/01	06/20/01
2002	1,	116	89.7%	03/11/02	06/13/02
2003	774	51	93.8%	03/12/03	06/21/03
2004	874	121	87.8%	03/15/04	06/21/04
2005	750	79	90.5%	03/01/05	06/23/05
2006	489	44	91.7%	01/25/06	06/08/06
2007	507	74	87.3%	03/26/07	05/31/07
2008	756	97	88.6%	03/21/08	06/23/08
2009	567	49	92.0%	04/09/09	06/03/09
2010	1,437	218	86.8%	03/19/10	06/23/10
2011	880	110	88.9%	03/17/11	06/15/11
2012	604	71	89.5%	03/16/12	06/29/12
2013	609	74	89.2%	03/15/13	06/25/13
2014	469	104	81.8%	03/21/14	06/26/14
2015	1,158	130	89.9%	03/17/15	06/05/15
2016	495	82	85.8%	03/16/16	06/25/16
2017	125	8	94.0%	04/04/17	06/30/17
2018	226	21	91.5%	03/19/18	06/16/18
Average			*89.6%*		

Table 4-6. Sample size (N), mean fork and post-eye to hypural plate (POH) lengths (cm), and weights (pounds) of downstream migrating kelt steelhead sampled at the Chandler juvenile fish monitoring facility, Jan. 1, 2001-June 30, 2018.

Year	Females				Males			
	N	Fork	POH	Weight	N	Fork	POH	Weight
2001	511	64.9	52.6	4.5	25	60.4	48.6	3.9
2002	987	63.3	51.0	4.4	101	61.2	48.0	4.0
2003	774	68.8	56.4	5.6	51	63.1	50.1	4.4
2004	874	60.5	49.6	3.7	121	58.6	46.7	3.5
2005	750	63.6	53.0	4.2	79	59.2	47.7	3.6
2006	489	66.7	56.1	4.8	44	63.5	52.0	4.4
2007	509	64.4	54.0	4.6	76	61.8	50.4	4.1
2008	756	62.1	51.8	4.1	97	61.2	49.8	3.9
2009	568	64.6	54.1	4.6	51	60.6	49.7	3.9
2010	1,437	62.2	52.3	4.0	218	60.7	50.2	3.8
2011	880	64.7	54.8	4.7	110	59.6	49.0	3.7
2012	604	64.0	54.3	4.6	72	59.1	48.8	3.8
2013	609	64.7	54.7	4.7	74	58.8	48.7	3.7
2014	469	60.8	51.0	3.5	104	57.8	47.1	3.0
2015	1,158	63.5	53.5	4.0	130	57.2	47.1	3.0
2016	495	63.8	53.8	4.3	82	60.4	49.7	3.7
2017	125	66.0	54.9	4.2	8	66.6	53.1	4.3
2018	226	61.7	51.6	3.5	21	61.7	50.0	3.8

4.3.5 Harvest

The Yakima River Basin was closed to steelhead fishing in 1994. In 1990, WDFW incorporated catch-and-release and selective gear restrictions for trout fishing in important Rainbow Trout/steelhead spawning and rearing habitats in the Yakima River mainstem between Roza Dam and Easton Dam. Selective gear rules (no bait, lures or flies only with single barbless hooks) during trout fishing have been implemented in tributaries to reduce incidental impacts on listed steelhead.

Fisheries for Coho salmon and fall Chinook salmon occur during a portion of the steelhead migration. The areas at the mouths of Satus Creek and Toppenish Creek are closed to fishing to protect steelhead staging prior to entering the tributaries to spawn. Spring Chinook salmon fisheries in the Yakima River are closed and only open by special rule changes. The spring Chinook salmon fisheries are limited to parts of the Yakima River below Prosser Dam and from Union Gap to below Roza Dam. In all of these fisheries, all steelhead must be immediately released unharmed and cannot be removed from the water prior to release.

Tribal harvest has remained very low and it is estimated that fewer than 10 steelhead are harvested annually in combined treaty and recreational Yakima Basin terminal fisheries. Harvest of steelhead in areas outside the Yakima River also occurs. Impacts from mainstem treaty and non-treaty fisheries have been estimated to be less than 10% of the Yakima River MPG natural-origin return (NMFS 2008c).

4.4 KELT RECONDITIONING PROGRAM

The number of steelhead kelts collected at Prosser Dam and reconditioned at Prosser Hatchery is determined by the proportion of the downstream migration that is diverted into the Chandler irrigation canal and varies annually with varying river conditions. The intent of this Master Plan is to describe the program and facility upgrades necessary to permanently accommodate a kelt reconditioning program of up to 1,500 steelhead kelts. An overview of the program is presented in Table 4-7. The remainder of section 4.4 presents details on the program.

Table 4-7. Overview of Yakima Steelhead Kelt Reconditioning program.

<table>
<tr><th></th><th colspan="6">Yakima Steelhead Kelt Reconditioning Program</th></tr>
<tr><td>Associated Natural Population</td><td colspan="6">Yakima River Steelhead MPG (4 populations)</td></tr>
<tr><td>ESU</td><td colspan="6">Mid-Columbia Steelhead ESU</td></tr>
<tr><td>ESA Status</td><td colspan="6">Threatened</td></tr>
<tr><td>Spawning Area</td><td colspan="6">Upper Yakima River, including the mainstem and all tributaries above the confluence with the Naches River; the Naches River system including Ahtanum Creek and Yakima Mainstem extending from the confluence of the Naches down to Toppenish Creek; Toppenish Creek; and Satus Creek</td></tr>
<tr><td>Program Purpose</td><td colspan="6">Increase the number of repeat spawners in the Yakima River MPG populations and increase the overall number of naturally-spawning steelhead in the system.</td></tr>
<tr><td>Harvest Goals</td><td colspan="6">Restore harvest opportunities for terminal fisheries in the Yakima Basin</td></tr>
<tr><td>Yakama Nation Cultural Goals</td><td colspan="6">Natural spawning of Steelhead over historic range and time periods in the Yakima River. Meet ceremonial and subsistence requirements.</td></tr>
<tr><td rowspan="8">Conservation Goals[1] for Natural Population</td><td rowspan="3">Population</td><td colspan="5">Natural Production</td></tr>
<tr><td colspan="2">Abundance</td><td colspan="3">Potential Goal Range</td></tr>
<tr><td>Recent</td><td>Historical</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>Satus Creek</td><td>1,100</td><td>4,000</td><td>1,000</td><td>1,500</td><td>2,000</td></tr>
<tr><td>Toppenish Creek</td><td>500</td><td>3,400</td><td>500</td><td>1,000</td><td>1,500</td></tr>
<tr><td>Naches River</td><td>1,200</td><td>8,400</td><td>1,500</td><td>3,450</td><td>5,400</td></tr>
<tr><td>Upper Mainstem</td><td>200</td><td>10,400</td><td>500</td><td>1,500</td><td>7,700</td></tr>
<tr><td>Total Yakima MPG</td><td>3,000</td><td>26,200</td><td>3,500</td><td>7,450</td><td>16,600</td></tr>
<tr><td>Kelt Collection Locations</td><td colspan="6">Prosser Dam</td></tr>
<tr><td>Program Size</td><td colspan="6">Up to 1,500 wild/natural kelts</td></tr>
<tr><td>Facility</td><td colspan="6">Prosser Hatchery used to temporarily recondition wild/natural kelts in artificial environment to increase survival to repeat spawner</td></tr>
<tr><td>Marking/Tagging</td><td colspan="6">100% PIT tagged</td></tr>
</table>

	Yakima Steelhead Kelt Reconditioning Program
Release Locations	Yakima River near Prosser Dam at a time and location that allows reconditioned kelts to choose their own mates, spawning locations, and spawn timing.

[1] Produced by YN staff as part of the "Quantitative Goal Worksheet" exercise for NOAA's Marine Fisheries Advisory Committee - Columbia Basin Partnership Task Force. https://www.fisheries.noaa.gov/webdam/download/93603722

4.4.1 Program Need and Justification

The Yakama Nation was guaranteed fishing rights by the Treaty of 1855. These rights were confirmed by a federal court in *U.S. v Oregon* in 1969. Since 1977, the parties to *U.S. v Oregon* have been involved in negotiating a series of plans for fisheries management in the Columbia River Basin. These plans have been adopted by the orders of the U.S. District Court for the District of Oregon. The planning process is the principal forum for addressing issues related to anadromous fish harvest, stock restoration, and hatchery production. The Memorandum of Understanding for the 2008-2017 Accords specifically states that the Yakima Wild Steelhead Kelt Reconditioning Program will continue to collect and recondition kelts and investigate reproductive success of released kelts. The Accords have been reauthorized through 2022.

In the FCRPS Biological Opinion, Reasonable and Prudent Alternative (RPA) 42 identifies the Yakima River kelt reconditioning strategy as a program to be implemented to assist in recovery of the Middle Columbia Steelhead DPS. The implementation strategy for RPA 42 includes funding for the Yakima kelt program, including capital construction, implementation, and monitoring and evaluation costs.

Historically, Yakama Tribal members fished for Chinook, Coho, steelhead and other species in the Yakima River and throughout the Columbia River Basin. Hatchery steelhead were released in the Yakima River Basin until 1994. From 1961 until 1986, an average of 63,500 hatchery steelhead smolts were released in the Yakima basin (Phelps 2000), originating primarily from the Skamania steelhead stock. From 1987-1994 steelhead releases ranged from 23,000-155,000, originating from native Yakima steelhead. No hatchery releases of steelhead have been made since 1994 in the Yakima Basin.

The Tribe's research has demonstrated that steelhead kelt reconditioning increases repeat spawner abundance and provides recovery benefits by increasing the number of naturally-spawning steelhead in the system (Trammel et al. 2016). In the long-term, this program also has the potential to decrease ESA-related harvest constraints in treaty fisheries in the Zone 6 fishing area and increase harvest opportunities in the terminal fisheries.

4.4.2 Program Goals and Objectives

The goals of the Yakima Steelhead Kelt Reconditioning Program are to 1) increase the number of repeat spawners in the Yakima River MPG populations and 2) increase the overall number of naturally spawning steelhead in the system. The program's wild steelhead abundance goals are shown in Table 4-7. The most recent 10-year average number of natural spawners counted at Prosser Dam is 4,064 steelhead adults (Table 4-3). This is the best estimate of escapement for the four Yakima River MPG populations combined. Escapement estimates are not available for the four populations within the MPG. Yakima River steelhead have comprised 5.3% of Group A steelhead at Bonneville Dam (10-year average) (Figure 4-3).

Since 2005, Yakima River kelts have been systematically PIT tagged following their collection at the CJMF as a 'control' population to assess return rates in the absence of a kelt reconditioning program. Repeat spawner return rates to BON averaged 2.8% from 2005 through 2012 (Table 4-8) and were comprised of 65% consecutive spawners and 35% skip spawners. This compares to an approximately 25% spawner return rate for kelts collected for reconditioning (see Tables 4-1 and 4-2 and discussion above).

Table 4-8. Summary of kelt steelhead PIT tagged and released back to the river and their associated return numbers and rates to Bonneville Dam. All kelt steelhead from the Yakima River were collected and released at the Chandler Juvenile Monitoring Facility (Hatch et al. 2013).

Year	# Released	# Returned to Bonneville Dam	Return Rate to Bonneville Dam
2005	67	3	4.5%
2006	52	1	1.9%
2007	53	3	5.7%
2008	88	4	4.6%
2009	58	3	5.2%
2010	155	2	1.3%
2011	85	1	1.2%
2012	59	0	0
Total	*617*	*17*	*2.8%*

4.4.3 Program Description

The program will collect up to 1,500 downstream migrating female kelts per year at the Chandler Juvenile Monitoring facility. Captured kelts will be reared for 4 to 10 months at Prosser Hatchery, treated for diseases and parasites, and fed a formulated diet. All captured fish will be PIT tagged for individual re-identification during reconditioning and following release.

Surviving reconditioned fish will be released into the Yakima River below Prosser Dam during the peak of the upstream migration. With an average survival rate of approximately 50%, the program expects to release up to 750 reconditioned kelts per year.

4.4.4 Scientific Basis for Program

The Yakima River Wild Steelhead Kelt Reconditioning program is similar to the long-term kelt reconditioning program described in the Snake River Basin Kelt Reconditioning Facility Master Plan. The programs use similar capture and reconditioning methods and have similar long-term objectives. As part of the Northwest Power and Conservation Council (NPCC) three-step review process, the Independent Scientific Review Panel (ISRP) reviewed the Snake River Master Plan (ISRP 2016-8), and requested a response to nine questions. Those questions are tailored to the Yakima River steelhead program below, along with a brief response to each question.

Questions 1, 3 and 4

1. **The biological and ecological rationale for annually increasing Yakima steelhead escapement by approximately 375[12] reconditioned female kelts needs to be explained in the Master Plan.**

3. **The biological escapement goals for the Yakima Steelhead MPG populations should be in the Master Plan along with a description of what project "success" entails. To what extent, for example, are reconditioned kelts expected to contribute to the rebuilding of natural steelhead populations and eventually to fisheries?**

4. **If available, information on the abundance and status and trends of steelhead populations in the Yakima River basin should be provided in the Master Plan. Current spawning levels should also be described with reference to numerical objectives for natural spawning steelhead. Additionally, a brief overview of the factors limiting each of these populations should be added to the Plan.**

Responses to questions 1, 3, and 4 are combined.

The program goal is to collect up to 1,500 kelts at Prosser Dam and release approximately 750 kelts, based on the average in-hatchery survival rate of 50% (Table 4-1). Based on average release to spawning ground migration (~50%; Table 4-2), this is expected to result in about 375 reconditioned kelts returning to the spawning grounds from a collection of 1,500 kelts. The collection goal of 1,500 kelts was selected because it provides an opportunity to test the value of long-term kelt reconditioning as part of the overall recovery strategy for Yakima River steelhead. The goal is also realistic in terms of: 1) the number of kelts that can be collected at the Chandler Juvenile Monitoring Facility, and 2) rearing space and water supply limitations at Prosser Hatchery.

Program 'success' is defined as increasing the number of repeat spawners in the Yakima MPG and increasing the number of natural spawners in the system. Currently, the Yakima River MPG populations are significantly under-escaped. Adult abundance at Prosser Dam averaged 2,634 from 2014-2019 (Table 4-3), whereas the long-term ('high') Mid-Columbia Recovery Plan abundance objective for the MPG populations is more than 16,000 (Table 4-7). On average, releasing 750 kelts per year would increase the total spawning population by approximately 375 adults, which is less than 10% of the MPG[13]. All of the reconditioned kelts would be repeat spawners. Estimated rates of repeat spawning for post-development Columbia River steelhead *Oncorhynchus mykiss* populations range from 1.6 to 17% and compares to "natural" rates as high as 79% for populations in the Utkholok River of Kamchatka, Russia 1994-96 (CRITFC and YN 2006).

The Snake River Kelt Conditioning Master Plan recognized that passage conditions in the mainstem Columbia River impact viability via mortality and delayed upstream passage (adults), direct and indirect mortality on downstream migrants (juveniles), alteration of the hydrograph (mainstem and estuary flow regime), depletion of historically available nutrients, and degraded rearing and food resources for both presmolts and smolts in the Columbia River. The Plan discussed three efforts to address mainstem problems: implement measures to improve in-river survival of migrating kelts, collect and transport kelts to areas below Bonneville Dam to improve adult return rates, and long-

[12] Based on data in Tables 4-1 and 4-2. If 1,500 kelts are collected, approximately 50% are expected to survive to release (750 kelts), and approximately 50% of released kelts are expected to migrate to the spawning grounds (375 kelts).

[13] This assumes that 50% of kelt releases migrate to the natural spawning grounds, based on recent program data (see Tables 4-1 and 4-2). If 750 kelts are released, this would result in 375 additional steelhead on the spawning grounds. This is approximately 10% of the recent return of wild adult steelhead to the MPG (2,600 – 4,100 depending on years included) based on counts at Prosser Dam (Table 4-3)

term reconditioning to increase the number of viable females on the spawning grounds. As described in the Plan, it is too early to assess whether hydropower facility modifications confer survival benefits to kelts. The Plan evaluated kelt transportation and reconditioning and concluded that long-term reconditioning is the strategy most likely to improve survival of kelts.

Long-term kelt reconditioning is a restoration alternative that will provide potential benefits not possible through any other existing or proposed action. Reconditioned kelts are expected to ascend directly to spawning grounds after release and are not subject to variations in passage, estuary, and ocean conditions. As a result, the program offers a potential buffer against poor passage and out-of-subbasin conditions. Thus, we view long-term kelt reconditioning as a "spread-the-risk" strategy that differs fundamentally from other approaches.

2. **Clarification on why male kelts are not included in the reconditioning program is needed.**

Male steelhead are not included in the reconditioning program because sex ratios of kelt steelhead are highly skewed toward females, male kelts generally survive reconditioning at a lower rate than females, and males tend to not be in short supply on the spawning grounds. Therefore, the program is more efficient by focusing reconditioning efforts on female kelt steelhead.

Recent investigations indicate that the sex ratio of Yakima steelhead runs returning to spawn are skewed toward females. Frederiksen et al. (2015) reported that the mean sex ratio was 65:45 in favor of females. The sex ratio of the kelt steelhead populations are further skewed toward females, with Yakima River kelts averaging 92% females. This bias toward female kelts may be a mechanism to reduce the probability of sibling mating and inbreeding depression.

In general, when male kelt steelhead are collected they are in poorer condition than females, decreasing their probability of surviving reconditioning. Therefore, excluding male kelts could potentially result in a very slight loss of genetic variation.

5. **Substantial habitat restoration actions affecting Yakima MPG steelhead are occurring in the Yakima River subbasin. The Master Plan should briefly describe these programs and indicate how the proponent's goal of annually releasing up to 700 reconditioned kelts will be coordinated with ongoing habitat restoration and existing hatchery programs.**

Habitat restoration activities in the Yakima River basin are described in Section 4.2 (Habitat Context), Table 7-4 and Section 7.3. Hatchery releases of steelhead were discontinued in the Yakima River in 1994.

6. **As it is currently designed, the kelt reconditioning program will recondition female steelhead kelts without targeting specific populations. It would seem that capturing, reconditioning, and releasing kelts from populations that have the potential to accommodate additional spawners would be a more efficient and productive way of directing this strategy. The Master Plan should explain why a more focused program was not considered.**

As the ISRP suggests, ideally the Yakima kelt reconditioning program would collect kelts directly from the target populations rather than at Prosser Dam. This would require significant new infrastructure for kelt collection, including substantial weir and holding tank facilities at multiple sites. Given high spring flows and debris load, the continuous operation of tributary weirs would not be possible in certain areas during the period of steelhead spawning. The cost and infrastructure associated with targeted kelt collections would likely exceed that of the existing program, which would collect outmigrating kelts at the Chandler Juvenile Monitoring Facility. In addition, operational costs would be substantially higher.

The kelt collection site at Prosser Dam has the potential to intercept kelts from any of the four Yakima River MPG populations. There is no indication that any one population would be overrepresented. By releasing reconditioned kelts near Prosser Dam when the natural run returns to the subbasin, reconditioned kelts have the opportunity to mingle with the run at large. This release strategy allows released kelts to volitionally migrate to the spawning grounds and select a spawning location.

Question 7 was specific to the Snake River program and will not be addressed here.

8. The Master Plan should compare the benefits and drawbacks of increasing Yakima MPG steelhead escapements by modifying harvest regulations, by long-term reconditioning for adult release, and long-term reconditioning for captive breeding and smolt release.

There is no question that reductions in harvest and/or expansion of traditional hatchery practices via the use of reconditioned kelts as broodstock could stimulate the return of a greater number of adults relative to kelt reconditioning and release. Harvest is a function of legal mandates, including trust responsibilities, and will not be addressed further here.

We view long-term kelt reconditioning and release as a valuable addition to the suite of restoration/conservation actions for the following reasons:

1. Reconditioned kelts are wild fish, temporarily reared in an artificial environment to facilitate rematuration of gonads and improve survival to the repeat spawning stage. Any artificial selection that may occur in the operation of this program is expected to be minimal as timing and location of release allows fish to choose their own mates, spawn location, and spawn timing.
2. Long-term kelt reconditioning and release directly increases the expression of iteroparity.
3. Naturally-spawned juveniles from reconditioned kelts would be considered “wild” and thus would be unmarked and ineligible for direct take in commercial and recreational fisheries.
4. As detailed in the response to ISRP question nine (below) risks of domestication are far reduced in the context of the existing program relative to a traditional hatchery.
5. Reconditioned kelts may buffer synchronous periods of low escapement imposed, in part, by common environmental conditions experienced by natural and hatchery-origin emigrating juveniles and immigrating adults.

In conclusion, we firmly believe that long-term kelt reconditioning and release is a valuable component of a diverse suite of strategies to conserve Yakima River steelhead and contribute to recovery.

9. **Some discussion of the genetic risks that may accompany reconditioning (e.g., heritable epigenetic effects and domestication selection) needs to be added to the Master Plan or incorporated into the Plan's HGMP.**

The following is condensed from CRITFC's response to the ISRP's Question 9 in their review of the Draft Snake River Kelt Management Plan.

The existing program is best described as a refuge from unnatural selection as opposed to a source of artificial selection, although we acknowledge that the risk exists. We believe that the best available scientific evidence suggests that heritable epigenetic changes are unlikely to result from the program. In the context of kelt reconditioning, heritable epigenetic effects could occur due to the effect of the hatchery environment on the mother during oocyte development (F0), or due to carryover effects of hatchery rearing on development of progeny (F1). However, such effects are very unlikely to occur due to kelt reconditioning, because sensitive periods for epigenetic reprogramming of the germline do not occur when fish are held in a hatchery environment. In mammals, heritable epigenetic effects occur due to alteration in DNA methylation during early germline development. Germline epigenetic marks associated with imprinting are erased during migration of the primordial germ cells through the genital ridge, and re-established early in gonadal development after gonadal sex determination. Known mechanisms for establishment of heritable epigenetic marks in mammals involve action of environmental agents during this sensitive period (Skinner et al. 2010). Little is known about the timing of establishment of epigenetic modifications to the germline in fishes, however, it is reasonable to assume that these occur at a similar early stage of development (Jonsson and Jonsson 2014, Li and Leatherland 2013).

Kelt steelhead mothers captured for reconditioning experience the hatchery environment for the first time after their initial spawning, long after the sensitive period for establishment of heritable epigenetic marks in the F0 generation. Furthermore, we believe the risk of heritable genetic changes are significantly reduced by the fact that candidate kelts have themselves survived from the gravel, to the ocean, from the ocean to spawning grounds, and from the spawning grounds to Prosser Dam. Similarly, candidate adults will not be spawned in the hatchery; instead they will be expected to undertake another migration to the spawning grounds. Please see CRITFC 2016 for more details.

While we acknowledge the potential for domestication, we believe that risks of domestication from the proposed program are minimal relative to standard hatchery programs, and pale in comparison to the strength of artificial selection imposed by anthropogenic modifications within the Columbia River Basin. We view domestication as a function of either/both artificial selection and relaxation of natural selection; each of which might cause phenotypic and/or heritable genetic traits that diverge from those anticipated in un-modified ecosystems. Traditional hatchery programs have multiple opportunities for artificial selection:

1. At broodstock collection (e.g., selection of larger individuals);
2. During adult holding (e.g., non-random mortality);
3. At spawning (e.g., exclusion of some individuals);
4. During rearing (e.g., non-random mortality, differential survival based on growth rate); and
5. At release (e.g., size-mediated marking mortality).

As proposed, the kelt reconditioning program could impose artificial selection during the collection of fish for reconditioning and during reconditioning; two of five of the opportunities described above. In kelt reconditioning programs, artificial selection is really the risk of collection and artificially-mediated survival of individuals that would otherwise perish *under natural conditions*. For example, the use of prophylactics might enable the survival of individuals with greater vulnerability to disease. Similarly, reconditioning might enhance the survival of individuals that would otherwise lack the somatic resources to sustain emigration to the ocean.

Ultimately, this program itself is the result of irrefutable and significant artificial selection (e.g., alterations to mainstem passage) and simultaneous relaxation of natural selection (e.g., relaxation of historical rates of competition for spawning and rearing habitat) imposed by anthropogenic factors. While we acknowledge the potential for both artificial selection and relaxation of natural selection, it is also clear that the proposed program poses a significant reduction in the risk of either relative to standard hatchery practices.

4.5 HATCHERY AND GENETIC MANAGEMENT PLAN

A draft HGMP for the existing wild steelhead kelt reconditioning program is attached as Appendix C. If the program described in the Master Plan is implemented, the HGMP may be revised for clarification and to incorporate facility modifications.

5.0 ADAPTIVE MANAGEMENT

The success of the hatchery programs proposed in this Master Plan is premised on the best available information about the existing populations, expectations about future conditions, and an adaptive management framework to translate new information into appropriate management responses. The purpose of the adaptive management process is to ensure that information gained through research, monitoring and evaluation is effectively incorporated into an annual decision making process. This ensures progress toward the program's long-term harvest, cultural and conservation goals.

5.1 MONITORING AND EVALUATION FRAMEWORK

The Columbia River Basin Research Plan (NPCC 2017), which was developed with input from the Independent Scientific Advisory Board (ISAB), ISRP, and PNAMP, identified a number of critical uncertainties regarding hatchery management that are relevant to the proposed programs:

1. Are current propagation efforts successfully meeting harvest and conservation objectives while managing risks to natural populations?
2. Can hatchery production programs meet adult production and harvest goals (integrated and segregated) while protecting naturally-spawning populations?
3. What are the interactions, by life stage, between hatchery-origin and natural-origin populations with respect to competition, predation (direct and indirect), and disease including harvest in fisheries targeting hatchery-origin adults; and from hatchery effluent?

4. What is the magnitude of any demographic benefit or detriment to the production of natural-origin juveniles and adults from natural spawning of hatchery-origin supplementation adults?

5. What are the range, magnitude and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules including the proportion of hatchery fish permitted on the spawning grounds, and the proportion of natural-origin adults in the hatchery broodstock?

The M&E plan for the proposed project is intended to address each of these uncertainties at least to some extent. In addition, the monitoring and evaluation program is designed to collect data needed to 1) evaluate program performance relative to program goals, 2) adjust hatchery and harvest management operations according to the Decision Rules, and 3) test key assumptions and adjust the Decision Rules accordingly.

The specific metrics needed to support decision making are described in the M&E plan (Appendix J) and summarized in Table 5-1, along with the appropriate standards for accuracy and precision (e.g., Crawford and Rumsey 2011).

Table 5-1. Field and in-hatchery monitoring and evaluation indicators, metrics, methods, and benchmarks for the Yakima Coho and Summer/Fall Chinook hatchery programs.

Monitoring Area	Indicators	Metric	Method	Benchmark
Natural Production	Smolt to adult survival	Adults at Bonneville and Prosser Dams/Smolt indices at Prosser; PIT detection analyses at all detection sites	PIT Tags are used to estimate the total number of NOR juveniles arriving at McNary Dam, and resulting adult production is estimated at Bonneville and Prosser Dams. Methods are being explored that allow smolts at Prosser to be estimated with confidence bounds; these estimates will be used if confidence bounds are reasonable. A spawner recruit analysis will be used to determine total recruitment of NORs.	See Tables 2-20 (Coho) and 3-16 (Chinook) for SAR assumptions. CV < 15%[14]
	Smolts per pre-spawner at Prosser and McNary	Smolts and adults at Prosser Dam (brood year specific), and smolts at McNary.	PIT Tags are used to estimate the total number of juvenile Chinook produced by brood year based on adult and juvenile detections at McNary Dam and Prosser. A spawner recruit analysis will be used to calculate productivity and capacity for the population over time.	See Tables 2-20 (Coho) and 3-16 (Chinook) for productivity and capacity assumptions.
	Natural spawner abundance	NOS + HOS	Coho spawners estimated based on adult returns to Prosser Dam, minus any adults removed for broodstock; Chinook spawners estimated based on adult returns to Prosser plus estimated number of adults spawning below Prosser based on redd expansion.	See Tables 2-19 (Coho) and 3-15 (Chinook) for program goals. CV < 15%
	Relative Reproductive Success (NOS and HOS)	Recruits produced per HOR spawner/recruits produced per NOR spawner.	Genetic samples will continue to be taken from all adults handled at Prosser Dam, all of the hatchery brood, and a subset of juveniles captured in following years at juvenile trapping facilities (primarily Chandler).	HOR RRS of 0.8 that of NORs.
Hatchery Production	Smolt to adult survival	Adult returns to the Yakima Subbasin	CWTs and PIT tags are used to estimate survival rates based on adult returns to the Yakima Subbasin.	See Tables 2-22 (Coho) and 3-19 (Chinook) for SAR assumptions. CV < 15%

[14] Based on guidance from Crawford and Rumsey (2011).

Monitoring Area	Indicators	Metric	Method	Benchmark
	In-hatchery survival	Survival rate by life stage	Hatchery staff will use standard inventory to track the number and survival rates of cultured fish by life stage.	See Tables 2-21 (Coho), 3-17 and 3-18 (Chinook) for in-hatchery assumptions.
	Ecological effects (in-basin predation, competition, disease)	Index of Predation, Competition and Disease Risk	PCDRISK modeling will be used to estimate ecological risk of HORs on naturally produced salmonids and other species.	Index <5%
	Genetic effects (primarily straying to other populations)	Proportion of returning HOR adults that do not return to the Yakima subbasin	PIT Tags and CWTs used to track and identify program fish captured/detected in areas outside of the Yakima subbasin	<5%
	Predation	Piscivory index for HOR juveniles.	Stomach sampling and genetic analysis of stomach content used to develop a piscivory index for HORs	Index <1%
	Minijack Production	Proportion of juvenile hatchery production consisting of minijacks.	Blood samples and visual inspection of gonads will be used to estimate proportion of minijacks in juveniles produced at the hatchery.	<10% of males; CV < 15%
Harvest	Out-of-basin harvest rate and number	Proportion and number of adults harvested in pre-terminal fisheries outside of the Yakima subbasin.	Program fish will be tagged with CWTs and PIT tags. Pre-terminal harvest rates will be developed based on analyses by PFMC and state fisheries management agencies.	Variable based on NOR run size of Columbia River Coho and summer/fall Chinook
	In-basin harvest rate and number	Proportion and number of adults returning to the Yakima subbasin harvested in fisheries within the subbasin.	Fisheries surveys will be used to determine the number of HOR and NOR adults harvested (or incidentally killed) as a result of in-basin fisheries.	See Table 2-23 (Coho) and 3-20 (Chinook) for harvest rates; Tables 2-19 (Coho) and 3-15 (Chinook) for program goals. CV < 15%
Decision Rules	Adult abundance (NOR and HOR)	Number of HOR and NOR returns to Prosser.	Fish arriving at Prosser will be counted daily based on origin (HOR/NOR), age (adults, jacks) and sex.	See Tables 2-19 (Coho) and 3-15 (Chinook) for program goals. CV < 15%
	Run forecast: to determine disposition of adult NORs for in-season management	Return of NORs and HORs to Prosser Dam.	Pre-season adult run-size estimates developed by the co-managers, combined with in-season updates and tracking of program PIT tagged fish will be used to develop the run forecast.	Varies by year
Out-of-basin	Status and Trends	Reporting of PDO, Mainstem Hydropower Operations, Survival rate of other populations, Columbia River Estuary improvements	Summarize and track data reported by others	Variable

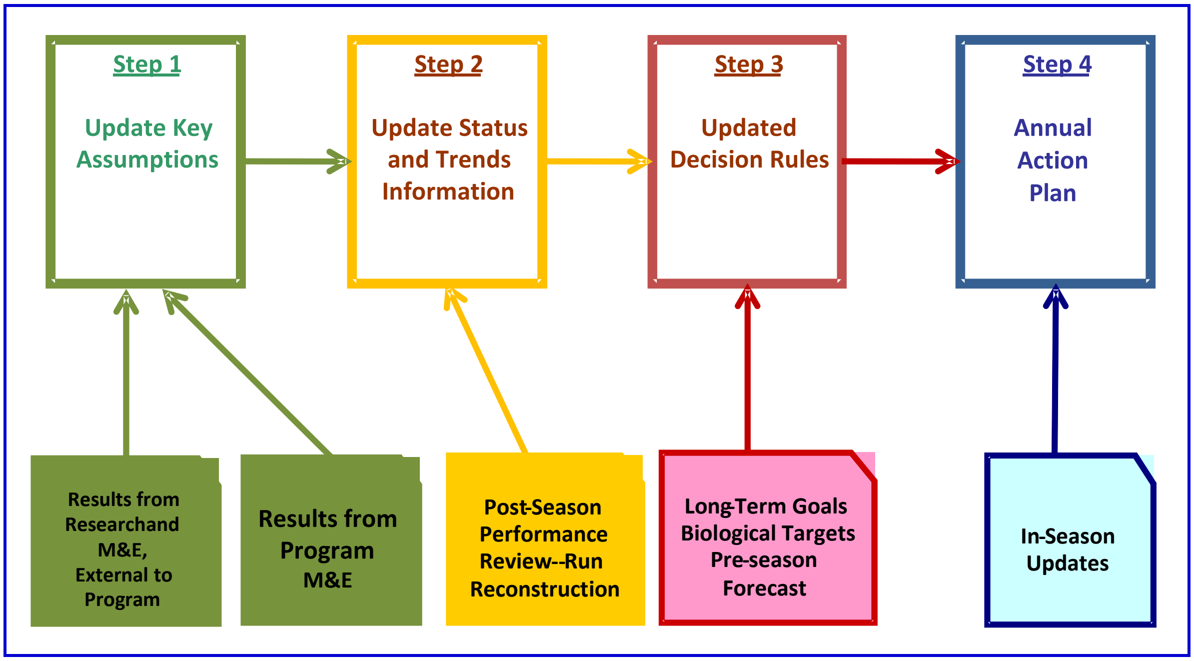
Evaluating Benefits from Habitat Restoration Actions

Habitat action effectiveness monitoring is beyond the scope of this Master Plan. The YN will continue to monitor results from ongoing habitat restoration programs throughout the region and monitor the literature for relevance to our work here in the Yakima Basin. For example, Clark and Roni (2018) specifically included some of the habitat restoration actions in the Upper Yakima watersheds in their study demonstrating positive results from such actions.

As described in Appendix J, we intend to assess benefits from habitat restoration actions and the integrated Coho, integrated Chinook, and wild steelhead kelt reconditioning programs largely through monitoring and evaluation of trends in natural-origin Coho, Chinook and steelhead juvenile and adult return abundance. The Upper Columbia program, which is very similar to that in the Yakima Basin, is already doing genetic evaluation (empirically testing gains in fitness) in cooperation with a CRITFC basin-wide supplementation evaluation project (see Campbell et al. 2017). Parentage-based tagging may be used to supplement the information being gained from the CRITFC/YN Upper Columbia Coho program in the future. As habitat actions and the proposed hatchery programs progress and additional information is gained, adaptive management will be used to modify program parameters as necessary.

5.2 ADAPTIVE MANAGEMENT PROCESS

The adaptive management process has four steps: (1) establish and document a scientifically defensible working hypothesis (set of key assumptions) for the programs; (2) report and review the most recent empirical data on key population metrics (status and trends); (3) establish biological targets and management triggers to ensure appropriate responses to annual variations in population abundance (referred to as the Decision Rules); and (4) apply the Decision Rules to set targets for hatchery broodstock, natural escapement, terminal harvest and priorities for M&E for the coming season (this is the annual Action Plan). This process is illustrated in Figure 5-1.



Source: D.J. Warren & Associates 2009

Figure 5-1. Components of the adaptive management process.

The key assumptions about each of the H's (habitat, harvest, hatchery, and hydro) are documented for the proposed Coho and Chinook programs in Sections 2.5.2 and 3.5.2 of this document, respectively. The key assumptions should be updated as new data become available along with status and trends data for spawning escapement, smolt production, and harvest. Biological objectives for each program are documented in section 2.5.1 (Coho), 3.5.1 (Chinook), and 4.4 (steelhead). Sliding scale broodstock management tables were developed for the integrated Coho and Chinook programs which apply Decision Rules on hatchery broodstock collection for different natural-origin run sizes.

Data collected on natural production, the hatchery program, and harvest will be summarized and reported annually and used to review each program's key assumptions and progress toward meeting biological objectives. Opportunities to make progress toward long-term goals will vary from year to year depending on status and trends in population abundance and productivity and forecasts for the coming season. Other unforeseen events and circumstances may also warrant in-season management responses.

The number of years needed to achieve program goals is difficult to predict as it is influenced by many factors including in-basin habitat quantity and quality; effectiveness of habitat projects to increase juvenile productivity and capacity; variable ocean conditions; and adult and juvenile survival conditions through the mainstem Columbia River. All of these factors create substantial uncertainty around any attempt to forecast future run sizes.

Because of this uncertainty, the program will hold an annual program review to review the working hypothesis, examine key assumptions, and review status and trend data and decision rules. Every 5 years, the program will provide a state of the program report documenting progress to date and clearly defining the scientific support for either continuing the approach as described in the Master Plan or making program changes. This report will be sent out for peer review.

At 5-year intervals, as part of the Annual Program Review, data on total NOR recruitment, population productivity and capacity (from spawner recruit analysis), relative reproductive success (NOS and HOS) and effectiveness of habitat actions will be reviewed to determine if the program is on track to achieve identified goals. Based on the results of the review, managers would formally consider making major changes to the program such as changing the hatchery release strategy or altering program goals

5.3 ONGOING AND PROPOSED RESEARCH

The Yakima-Klickitat Fisheries Project (YKPF) was specifically designed to address scientific uncertainties regarding the use of hatchery supplementation to meet harvest and production objectives while limiting adverse ecological and genetic impacts. To date, most of the YKFP research effort in the Yakima Basin has focused on the Cle Elum spring Chinook supplementation program, with over 50 articles relating to this work published in peer-reviewed literature through 2010 (for a list of publications, see http://www.cbfish.org/proposal.mvc/summary/RMECAT-1995-063-25).

As noted earlier, Phase I feasibility results for the Coho reintroduction program were published in Bosch et al. 2007. The YN is presently collaborating with WDFW to study the effects of Coho adult outplants on juvenile productivity, interactions, and biomass in Taneum Creek (Temple et al. 2011, Temple et al. 2017). With respect to fall Chinook, the YN expects to intensively monitor efforts to reestablish a naturally-spawning, locally-adapted bi-modal summer-fall Chinook population above Prosser Dam, work that also is expected to result in future publications.

The YN is also conducting steelhead viable salmon population and kelt reconditioning research; protecting, restoring and enhancing habitat; and working to reestablish Sockeye, lamprey and sturgeon in the Yakima Basin.

Because these research and restoration efforts are so broad and involve so many regional partners, the Tribe has been conducting Yakima Basin Aquatic Science and Management Conferences annually since 2003 to review and coordinate activities in the basin. Summaries of these conferences are available at http://dashboard.yakamafish-star.net/DataQuery/Reports?field_subject_type_target_id=87&field_subbasin_target_id=All&field_project_value=&title=&sort_by=field_report_date_value&sort_order=DESC.

6.0 CONCEPTUAL DESIGN OF FACILITIES

6.1 CONCEPTUAL DESIGN OF CHINOOK PROGRAM FACILITIES

6.1.1 Overview of Facilities

The Yakama Nation has ongoing URB fall Chinook salmon artificial fish production programs at their existing Prosser and Marion Drain hatcheries. As described in this Master Plan, the Tribe proposes to initiate an integrated summer/fall Chinook program. Both programs will convert to local broodstock as recommended by the HSRG with the implementation of this Master Plan. Figure 6-1 shows the locations of the existing and proposed facilities. The following sections describe existing conditions and proposed improvements.

6.1.2 Existing Fall Chinook Facilities at Prosser Hatchery

Prosser Hatchery is located on a 14-acre parcel on the north side (left bank) of the Yakima River at RM 46.8, adjacent to the City of Prosser. The parcel is federal land managed by the U.S. Bureau of Reclamation (USBR). The Yakama Nation operates the hatchery and has constructed various fish production systems and support buildings gradually over the last 15 years at this site. Figure 6-2 is a site plan of Prosser Hatchery's existing structures and facilities.

Fish production at Prosser primarily consists of incubation, early and final rearing of URB fall Chinook and Coho salmon. The facility also provides round tanks for steelhead kelt re-conditioning and lamprey research. The Chandler Juvenile Fish Monitoring Facility occupies the southeast corner of the site and is used to monitor all downstream migrating fish species. Existing hatchery infrastructure is described below.

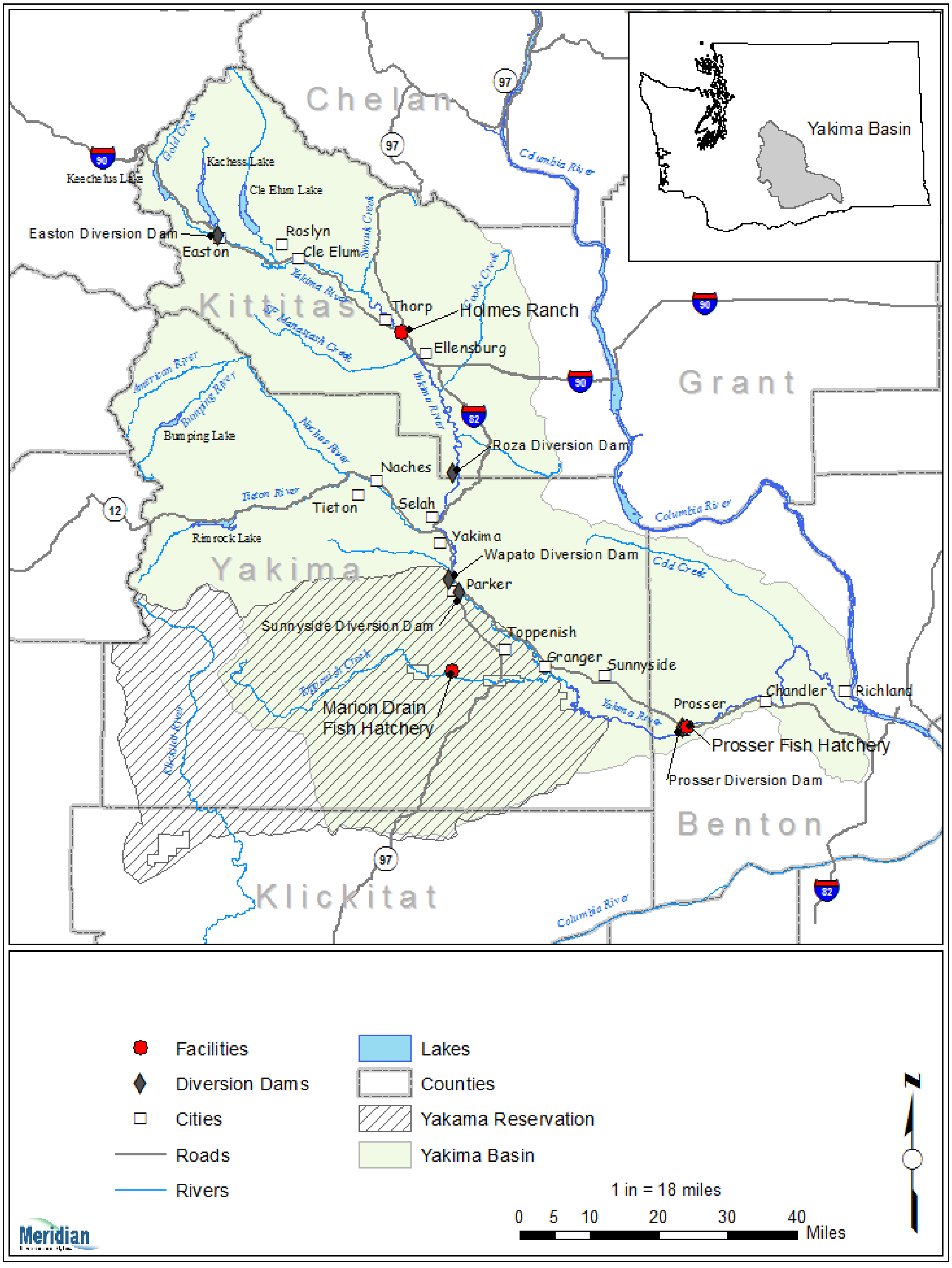


Figure 6-1. Location of existing and proposed fall Chinook aquaculture facilities

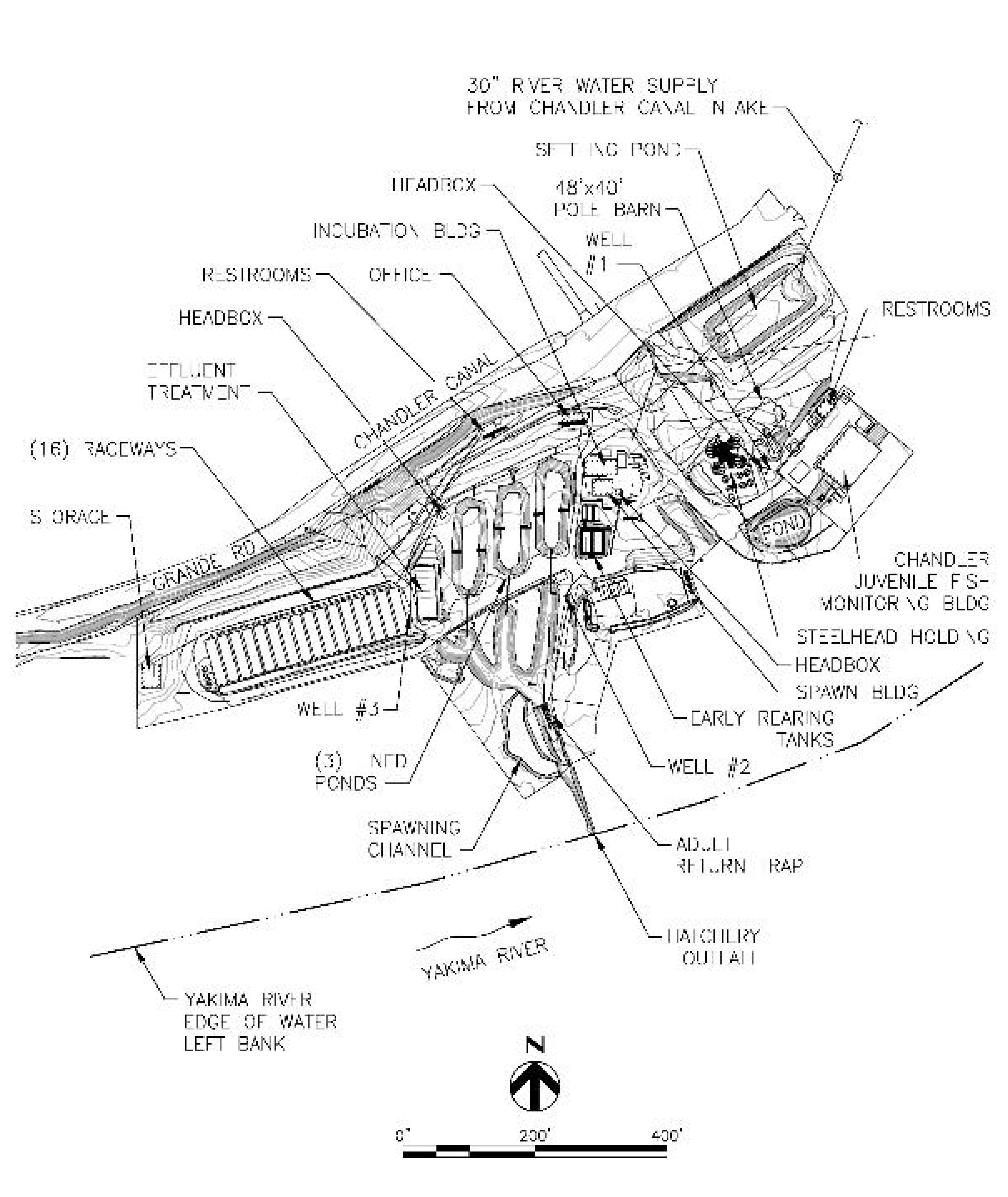


Figure 6-2. Plan view of existing facilities at Prosser Hatchery

Site Access and Security – Access to Prosser Hatchery is via Grant Street Bridge and Grande Road, a gravel road that parallels the south side of the USBR Chandler Canal. The City of Prosser wastewater treatment plant and USBR Chandler Canal screening facility are also located along the gravel road to the west and north of the hatchery site, respectively. The 14-acre parcel has a six-foot-high chain link perimeter fence, with gates at the main entrance off of Grande Road and at the hatchery outfall near the Yakima River (Figure 6-3).

Figure 6-3. Prosser Hatchery, looking southeast from Grande Road

Topography – This irregularly shaped site slopes steeply from Grande Road at the north (elevation 641 to 643) down to the main hatchery area at elevation 625 to 630. Most existing permanent buildings, including the incubation/shop, spawning building, and visitor center/juvenile fish sampling facility, have finished floor elevations of approximately 627. The lowest portions of the site, along the south perimeter near the river, are at an average elevation 620. From the south-central part of the site, the hatchery drain channel slopes more steeply to the river outfall. Ordinary high water in the Yakima River is approximately elevation 610.

Floodplain – A significant portion of the site appears to be within the 100-year floodplain according to available flood insurance mapping. The current federal floodplain modeling and mapping was completed in 1975 and does not take into account many changes that have occurred at and around the project site. Detailed studies are underway to update floodplain boundaries and impacts (see Appendix I). In summary, the regulatory floodway passes through the southern-most portion of the hatchery site, and no hatchery infrastructure except the portable adult collection trap and hatchery outfall channel is within the floodway footprint. The 100-year floodplain elevation is at elevation 622.8. The modular metal raceways, effluent pond, and upper portions of the hatchery drain channels are within the floodplain and are outside the floodway.

Process Water Supply Systems – Fish culture facilities are supplied by both river and groundwater through separate piping systems. The river water supply is gravity flow via a screened intake pipe located in the USBR Chandler Canal. The intake is just downstream of the Chandler Canal drum screens, and has a travelling screen for additional protection of the 30-inch intake pipe. The hatchery uses up to 30 cfs of Yakima River water during the late fall, winter and spring for outdoor rearing. River water is not used for incubation. June through October, the river water is generally too warm for salmonid culture and hatchery operations switch to groundwater from on-site wells.

The 30-inch river water supply pipe enters the northeast corner of the site, where it connects to a flow control structure (Figure 6-4). From there, flow is either routed through a small silt settling pond or bypassed directly into the hatchery water supply piping system. River water is untreated except for the coarse screening and settling described above. The settling pond is roughly 65 feet wide, 165 feet long, with an average depth of 3 feet, which is relatively small in relation to the peak flows up to 30 cfs. Historically, significant amounts of sediment did not settle out when the river was turbid and were deposited in the rearing ponds and tanks. Since the original master plan, YN added some baffles inside the pond which has helped to improve sediment removal. The existing 30-inch HDPE river water supply pipe will be protected during construction.

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Figure 6-4. River water flow control structure and upper end of silt settling pond at Prosser

Three high production process water wells, ranging from 120 to 160 feet deep, are located on the hatchery site. Each well produces at least 1,200 gallons per minute (gpm) using submersible pumps that discharge into separate degassing head boxes. The head boxes are eight-foot-diameter stainless steel tanks with packing media, supported about 10 feet above grade (Figure 6-5).

Groundwater flows by gravity from each head box to various hatchery rearing or holding tanks, chiller and incubation systems. The gravity flow pipes are interconnected on the downstream side of the head boxes. There are some flow balancing problems since the head box water levels are not at the same elevations. Groundwater temperature is a fairly constant 56 to 57°F year round. For incubation, this water must be chilled to between 44 to 48°F. Hatchery staff report that the wells draw down very little during prolonged pumping and do not appear to interfere with each other in terms of flow production. The existing wells and head boxes will be protected during new facility construction to avoid water supply interruptions.

Figure 6-5. Prosser Hatchery Well No. 1 and head box (at right) and steelhead kelt re-conditioning tanks (at left)

The process water distribution systems are mostly solvent-welded PVC piping installed by the hatchery staff. As-built mapping prepared for this project showing the piping runs is included in Appendix G. Portions of these piping systems will be retained and incorporated into the new facility.

Process Water Drain Systems – Overflow drains from the fish culture facilities are collected in a system of pipes and open channels. They are combined into a single open channel discharge to the Yakima River except for the kelt reconditioning tanks which have a separate drain into an irrigation pond and no direct river discharge. The Chandler Juvenile Fish Monitoring Building also has a separate drain and outfall to the river associated with the juvenile bypass system from Chandler Canal. Portions of the existing drain system will be replaced or re-routed as part of the modernization effort.

Incubation Building – The incubation building is centrally located near the site entrance off Grande Road. It is a prefabricated metal building with cast-in-place concrete floor (Figure 6-6). The western portion of the building houses 25 stacks of 8-tray Marisource incubators, 8 of them in double and 17 of them in triple stack configuration. There are also five fiberglass troughs used for bulk eyeing of green eggs for the Coho and fall Chinook programs (Figure 6-7). Floor trenches for incubator drains have been cut and chipped into the floor and do not have grating covers. A six-inch drain pipe conveys drain water from the floor trenches and several floor drains to the hatchery outfall. A 100-ton chiller system is located adjacent to the east end of the building. Chilled and ambient groundwater supply pipes are routed into the incubation room via a dual overhead piping system, with valved supply drops to each stack and tank. These facilities are used for both the fall Chinook and Coho programs.

Figure 6-6. Prosser Hatchery incubation building (blue with white shed roof), with chiller and electrical panels in foreground

Figure 6-7. Prosser Hatchery incubation room, triple stacks (left), bulk eyeing trough (center) and chilled (blue) and ambient (red) groundwater supply headers

The eastern portion of the building contains a locker room, a light storage/ shop area and a small electrical room that houses the hatchery monitoring and alarm panel. The incubation building is serviceable and will be retained as part of the new facility. A small chemical storage shed, egg isolation trailer, and propane tank are located nearby. The spawning building is immediately south of the incubation building.

Outdoor Rearing Facilities – Fall Chinook are transferred directly from incubators at 1,100 fpp to three outdoor fiberglass raceways (21 feet long, 6 feet wide and 3.3 feet deep) for early rearing on groundwater. The fish are then transferred at 500 fpp to four larger fiberglass raceways (31 feet long, 6 feet wide and 3.5 feet deep), and are converted to river water. At a size of 150 fpp, the fall Chinook juveniles are transferred to the 16 large modular steel raceways (16 feet wide, 72 feet long, by 4 feet high) for acclimation on river water prior to release. The steel raceways are lined with plastic. Each of the outdoor rearing tanks are plumbed to have dual source water supply pipes configured to delivery river water, groundwater, or a blend of the two to each unit (Figure 6-8).

The fiberglass early rearing raceways are in serviceable condition and will be retained for use in other programs. The modular steel raceways with plastic liners are nearing the end of their service life. The tank sidewalls are deflecting, causing the screens to fail, resulting in unplanned fish escapes. Replacement units are described in Section 6.4.3.

Figure 6-8. Prosser Hatchery dual source process water supply pipes into steel raceways

There are three large plastic-lined earthen ponds that are mostly used to hold adult fish (Figure 6-9). Each of these ponds has a water supply header, concrete outlet control structure, work platform, and level alarm system. An overhead cable system provides support for deployment of predator control netting. There have been problems with high groundwater floating the pond liners. In addition, the Tribe has had difficulty containing and segregating smaller fish in these ponds due to poor structural and screen tolerances at the outlet structures. It is also difficult to crowd and sort adult fish. The westerly pond will be retained and the other two will be filled in to facilitate construction of new facilities.

Figure 6-9. One of three large outdoor holding ponds at Prosser Hatchery

Monitoring and Alarm System – Each of the outdoor rearing raceways has a magnetic flow meter connected to a central supervisory control and data acquisition (SCADA) system that provides continuous flow rate and flow alarm functions. Dissolved oxygen sensors in each raceway and water level alarms at the head boxes are also connected to the SCADA system. It will be possible to salvage and or maintain portions of the existing SCADA system; however, much of it will need to be rebuilt to serve the modernized hatchery.

Utilities – Prosser Hatchery is connected to three-phase utility power via an overhead line extending along the north perimeter of the site. There are three separate electrical services. The main service powers the existing chiller and some of the well pumps and is connected to a new 460 kW emergency power generator. The juvenile sampling facility and Well No. 1 has a separate service. Well No. 3 has yet another service that is connected to a portable emergency generator. Propane is provided to the spawning and incubation buildings. Potable water is available to the various support buildings around the project site. Sanitary drains and restrooms are routed to pump out tanks. Data and voice communications are hard-wired in to the office and juvenile monitoring buildings.

Support Facilities - Additional infrastructure at Prosser Hatchery includes the following support facilities:

- An office trailer and modular restrooms for hatchery staff
- Spawning building
- Steelhead kelt reconditioning ponds (outdoor circular FRP tanks)
- 100-ton chiller for incubation temperature control
- Demonstration ponds and two public education kiosks. The ponds primarily display large sturgeon and trout.
- Freezer
- Two pole barns for feed storage and miscellaneous dry storage
- Portable emergency power generator for well No. 3

- A steep pass fishway and false weir for trapping adult fish that enter the hatchery outfall channel
- Several lamprey research tanks and troughs located outdoors to the south of the incubation area.

The office trailer and modular "pump-out" restrooms are temporary facilities that will be replaced with a new administration building connected to the municipal sewer. The demonstration ponds will be expanded and upgraded to provide better public interpretation and viewing opportunities. Wells will be provided with permanent emergency back-up power. The remainder of the support facilities will be retained as part of the modernized facility.

6.1.3 Proposed Fall Chinook Facilities at Prosser Hatchery

The Yakama Nation proposes to modernize Prosser Hatchery in order to achieve the fall Chinook production goals outlined in the preceding sections. Several of these improvements will be shared by the Prosser Coho program. The proposed improvements include the following major elements:

- One new high capacity well to provide groundwater supply redundancy
- Minor modifications to one of the degassing head boxes for groundwater treatment and supply to incubation and adult holding
- Incubation isolation facility for out-of-basin eggs, with effluent disinfection
- A new 25,600 sf fall Chinook rearing building to contain twelve 30 foot diameter circular tanks and 6 PRAS modules (two tanks per module).
- New concrete adult holding ponds and covered spawning area adjacent to existing spawning building
- New 2,400 sf administration building and parking area
- Site paving and utility upgrades

Figure 6-10 shows a preliminary layout of the proposed improvements. These improvements are described in more detail below and in the concept design drawings in Appendix G. The improvements will be planned to minimize interruptions to the existing fish production programs at Prosser Hatchery. More detailed descriptions of the proposed improvements are provided below.

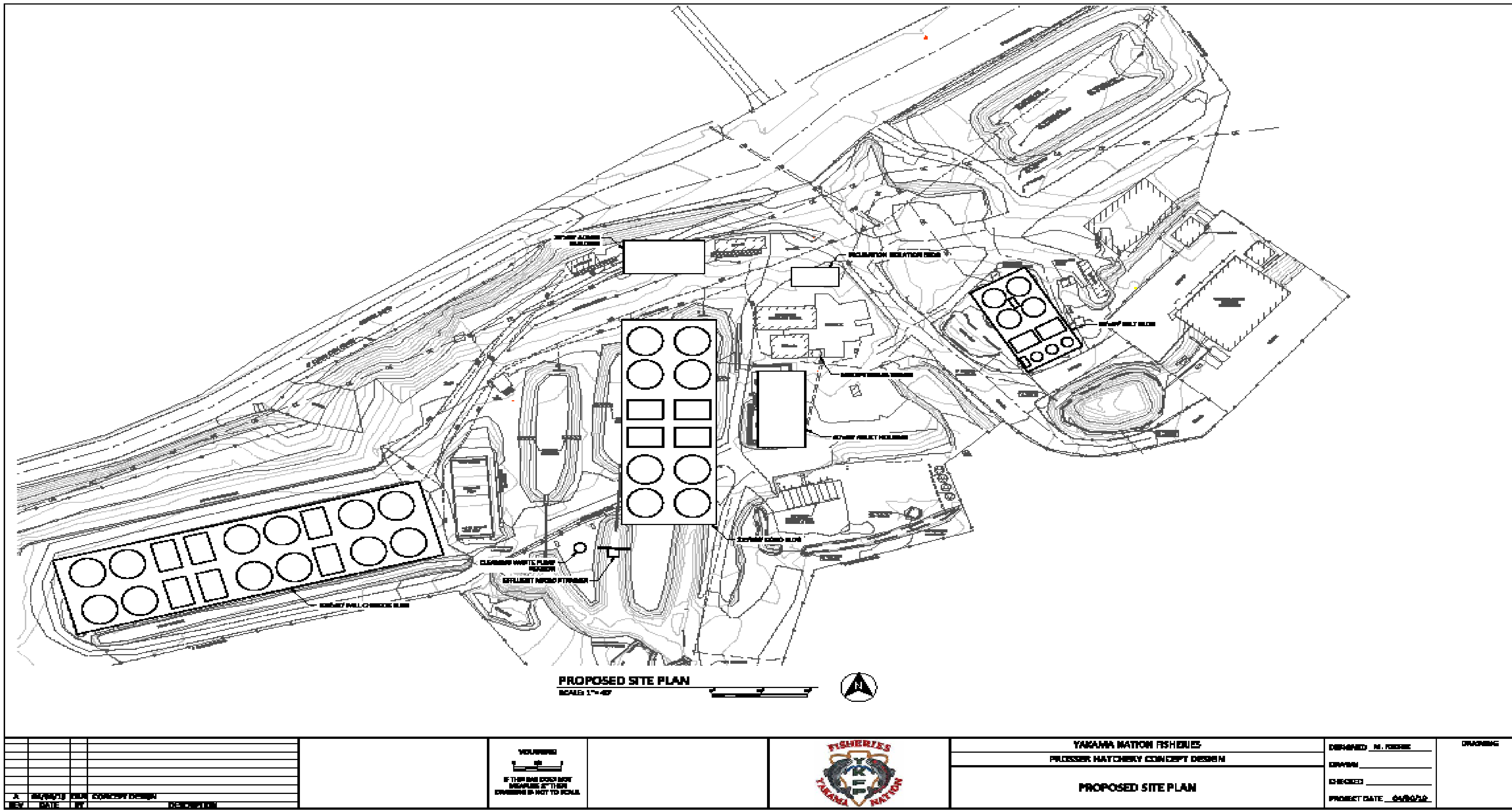


Figure 6-10. Preliminary layout of proposed improvements at Prosser Hatchery.

One New High Capacity Well: The three existing wells yield approximately 1200 gpm each, for a total of 3,600 gpm. The peak groundwater demand for the proposed facility is in the 3,600 to 3,765 gpm range. Therefore, one new well, with a capacity of 1,000 to 1,200 gpm is proposed in order meet peak demand and to provide a stand-by well during non-peak demand periods.

Centralized Degassing Headbox: The three existing degassing head boxes have been upgraded and modernized since the original master plan. Two of them will be obsolete after the PRAS systems are fully operational. The third one, serving adult holding and incubation, will require minor modifications to outlet piping to allow for increased flow rates. Groundwater used for make-up to the new grow-out facility PRAS modules will be introduced into the top of the gas management towers and will not need to be treated at the centralized degasser.

Incubation Isolation Facility: An incubation isolation building will be needed to incubate out-of-basin green eggs for the downstream of Prosser URB fall Chinook program. This building will be constructed just north of the existing incubation building, close to the existing chilled water system and drain system. The building will house up to 400 iso-buckets, stacked on shelves, with individual chilled and ambient water supply drops to each bucket. After eyeing, the eggs will be transferred into Marisource trays for final incubation. The trays will be configured in 29 double stacks. Iso-bucket and tray stack effluent will be collected in a single drain pipe and routed through an ozone disinfection tank prior to being combined with the main hatchery drain to the Yakima River.

Fall Chinook Production Building: A new 25,600 square foot hatchery building will house twelve 30-foot diameter circular dual drain tanks. Each pair of tanks will be connected to a PRAS system that will re-condition recirculated water and provide gas stabilization of the incoming groundwater make-up supply. The building will be approximately 80 feet wide and 320 feet long, located within the general footprint of the existing obsolete metal raceways. The grow-out tanks are arranged in groups of four adjacent to PRAS equipment modules for piping economy. Each grow-out tank is 30 feet in diameter and 6.5 feet in depth. The tanks will be recessed into the floor to provide a sidewall height of 4 feet above finished floor elevation. The water treatment equipment associated with each group of tanks consists of the following:

- A 40-micron microstrainer for particle removal.
- A 10-foot-diameter pump sump.
- Three horizontal end-suction reuse pumps.
- A 5- to 6-foot-diameter by 17-foot-tall gas management tower with make-up water connections.
- A dissolved oxygen monitoring and management system.

Each PRAS module would occupy a floor area of 750 square feet (25 feet by 30 feet), with the microstrainer, pump sump, and pumps situated in a recessed floor area, 2.4 feet deep. This will accommodate gravity flow from the grow-out tanks side box drains to the microstrainers and reuse pump sumps.

The water level in the grow-out tanks is controlled by an external standpipe on the bottom drain pipe. Approximately 20% of the flow entering each tank will exit through the bottom drain. Effluent leaving the grow-out tank bottom drains will contain concentrated wastes and will be routed to an effluent microstrainer with the filtered effluent then flowing into the main drain system. Backwash from the effluent microstrainer will be a small flow of 20 to25 gpm that is pumped and routed to the existing pollution abatement pond.

Approximately 80% of the total flow will leave each tank via the sidebox drain and will flow directly to a reuse microstrainer and then into a reuse pump sump. The pump sump is at the low point in the reuse system and will be equipped with a float valve to automatically add make-up water to the system if outflows exceed inflows. Three recirculation pumps, each rated for 60% of total flow, will draw water out of the sump and boost it up to the top of the gas tower. Two pumps are normally ON and the third pump is Standby duty.

The gas tower accomplishes three functions in sequence, starting with the filtered reuse water and make-up water being introduced into the top of the unit. The incoming water is spread out over a diffuser plate and trickles down through a fan-induced, counter-current air flow to strip carbon dioxide. The next step is re-oxygenation via a low-head oxygenator. The gas-stabilized water then falls into the lower portion of the gas tower, which serves a headbox for gravity flow distribution via piping, back to the grow-out tanks.

After leaving the gas tower, the water is routed back to each tank in a given module where it is introduced via a vertical, perforated supply header. Most of the reuse system piping is routed below-slab to allow improved operator access to the tanks and equipment.

Adult Holding Ponds: Broodstock holding ponds will be constructed at Prosser Hatchery to support the Chinook and Coho programs. The summer and fall Chinook broodstock holding requirement is for a peak of 1,050 adult fish during overlapping periods at a 1:1 male to female ratio, to be held in 5,250 cubic feet of water. The Coho broodstock holding requirement is for 600 adult fish (350 at a time, 1:1 male to female ratio) in 1,750 cubic feet of water. In addition, 300 adult fish will be held in 1,500 cubic feet of water for planting in tributaries. A blend of chilled and ambient groundwater will be used to hold early fish on 55 F water from July through mid-October. On October 15th, the adult holding supply will be switched to higher flows of cooler surface water. Groundwater will also be used later in November when the river water supply is reduced due to annual maintenance on Chandler Canal.

In order to provide flexibility to sort and segregate fish, four holding ponds with a volume of approximately 2,000 cubic feet each are proposed. Each pond will have screen guides to divide them into to three cells of 660 cubic feet, providing a total of twelve holding cells. Fall Chinook will be sorted into at least four cells in order to segregate new, ripe, green, and close-to-ripe fish. An open-sided roofed over concrete slab is provided for spawning activities at the upstream end of the holding ponds.

The combined adult holding pond facility will have an overall footprint of approximately 42 feet by 80 feet. The concrete walls of the holding cells will have five feet of freeboard plus jump panels to contain the fish. To minimize fish transport during the spawning process, the holding facilities will be located adjacent to the south of the existing spawning building.

Administration Building: The proposed administration building is approximately 2,400 square feet. It will provide office space for the hatchery manager and three staff, along with a break room/kitchen, showers lockers restrooms, mud room, and mechanical/electrical room. This building will be located to the west of the existing office trailer, and will overlook the new rearing buildings to the south and west. The existing three-phase overhead powerline in this area may need to be relocated or routed underground to avoid conflicts with the new building depending on final site layout.

Site Paving and Utility Upgrades: The major travel and circulation areas on the site will be asphalt surfaced to reduce dust and disease vectors and to provide all-weather driving surfaces for hatchery operations. Utility upgrades will include a possible domestic wastewater connection to the municipal sewer, treatment of stormwater run-off from parking areas, centralized emergency power, and communications upgrades.

6.1.4 Prosser Fall Chinook Production and Operation Schedules

Detailed operations schedules have been developed to illustrate groundwater supply flows and culture tank holding requirements by month for the proposed Prosser Hatchery programs (see Appendix D). Table 6-1 provides a summary of peak monthly demands and tanks in service for the summer Chinook transition phase and fall Chinook program at Prosser.

Table 6-1. Projected peak monthly groundwater flows (in gallons per minute) and rearing tank summary for Prosser Hatchery Summer Chinook Transition Phase and Fall Chinook Programs

Month	Adult Holding Flow	Incubation Flow	Ground Water Make-Up to Rearing Flow	Total Groundwater Flow for Fall Chinook	30-ft Dia Rearing Tanks in Service
January		324	1,733	2,057	11
February			1,733	1,733	11
March			1,733	1,733	11
April			1,575	1,575	10
May			1,260	1,260	8
June			473	473	3
July	200		473	673	3
August	600		473	1,073	3
September	2,000		473	2,473	3
October	2,000	324	473	2,797	3
November	1,350	324	473	2,147	3
December		324	473	797	3

6.1.5 Summer Chinook Facilities

The summer-run Chinook program described in the original master plan has been changed to phase out production at Marion Drain Hatchery due to imprinting issues, delete the yearling program and focus on the production of 1,000,000 sub-yearlings (90 to 100 fpp). This sub-yearling production program would be supported initially during a transition phase at the existing Prosser Hatchery for adult holding, incubation, and early rearing. Long term, the program would be moved to a new hatchery site upstream of the Naches-Yakima River confluence. During the transition phase, fish would be reared to a size of 250 fish per pound at Prosser, marked and half the fish moved to two remote acclimation/release sites for rearing to a release size of 90 to 100 fpp. Two potential acclimation sites are under consideration:

a) An expansion of the existing RAMF at Roza Dam on the Yakima River

b) WDFW property near Oak Flats, just upstream of the town of Naches on the Naches River.

The grow-out portion for the other half of the transition phase program would utilize two of the dual drain circular tanks and a 75% PRAS system in the proposed Prosser fall Chinook building. Table 6-2 provides a summary of the proposed program.

Table 6-2. Operations schedule for proposed Summer Chinook program.

Species/Life Stage	Timeframe	No. of Fish	Water Requirement	Holding Volume
Summer Chinook/Adult Holding	Aug-Sept	620 adults	1,000 gpm	2,500 cf
Summer Chinook/Incubation	Nov- Early Jan	1,178,000 Eggs	96 gpm chilled groundwater	16 double stacks
Summer Chinook Early Rearing	Jan-Feb	1,000,000 sub-yearlings	156 gpm groundwater at 25% make-up	3,965 cf
Summer Chinook/Acclimation	Mar - April	500,000 sub-yearlings at two facilities	832 gpm surface water single pass at each facility	5,006 at each facility

6.1.6 Existing Facilities for Summer Chinook

The transition phase of the summer Chinook program from Marion Drain Hatchery to Prosser will start with limited production at Prosser Hatchery and would utilize a portion of the proposed adult holding, incubation and grow-out facilities. For the long-term phase, it may be feasible to utilize some existing facilities at the Melvin R. Sampson (MRS) Coho Hatchery for adult holding and early rearing. The summer Chinook holding adult holding period ends in mid-September, a month before the Coho adult holding period begins. There would be adequate adult holding capacity to accommodate both programs at MRS, however groundwater shortages would need to be addressed. For early rearing, one of the two-tank PRAS modules at MRS could be used for the summer Chinook early rearing phase since only seven of the ten tanks available are needed for the Coho program in January and February. The incubation room at MRS has a couple spare 16 tray stacks and would not be adequate to support the summer Chinook program. An alternative would involve using existing facilities at MRS to support the long term phase of the summer Chinook program. This alternative is presented below.

6.1.7 Proposed Summer Chinook Facilities

Transition Phase: The transition phase of the summer Chinook program at Prosser would not overlap with peak adult holding and rearing for the fall Chinook and Coho programs and would utilize available water supply and holding capacity except for incubation. A total of four additional double stacks of vertical tray incubators would need to be added to the existing Prosser incubation room, along with a small amount of associated supply and drain piping. The proposed Chinook building has adequate tankage to accommodate the summer chinook transition program. The remainder of the proposed improvements for the summer Chinook transition phase would be the new portable acclimation facilities for 250,000 fish each, at release sites on the Naches and upper Yakima Rivers. Each acclimation site would have the following major components:

- A surface water intake with duplex pumps to deliver 416 gpm of surface water supply
- A 24-inch diameter degassing column and headbox
- Two 20-foot diameter dual drain circular tanks, each to be loaded with 125,000 sub-yearlings
- Drain piping and outfall to river, also configured for fish release
- Monitoring and alarm system
- Predator protection
- Feed storage
- A gravel pad for the tanks and site access improvements as needed

Long-Term Phase: Two alternatives were considered for infrastructure to support the long-term phase of the summer Chinook program. Alternative LT1 would utilize a portion of the MRS Coho hatchery for adult holding, incubation, and early rearing, while Alternative LT2 would construct all new facilities at an undeveloped upper Yakima or Naches River site.

Under Alternative LT1, a new incubation room containing 16 double stacks of vertical incubators would be added adjacent to the north wall of the present incubation room at MRS. A dual temperature supply head trough with chilled and ambient water supply drops would be incorporated to allow control of egg development rates. The supply and drain piping could be connected to existing piping systems fairly easily.

The adult holding period for the summer Chinook program is completed in mid-September, before Coho adult holding begins in mid-October, so there would be plenty of holding capacity for the 620 summer Chinook adults at MRS. If MRS releases the 500,000 parr equivalent Coho in July as described in Section 2 above, chilled groundwater may be available for summer Chinook adult holding beginning in August. A new booster pump system, and perhaps a new groundwater well may be required to supply water to adult holding. It may be possible to utilize up to 600 gpm of groundwater from the downstream side of the MRS pre-cooling heat exchangers, blended with a portion of chilled groundwater. The final configuration and capacity of the MRS chiller system would need to be verified to determine the scope of potential modifications that would be needed to accommodate summer Chinook adult holding.

The early rearing for summer Chinook could be accomplished at MRS in two of the 26-foot diameter grow-out tanks which would be available for the January-February early rearing period. Either river water or groundwater would be available during this time period.

Alternative LT2 would construct a completely new summer Chinook hatchery on tribal, state, or federal land along the upper Yakima or Naches Rivers. The major components of the new hatchery would be:

- A 2,500 cf adult holding raceway with predator protection

- A 5,000 sf hatchery building to house incubation, four 20-foot diameter dual drain early rearing tanks, 75% reuse equipment, a small office, restroom, feed storage, and mechanical/electrical rooms.
- An 800 gpm river water supply (with screens), and 208 gpm groundwater supply. A chiller system with energy recovery would be needed to cool water for both adult holding and incubation supply, with an approximate capacity of 50 tons.
- An allowance for an effluent microstrainer and dual cell treatment pond is included as a Best Management Practice, though since production is less than 5,000 lbs/yr and NPDES permit would not be required.

The overall land requirement for Alternative LT2 would be less than an acre, however, environmental set-backs and floodway considerations may increase the land area needed by a significant amount. More detailed descriptions of the Alternative LT2 infrastructure are provided below.

Surface Water Supply – Due to the low flow rate required, the surface water supply could use passive screens. Actively cleaned screens are recommended to improve system reliability. The concept design cost estimate includes actively cleaned screen and enclosed duplex submersible wet well-type pumps, with automated controls, along with a micro-strainer, UV disinfection and aeration treatment.

Groundwater Wells – Three wells with capacities of 100 to 150 gpm are included to meet peak demands and provide redundancy. The availability of groundwater at a specific site should be investigated for water rights, quantity and quality prior to proceeding with any further planning and design

Hatchery Building – The proposed hatchery building will have a rectangular footprint, approximately 80 feet long and 54 feet wide. It will house four 20-foot circular tanks connected to a PRAS system for early rearing. Proposed exterior materials include steel siding with a concrete or masonry base to reduce potential impact damage by equipment or trucks. Metal roofing and trim are also envisioned. Insulated translucent sandwich panels will provide natural daylight into the production area. The exterior color palette is proposed to be earth tones.

Utility Systems – Needed improvements to utility systems include?

Power: Three phase power with a standby generator for critical loads.

Communications: Phone and data services will be extended to the new hatchery building.

Potable water: A separate potable well is included.

Domestic Wastewater: On-site septic tank and drainfield.

Stormwater: Run-off from the newly developed portions of the site would be directed into filter strips and/or bio-swales for treatment prior to leaving the site.

Adult Holding and Spawning Facility – Summer Chinook broodstock would be collected at the existing Prosser or Roza Dam traps and transported to the selected site for holding and spawning. The broodstock goal is 620 fish that will be held onsite for two to three months, from late July through mid-September of each year.

The adult holding facility would consist of two concrete post-sort pools with screen partitions to segregate new fish, green fish, ripe and un-ripe fish, similar to the ponds planned for Prosser Hatchery. Adult fish will be held on surface water and/or groundwater depending on water temperatures, at maximum densities of 5 cubic feet per fish, with upwelling water supply flows of 2.0 gpm per fish. The holding ponds will have 4 to 5 feet of freeboard plus jump panels to contain the fish. At the head end of the ponds, a concrete pad with an open-sided roof covering would provide a spawning area for collecting eggs as the fish ripen. The concrete pad will sloped toward floor drains that routes spawning wastes to a buried holding to be pumped out at the end of each season.

Incubation Facilities – Green eggs would be processed in an egg prep room located in the hatchery building. They would be loaded into bulk incubation troughs in the incubation room until eye-up, then transferred into adjacent heath trays at 5,000 eggs per tray for the duration of the incubation period. Chilled and ambient groundwater supplies would be routed to each trough and incubation unit. The target incubation water temperature is 44°F, with 6 gpm of supply flow to each stack of incubators. Sixteen double stacks will be required, with a total single pass flow-through rate of 96 gpm.

A hard-piped chemical feed system will be used to deliver argentine or formalin treatments to the water supply as needed to prevent fungus growth on the eggs. Overflow water from the troughs and trays will be collected in floor trenches that convey the water into the hatchery drain system. Adequate dilution flow will be maintained through the drain system to avoid exceeding chemical concentration limits in the hatchery outfall. For the duration that the program uses out-of-basin broodstock, the effluent from the incubation facility will be disinfected with an ozone treatment system prior to discharge from the hatchery building.

Rearing Facilities – Beginning in late January, swim-up fry will be transferred from the incubators into the early rearing tanks fitted with water reuse technology to reduce overall water demand at the facility by 75 percent. Water to be reused will overflow from each tank via an overflow in the tank sidewall. It will then flow by gravity through a micro-strainer drum screen to remove suspended particulates, and then into a pump sump. Booster pumps will then lift the water into a degassing and oxygenation tower to remove the carbon dioxide byproduct from fish respiration, and increase dissolved oxygen to near saturation before the water is returned to the rearing tanks. The 25 percent make-up water flow will be introduced via a metered connection at the top of the tower to improve water quality before it enters the rearing tanks.

For the early life stages groundwater will be used as the make-up water source. Peak make-up water flow rates to the reuse system will be 208 gpm, or 25 percent of the total flow rate.

Cleaning Waste Treatment – Each rearing tank will have a center bottom drain to collect solids and convey them along with about 15 percent of the total flow to an effluent microstrainer. The microstrainer overflow line will route clarified drain water to the existing earthen ponds for serial reuse. The micro-strainer backwash drain line will route the concentrated feces and un-eaten along with the to an offline cleaning waste settling pond.

Acclimation Facilities – Acclimation facilities for the long-term phase would be portable style facilities, and would each be sized for 500,000 sub-yearlings. Therefore, components would be double the capacity shown for the transition phase described above; an 832 gpm river water intake and pump station, four of the 20-foot diameter circular tanks, etc. Potential acclimation sites for both the transition and long-term phases have been identified:

Upper Yakima River Site: An area to the north of the existing Roza Adult Monitoring Facility (RAMF)

Naches River Site: A WDFW owned parcel at Oak Flats, just west of the town of Naches, on the left bank of the Naches River.

The RAMF is located on the left bank of the Roza Dam reservoir pool, on a 26.85 acre parcel #544233, owned by the US Department of Interior and zoned for fish passage land use according to Kittitas County records (Figure 6-11). The site has a pumped surface water supply from the USBR. Further investigations of the site is needed to verify feasibility.

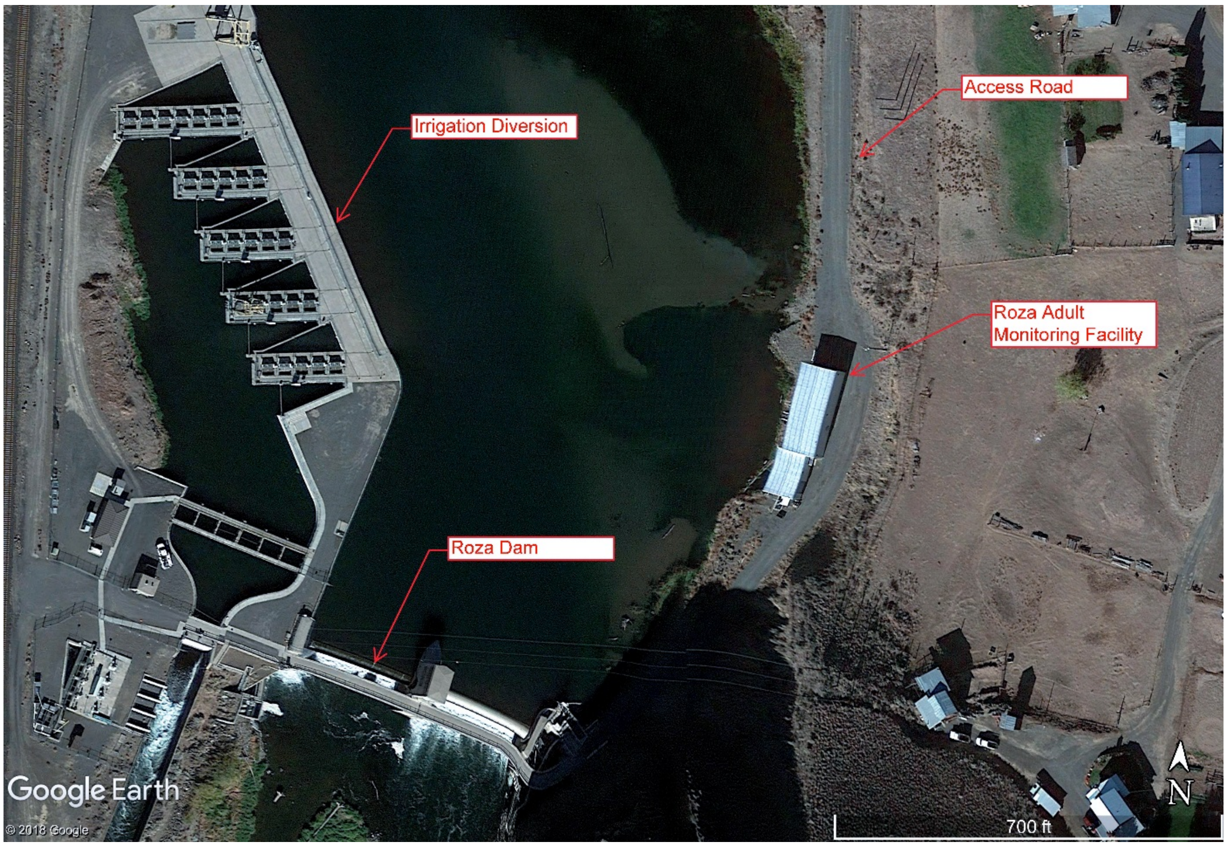


Figure 6-11. Roza Dam – Potential Upper Yakima Acclimation Site

The WDFW land at Oak Flats is Parcel #16153412001, a 208.3 Acre lot, located a short distance upstream of the Highway 12-Highway 410 intersection (Figure 6-12). The site is approximately 18 miles upstream of the confluence of the Naches with the Yakima River.

Figure 6-12. Oak Flats - Potential Acclimation Site

The Oak Flats site is entirely classified as a “Conservation – Wetlands” zone under the State critical areas designation and is mostly outside of the regulatory floodway. Determination of the Naches River ordinary high water mark, wetland delineation, and topographic survey of the site would be needed in order to develop conceptual design of the planned improvements.

The Oak Flats site is located upstream of high-quality spawning habitat which makes it desirable from a biological standpoint according to YKFP. Detailed site selection and planning for acclimation facilities will be conducted separately from this master plan update.

6.1.8 Summer Chinook Long-Term Production and Operation Schedules

Detailed operations schedules have been developed to illustrate groundwater supply flows and culture tank holding requirements by month for the proposed long-term Summer Chinook program (see Appendix D). Table 6-3 provides a summary of peak monthly demands and tanks in service. For adult holding, a blend of groundwater (GW) and surface water (SW) will be used to control temperatures. Incubation and early rearing will utilize only groundwater. Acclimation will use surface water for imprinting fish.

Table 6-3. Projected peak monthly groundwater flows (in gallons per minute) and rearing tank summary for long-term Summer Chinook Program.

Month	Adult Holding Flow (GW-SW Blend	Incubation Flow	Ground Water Make-Up to Rearing Flow	Acclimation Site Flow – Single Pass SW	Tanks in Service
January		96	315		Two 26 foot Dia
February			315		Two 26 foot Dia

Month	Adult Holding Flow (GW-SW Blend	Incubation Flow	Ground Water Make-Up to Rearing Flow	Acclimation Site Flow – Single Pass SW	Tanks in Service
March			315	833 per site	Four – 20 foot Dia
April			315	833 per site	Four – 20 foot Dia
May					
June					
July					
August	600				Adult Ponds
September	1000	96			Adult Ponds
October		96			Adult Ponds, Incubation
November		96			Incubation
December		96			Incubation

6.2 CONCEPTUAL DESIGN OF COHO PROGRAM FACILITIES

6.2.1 Existing Coho Facilities at Prosser Hatchery

The Coho program at Prosser Hatchery shares water supply and drain systems, utilities, adult holding, incubation building, and related supporting infrastructure with the fall Chinook program described in Section 4 above. Please refer to Section 4.5.2 for a detailed description of these existing facilities.

6.2.2 Proposed Coho Facilities at Prosser Hatchery

The proposed Coho facilities at Prosser Hatchery will continue to share proposed incubation and adult holding facilities with the Fall Chinook program described in Section 4.5.3 above. The Coho rearing would be conducted in a new 17,200 square foot building located within the general footprint of the two easterly existing lined ponds in the central portion of the site. The building would be approximately 80 feet wide by 215 feet long, with a total of eight 30-foot diameter circular dual drain tanks and four PRAS modules. The tanks would be arranged in two groups of four at either end of the building, with the four PRAS modules located in the center of the building for piping economy. The tanks, PRAS equipment, and water supply and drain piping would be very similar to those described for the Fall Chinook hatchery building described in Section 4.5.3 above.

6.2.3 Prosser Hatchery Coho Production and Operation Schedules

Planning level production and operations schedules for the proposed Coho programs have been developed based on the program described in Sections 2.2 and 5.2.2 and the facilities described above. These schedules demonstrate how the target production goals will be achieved. Operations schedules were developed using the same loading densities and groundwater supply flows as the Fall Chinook program described above.

Each preliminary operations schedule covers a two-year period in order to understand and incorporate overlapping water requirements for juvenile fish (reared to a yearling size) from two brood years on site at one time. Summary schedules of the flow rates proposed for Coho rearing at the Prosser are shown in Table 6-4.

The yearling Coho development cycle at Prosser will be as follows:

- October through November: Adult holding, (most fish show up after October 15 when higher flows of surface water will be used instead of groundwater).
- October through February: Egg incubation.
- Late February until the following March: Rearing.

Table 6-4. Projected peak monthly groundwater flows (in gallons per minute) and rearing tank summary for Prosser Hatchery Coho Program.

Month	Adult Holding Flow	Incubation Flow	Ground Water Make-Up to Rearing Flow	Total Groundwater Flow for Coho	30-ft Dia Rearing Tanks in Service
January		72	945	1,017	6
February		72	1,260	1,332	8
March			1,260	1,260	8
April			315	315	2
May			945	945	6
June			945	945	6
July			945	945	6
August			945	945	6
September			945	945	6
October	500	72	945	1,517	6
November	700 SW	72	945	1,017	6
December		72	945	1,017	6

The peak flow requirement at Prosser for this program is approximately 1,517 gpm (3.82 cfs) of groundwater in October when there are overlapping demands for adult holding, incubation, early rearing and final rearing life stages.

6.3 CONCEPTUAL DESIGN OF STEELHEAD PROGRAM FACILITIES

The existing steelhead kelt program facilities at Prosser Hatchery are proposed to be upgraded to accommodate improvements generally described in the 2016 CRITFC Master Plan for Snake River kelt re-conditioning. The capacity of the facility will be 1,500 kelts. These fish would be held year-round in four

20-foot diameter circular dual drain tanks, and three 10-foot quarantine tanks with two 75% PRAS modules and groundwater make-up supply. The tanks and PRAS equipment would be located in an enclosed building, approximately 96 feet by 54 feet (5,184 square feet) to save on maintenance costs and eliminate predation.

Based on a recirculated flow rate of 1.5 gpm per fish, and 25% make-up water, the groundwater demand for the kelt facility would be 563 gpm (1.25 cfs) on continuous year round flow. The dual drain circular tanks and PRAS equipment would be the same at described for Fall Chinook in Section 4.5.3, except that the equipment would be proportionally smaller due to the reduced water volumes and tank size.

6.4 PROSSER HATCHERY OPERATIONS

Provide summary information for Prosser in this section since all three programs will have components here.

6.4.1 Summary of Prosser Operations for all Programs

A summary schedule of all fish programs at Prosser Hatchery is provided in Table 6-5.

Table 6-5. Prosser Hatchery operations schedule, flow and tankage requirements for proposed URB fall Chinook, fall component of the summer/fall Chinook and lower Yakima Coho programs.

Species/Life Stage	Timeframe	No. of Fish	Water Requirement	Holding Volume
Fall Chinook / Adult Holding	Sept – Nov	1000 adults	150 gpm Groundwater (Oct) 2000 gpm surface water (Nov)	3000 cf
Summer Chinook/Adult Holding	Aug-Sept	620 adults	1000 gpm Groundwater	2,500 cf
Coho / Adult Holding	Oct – Nov	500 adults	100 gpm groundwater (Oct) 1000 gpm Surface Water (Nov)	1000 cf
URB Chinook / Downstream of Prosser Program Incubation	Oct – mid-Jan	2,145,000 eggs	160 gpm chilled groundwater	500 isolation buckets, transferred to 27 double stacks of Marisource trays (5,000 eggs per tray)
Fall Chinook / Upstream of Prosser Program Incubation	Oct – mid-Mar	556,000 eggs	44 gpm chilled groundwater	FRP troughs, transferred to 8 double stacks of Marisource trays (5,000 eggs per tray)
Summer Chinook Incubation	Oct - Jan	1,178,000 eggs	96 gpm chilled groundwater	16 double stack of Marisource trays (5,000 eggs per tray

Species/Life Stage	Timeframe	No. of Fish	Water Requirement	Holding Volume
Coho Incubation	Oct – Feb	770,000 eggs	74 gpm chilled groundwater	FRP troughs, transferred to 13 double stacks of Marisource trays (4,000 eggs per tray)
URB Chinook / Downstream of Prosser Program Juvenile Rearing	Jan – March	1,800,000 mark and split	470 gpm groundwater at 25% make-up	11,400 cf
	March- July	1,700,000 sub-yearlings	940 gpm groundwater at 25% make-up	22,800 cf
Fall Chinook / Upstream of Prosser Program Juvenile Rearing	Jan – Apr	500,000 sub-yearlings	315 gpm groundwater at 25% make-up	7600 cf
Summer Chinook Rearing	Jan - Feb	500,000 sub-yearlings	315 gpm groundwater at 25% make-up flow	5000 cf
Coho / Yearling Rearing	Feb – +1 March	500,000 yearlings	945 gpm groundwater	22,800 cf
Steelhead Kelt Re-Conditioning	Year-round	1,500 kelts	601 gpm groundwater	4,500 cf

6.4.2 Prosser Hatchery Biological Criteria and Rearing Units

Significant changes from the original design is for the new rearing facilities to utilize dual drain circular tanks with 75% partial recirculating aquaculture systems (PRAS), and only groundwater (no river water) as the water supply source. The dual drain tanks feature a center bottom drain which removes a large percentage of solid wastes in a small flow sidestream, and a sidewall drain that conveys clarified overflow water from the tank (Figure 6-13). This type tank has several documented benefits (Summerfelt 1998) over rectangular raceways including:

- Vertical inlet diffusers that allow for adjustable rotational flow velocities that produce stronger swimming fish that have faster downstream migration speeds and survival rates.
- More uniform mixing of the water column inside the vessel and improved water quality that increases allowable loading densities at reduced water flow rates.
- Flow patterns that provide rapid, self-cleaning, settleable solids flushing with concentration of wastes in the bottom drain flow. This results in reduced labor costs for vessel cleaning and increases the efficiency of TSS, BOD, and phosphorous removal from hatchery effluents.

Figure 6-13. 30-Foot-Diameter Circular Tank with Side Drain and Bottom Drain

Other circular tank advantages include long lasting smooth interior vessel surfaces (less prone to freeze/thaw degradation and roughening compared to concrete), which offer long service life, especially when protected from direct sunlight by a roof cover.

The tanks incorporated in the plan have a screened center bottom drain sump, plumbed to an external standpipe. This standpipe is temporarily pulled to flush solids from the tank or is pulled with the water supply turned off to fully drain the tank. Each tank also has a screened sidebox drain that also has a standpipe that is set to control the water level in the tank. Tanks floors are sloped at 2 to 3 degrees towards the center bottom sump for ease of cleaning and drainage. Tank accessories include an 18-inch square viewing window in the sidewall of each tank.

A maximum density index of 0.3 lb/cf/in of length has been used for the fall Chinook and Coho programs reflecting the experience of Yakama Nation fish culturists. The resulting bio-programming schedules depict water use by month and space requirements for each operational area of the fish culture process, including incubation, and juvenile rearing indoors. The adult holding component of each program is also identified along with a separate kelt re-conditioning program. Adult holding volumes are based on 2 cubic feet per fish for Coho and 3 cubic feet per fish for fall Chinook. Flows are 2 gpm per fish. Steelhead kelt long-term holding volumes are based on 3 cubic feet per fish and 1.5 gpm per fish of PRAS flow with full dissolved oxygen saturation on the supply.

The preliminary operations schedules (Appendix D) depict a two-year period in order to understand and incorporate potential overlapping water requirements for juvenile fish (reared to a yearling stage) from two brood years on site at one time for the yearling program. Detailed descriptions of facilities associated with each of the programs are provided in Sections 6.1, 6.2 and 6.3.

6.4.3 Summary of Prosser Groundwater Flow Requirements

After October 15th of each year, when irrigation season ends in the lower Yakima Valley, surface water becomes available to Prosser Hatchery and will be used to supply adult holding for the late October-early November peak holding season. The remainder of the proposed facilities at Prosser will utilize groundwater as the sole source of supply. Table 6-6 illustrates the total groundwater flow requirements for the facility.

Table 6-6. Prosser Hatchery Proposed Groundwater Flow Summary.

Month	Fall and Summer Chinook Flows	Coho Flows	Kelt Flows	Total Groundwater Flow
January	2,057	1,017	601	3,675
February	1,733	1,332	601	3,666
March	1,733	1,260	601	3,594
April	1,575	315	601	2,491
May	1260	945	601	2,806
June	473	945	601	2,019
July	473	945	601	2,019
August	1,073	945	601	2,619
September	1,373	1045	601	3.019
October	1,297	1,517	601	3,415
November	2,147	1,017	601	3,765
December	797	1,017	601	2,415

7.0 LOCAL AND REGIONAL CONTEXT FOR THE YAKIMA COHO, CHINOOK AND STEELHEAD PROGRAMS

7.1 GEOGRAPHIC AND ENVIRONMENTAL CONTEXT

7.1.1 Location

The Yakima River Basin is located in south central Washington. The 6,100 square mile area is bordered by the Cascade Mountains to the west, the Columbia River to the east, the Wenatchee Mountains to the north, and by the Simcoe Mountains and Horse Heaven Hills to the south. Major cities in the Yakima Basin include Ellensburg, Yakima, Prosser, and Toppenish.

The Yakima River bisects the basin from north to south. Most major tributaries enter from the west down the slopes of the Cascade Mountains. Primary project facilities are in the lower portion of the subbasin (Figure 4-4). Prosser Hatchery is on the mainstem Yakima River at RM 47. Marion Drain Hatchery is 6.7 miles upstream of the mouth of an 18-mile-long irrigation drain which enters the Yakima

River at RM 77. Much further upstream in the watershed to the north of Ellensburg, the Melvin R. Sampson Hatchery is being built at RM 158 of the mainstem Yakima River.

7.1.2 Climate

The climate of the Yakima Basin is highly variable with elevation. Near the Cascade crest, annual precipitation ranges from 80 to 140 inches, while the lower elevations in the valleys to the east receive 10 inches or less. This sharp precipitation gradient in the basin falls off in a southeasterly direction. Moist maritime air passing over the Cascade Range results in precipitation in the western part of the subbasin and a rain shadow in the east. The rainy season in the valleys occurs from November through January, when approximately half the annual precipitation falls. Cascade Mountain snowpack contributes most of the river flow and water for irrigated agriculture; virtually all of the streams in the basin originate at higher elevations where the annual precipitation exceeds 30 inches.

Summer temperatures average 55˚F in the mountains and up to 82˚F in the valleys. Average maximum winter temperatures range from 25˚ to 40˚F, while average minimum winter temperatures range from 15˚ to 25˚F. Minimum temperatures of -20˚ to -25˚F have been recorded in most areas.

7.1.3 Geology, Soils and Land Types

The Yakima Basin contains two very different geographic regions. The western third of the basin contains the Cascade Range geologic province. This area is a thick sequence of volcanic rocks resting on older metamorphic, intrusive, and sedimentary rock. The volcanic rocks include lavas and pyroclastic materials that originated from numerous volcanic centers. Younger rocks are exposed where uplift and erosion has occurred. These areas are typically metamorphosed oceanic crust and granitic intrusions. The upper mainstem Yakima and Naches rivers and several tributaries occupy valleys excavated by glaciers. Along the sides and bottom of most of these valleys, younger materials such as glacial deposits, mudflows, landslides, and stream alluvium are often present.

The remainder of the Yakima Basin lies in the Columbia Basin province where the dominant geologic materials are basalts and sedimentary interbeds of the Columbia River Basalt Group (CRBG). The CRBG consists of a thick sequence of basalt lavas, interspersed with sedimentary layers. The CRBG includes three main units: Saddle Mountains Unit, Wanapum Unit, and the Grande Ronde Unit. Each of these units may consist of many individual flows. The thickness of the basalt in the lower and middle Yakima River Basin ranges from 9,000-12,000 feet, growing thicker in the downstream direction. Individual flows typically have volumes of two to seven cubic miles (TCWR 2001). The basalt plateau of the eastern basin was folded and faulted into a series of west-east trending ridges and valleys. Outflow from glaciers along the Cascade crest delivered glacial outwash to the basins, resulting in the partial filling of Cle Elum, Kittitas, and upper and lower Yakima valleys with sand, gravel, and silt over the basalt.

7.1.4 Hydrology

The Yakima Basin has approximately 1,900 miles of streams that have been mapped by the US Geological Survey. The Yakima River originates at the outlet of Lake Keechelus and flows for 214 miles in a southeasterly direction to its confluence with the Columbia River at Richland, Washington. With its tributaries, the Yakima River drains about 6,150 square miles, or 4 million acres (YSFWPB 2004). Primary tributaries include Naches River (Little Naches, Bumping, and Tieton rivers), Sqauk, Taneum, Umtanum, Manastash, and Wenas creeks, and Ahtanu, Toppenish and Satus creeks.

The hydrologic features of the basin vary along with topography. In the higher elevations, steeply-dropping streams form waterfalls, pools, and rapids. In the lower portions of the valley, the Yakima River alternates from narrow canyon sections to broad meandering stretches with floodplains and terrace features. The Yakima Basin can be broken into five distinct channel types that are very apparent along the altitudinal gradient from source to mouth: 1) high gradient, largely constrained headwaters; 2) expansive braided alluvial floodplains; 3) constrained canyons; 4) meanders with expansive floodplains containing oxbows; and 5) deltaic floodplain at the confluence with the Columbia River.

Six major reservoirs are located in the basin and form the storage component of the federal Yakima Project, managed by the US Bureau of Reclamation (USBR). The Yakima Project irrigates a narrow strip of fertile land that extends for 175 miles on both sides of the Yakima River and totals approximately 464,000 acres. These reservoirs are the Keechelus, Kachess, and Cle Elum lakes on the upper Yakima River; Rimrock and Clear lakes on the Tieton River; and Bumping Lake on the Bumping River. The Tieton and Bumping rivers are tributaries to the Naches River. Total storage capacity of all reservoirs is approximately 1.07 million acre/feet. The construction and operation of irrigation reservoirs has significantly altered the natural, seasonal hydrograph of all downstream reaches (Eitemiller et al. 2000).

Groundwater in the Yakima Basin is controlled by a variety of factors such as structural folds and faults, and characteristics of the rock fabric or unconsolidated sediments. The basalt folds of the Yakima Basin produced a series of groundwater basins that influence the hydrologic cycle. For example, Marion Drain is an irrigation runoff ditch that intercepts alluvial gravels and collects and distributes large quantities of groundwater (HSRG 2009a).

7.1.5 Water Quality

The Washington Department of Ecology has rated the Yakima River from the confluence with the Cle Elum River (RM 185.6) to the mouth as having Class A, or “excellent” water quality. The American, Bumping, upper Naches and upper Yakima rivers were classified as AA or “exceptional”. However, there are some specific water quality parameters that do not conform to this classification.

The extensive irrigation water delivery and drainage system in the Yakima River Basin exerts a significant effect on water quality conditions and aquatic health in agricultural streams, drains, and the Yakima River. Chemicals and other agricultural byproducts are the most common contaminants in the Yakima River system. Nitrate and orthophosphate were the dominant forms of nitrogen and phosphorus found in the Yakima River and its agricultural tributaries. These forms of nitrogen and phosphorus are highly water soluble, and concentrations in some agricultural drains were high enough to support nuisance-level growths of algae (Fuhrer et al. 2004).

Historically, organochlorine insecticides were frequently detected in agricultural streams in the Yakima River Basin. DDT, DDE, dieldrin, and heptachlor epoxide exceeded the USEPA chronic water quality criteria for the protection of aquatic life, but concentrations of total DDT in water are decreasing over time (Fuhrer et al. 2004).

7.1.6 Habitat and Biota

7.1.6.1 Fish

The abundance of salmon, steelhead and resident fish in the Yakima Subbasin have been an important cultural and subsistence resource for the Yakama Nation as well as for sport anglers. Currently, the basin is known to support 38 species of fish, of which 24 are native and 14 nonnative (Table 7-1; Tri-County Water Resource Agency 2001). Populations of anadromous fish have declined sharply during the 20th Century, and some native populations have been extirpated. Bull Trout (*Salvelinus confluentus*) were listed as threatened in the Columbia River Basin by the US Fish and Wildlife Service in June 1997. Steelhead (*Oncorhynchus mykiss)* were listed as threatened species in the mid-Columbia River watershed by the National Marine Fisheries Service in March 1999. Key species are described in the sections that follow.

Table 7-1. Fish species found in the Yakima River System.

Fish Species	Scientific Name
Western Brook Lamprey	*Lampetra richardsoni*
Pacific Lamprey	*Entosphenus tridentatus*
Mountain Whitefish	*Prosopium williamsoni*
Brown Trout[1]	*Salmo trutta*
Cutthroat Trout	*Salmo clarki*
Brook Trout[1]	*Salvelinus fontinallis*
Bull Trout	*Salvelinus confluentus*
Coho	*Oncorhynchus kisutch*
Rainbow Trout	*Oncorhynchus mykiss*
Steelhead	*Oncorhynchus mykiss*
Chinook	*Oncorhynchus tshawytscha*
Kokanee	*Oncorhynchus nerka*
Carp[1]	*Cyprinus carpio*
Chiselmouth	*Axcrocheilus alutaceus*
Redside Shiner	*Richarsonius balteatus*
Longnose Dace	*Rhinichthys cataractae*
Leopard Dace	*Rhinichthys falcatus*
Speckled Dace	*Rhinichthys osculus*
Northern Pikeminnow	*Ptychocheilus oregonensis*
Peamouth	*Mylocheilus caurinus*
Largescale Sucker	*Catostomus macrocheilus*
Mountain Sucker	*Catostomus platyrhynchus*
Bridgelip Sucker	*Catostomus columbianus*
Channel Catfish[1]	*Ictalurus punctatus*
Brown Bullhead[1]	*Ictalurus nebulosus*
Black Bullhead[1]	*Ictalurus melas*

Fish Species	Scientific Name
Mosquitofish[1]	*Gambusia affinis*
Three-Spine Stickleback	*Gasterosteus aculeatus*
Largemouth Bass[1]	*Micropterus salmoides*
Smallmouth Bass[1]	*Micropterus dolomieui*
Black Crappie[1]	*Pomoxis nigromaculatus*
Bluegill[1]	*Lepomis macrochirus*
Pumpkinseed[1]	*Lepomis gibbosus*
Walleye[1]	*Stizostedion vitreum*
Yellow Perch[1]	*Iperca flavescens*
Piute Sculpin	*Cottus beldingi*
Torrent Sculpin	*Cottus rhotheus*
Mottled Sculpin	*Cottus bairdi*

[1] Species introduced to the basin.
Source: Tri-County Water Resource Agency 2001.

Coho Salmon

Coho salmon were extirpated from the Yakima Basin in the early 1980s due to overfishing, instream flow reductions, habitat degradation, and the presence of fish passage barriers (Dunnigan et al. 2002). Historical runs of Coho to the Yakima River Basin are estimated to have been between 44,000 and 100,000 fish (HSRG 2009a). Today, natural reproduction of hatchery-origin Coho is occurring in both the Yakima and Naches rivers. Historically, spawning occurred in the upper Yakima above the Cle Elum confluence as well as in the lower alluvial reaches of the Naches below the Tieton confluence (HSRG 2009a).

Since regular outplanting of hatchery smolts began in 1985, Coho returns have steadily increased. From 1999 through 2018, Coho escapement into the Yakima Basin averaged approximately 5,200 adults (after terminal harvest but before broodstock collection; Table 2-6). The recreational terminal Coho fishery is negligible and averages about 1% of the terminal run size (Table 2-12). The majority of Coho redds are located in the mainstem Naches and Yakima Rivers in reaches downstream of historic production areas, presumably due to hatchery smolt acclimation and/or release sites that are downstream of historic spawning areas. Over time, the major spawning area has moved from in or below the Granger Drain (RM 83) to Sunnyside Dam (RM 103.8), to the middle and upper Yakima, much closer to historical spawning grounds.

Coho return to the Yakima Basin from September to November. Spawning occurs in riffles or where groundwater seepages occur. Coho generally spend one season in freshwater before migrating to the ocean, and return as 3-year old adults to spawn in their natal streams.

The Yakima River Coho population has not been defined formally by Endangered Species Act petitions or listings because it is derived from reintroduced non-native stocks.

Summer/Fall Chinook Population Components

Yakima River summer/fall Chinook are part of the Upper Columbia River summer/fall Chinook ESU, which is not listed under the ESA.

Summer/fall Chinook salmon were once abundant in the Yakima River Basin. Naturally propagated returns may have been as high as 250,000 fish prior to the mid-19th century. As a result of historical land and water development and fisheries management practices, the summer run component was extirpated by 1970.

Fall Chinook salmon spawn in the Yakima mainstem from Sunnyside Dam (RM 103.8) downstream almost to the confluence with the Columbia River (Figure 2-2). Redds are distributed patchily throughout the river, depending on the amount of submerged aquatic vegetation. Spawning upstream of Prosser Dam (RM 47) begins in mid-October, peaks in the first week of November, and ends by the third week of November. Fish in the lower mainstem may continue spawning into December, and spawning has been observed as late as early January. Fry emerge from late March through April.

Historically, the Yakima Basin had adult run sizes of 38,000 to 100,000 fall Chinook (HSRG 2009a). The population has declined since the 19th century due to unscreened diversions, logging, channelization, and overharvesting. Declines continued in the early 20th century with construction of unladdered dams, high harvest in the ocean fishery, dewatered spawning and rearing habitats, and altered natural summer flow regimes. The number of adult summer/fall Chinook that spawned in the mainstem Yakima River from 1998 to 2018 ranged from 1,100 to 13,900, with an average of 5,100 fish (Table 3-4). Prior to 1999, there was little, if any harvest of fall Chinook salmon in the Yakima Basin. Since 1999, terminal harvests have averaged about 800 fall Chinook (approximately 14% of the terminal run size; Table 3-8).

Steelhead

Steelhead are the anadromous form of the species *Oncorhynchus mykiss*; Rainbow Trout are the resident form. Anadromous *O. mykiss* in the Yakima Basin are part of the ESA threatened Mid-Columbia River Distinct Population Segment of steelhead, but resident Rainbow Trout are not listed and are managed separately (NMFS 2013). The Yakima Basin supports four genetically distinct stocks of summer steelhead: Satus Creek, Toppenish Creek, Naches River, and upper Yakima River. A radio tagging study performed over brood years 1990 to 1992 showed the relative abundance of fish spawning in the following locations: Satus Creek (48 percent), the Naches River watershed (32 percent), Toppenish Creek (13 percent), and the upper Yakima River (7 percent).

Estimates of the historical steelhead run size range from 20,800 to 100,000 fish (HSRG 2009a). Production in the Yakima subbasin has dramatically declined in the 20th century. Factors in the decline include damming of spawning tributaries, closing the fish ladder at Roza Dam during much of the steelhead spawning run from 1941 through 1959, and the large diversion dams downstream of Roza Dam, which each pose a significant mortality risk for outmigrating smolts. All populations of Yakima steelhead have grown somewhat since 2000. The mean abundance from 2001 through 2007 was as follows: Satus Creek stock - 929 fish, Naches River stock - 861 fish, Toppenish Creek stock - 669 fish, and upper Yakima stock - 161 fish.

Summer steelhead spawn in most of the accessible tributaries in the upper Yakima, but especially in the Teanaway River and its tributaries, Taneum Creek, Swauk Creek and Umtanum Creek. With the exception of the Tieton River and probably the American River, summer steelhead spawn in virtually all of the accessible tributaries in the Naches watershed, particularly the Little Naches River, Rattlesnake Creek, and the Bumping River. Steelhead spawning in Toppenish Creek is currently restricted to the upper watershed due to habitat degradation in the lower reaches. Spawning occurs in upper Simcoe Creek and in Toppenish Creek above the Simcoe confluence. Satus Creek steelhead spawn in almost all reaches and tributaries of Satus Creek, including intermittent tributaries.

Spawn timing, with the exception of the Satus Creek stock, varies throughout the basin with elevation and seasonal water temperatures in the watershed. At the lowest elevations, like Satus Creek, spawning begins in February, while at the higher elevations, spawning can continue into June (YSFWPB 2004). Satus Creek steelhead differ from other Yakima steelhead stocks in a number of respects. Satus Creek is the lowest and warmest watershed in the basin, so spawning begins in February. Steelhead fry typically emerge from April through mid-June. After spending 2 to 3 years rearing in freshwater, steelhead smolts out-migrate from the basin from early spring through June.

Although the entire Yakima Basin has been closed to steelhead fishing since 1994, considerable illegal and/or inadvertent steelhead harvest is believed to occur during the winter whitefish fishery. The estimated terminal harvest rate is 8 percent (HSRG 2009a).

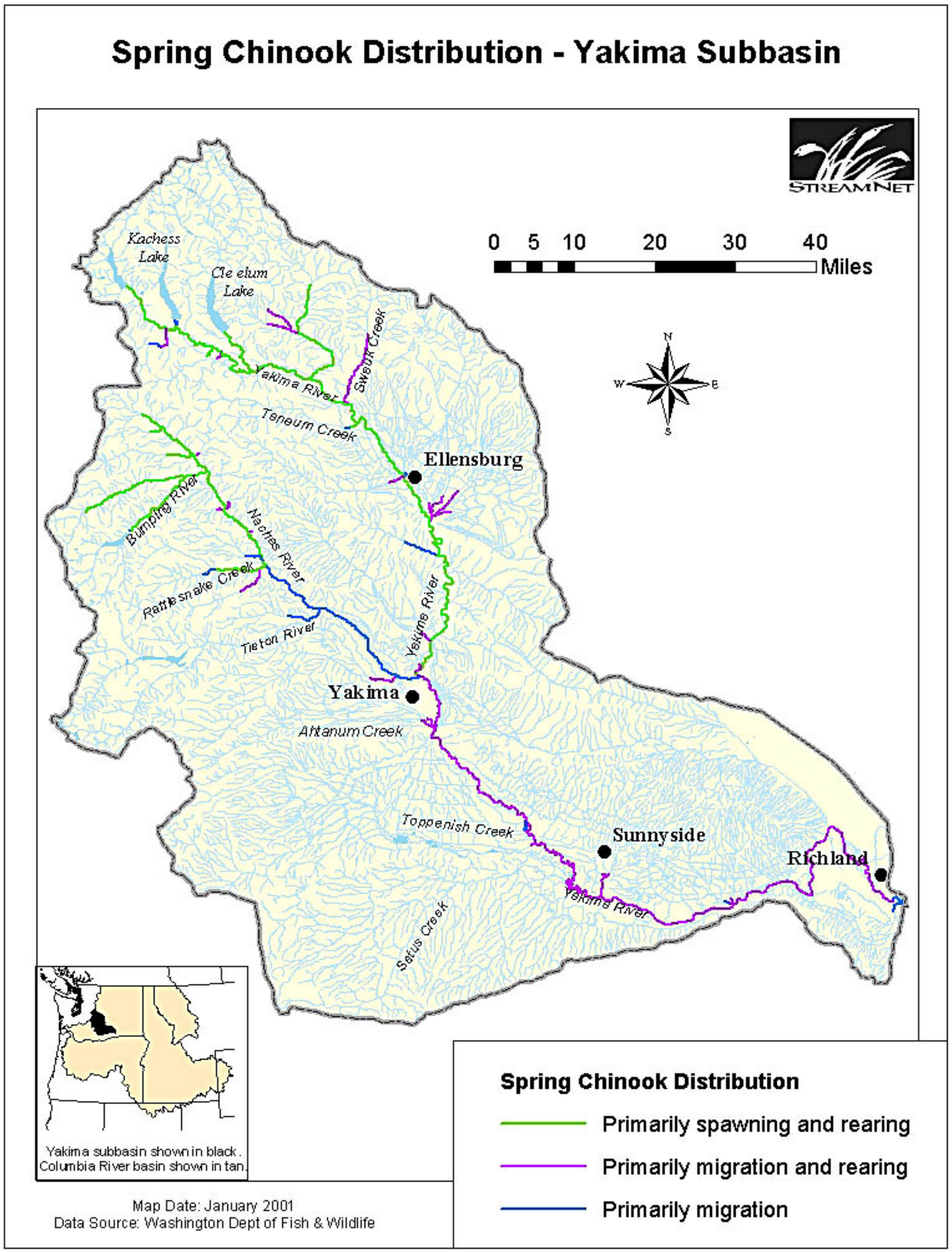
Spring Chinook Salmon

Yakima River spring Chinook are part of the Mid-Columbia River spring-run Chinook ESU, which includes all naturally spawned populations of spring-run Chinook salmon in Columbia River tributaries from the Klickitat River upstream to, and including, the Yakima River. The spring Chinook ESU is not listed under the ESA.

The Yakima River Basin supports three genetically distinct stocks of spring Chinook: the American River stock, the Naches River stock, and the upper Yakima stock. The Yakima River stock of spring Chinook spawn in the mainstem Yakima from just below Roza Dam (RM 128) to Keechelus Dam (RM 214), but are concentrated between the Cle Elum River confluence (RM 186) and Easton Dam (RM 202) (Figure 7-1). Spawning also occurs in the Teanaway River and the Cle Elum River. The Naches stock spawns in the mainstem Naches River from the confluence of the Tieton River (RM 17.5) to the confluence of the Little Naches and Bumping Rivers (RM 44.6), as well as in Rattlesnake Creek, the Little Naches River, and in the Bumping River downstream of Bumping Lake Reservoir. The American River stock spawns almost exclusively in the American River itself (a tributary of the Naches River) and is concentrated between RM 1 and RM 15.

Spring Chinook avoid high water temperatures by migrating past Prosser Dam from late April through July, and spawn and rear in the upper watershed (Figure 7-1) where high water temperatures are not normally a concern. The American River stock begins spawning in late July, and the Naches River stock begins spawning in late August/early September. The upper Yakima River stock begins spawning in early September. All stocks typically complete spawning by mid-October. Fry emerge from late March to early June and rear in freshwater for 1 year before migrating to the ocean as smolts. Smolts typically out-migrate from late March through early June, peaking in late April.

Historic spawner escapement to the Yakima Basin may have ranged from 50,000 to 200,000 spring Chinook (YSFWPB 2004). From 2000 to 2012, annual abundance estimates of juvenile smolts migrating downstream at Prosser Dam averaged 202,550 natural-origin spring Chinook and 305,130 hatchery-origin spring Chinook (Sampson et al. 2013). From 1984 to 2012, the average number of adults that returned to the upper Yakima River to spawn was 4,114. During that same period, the average number of adults returning to the Naches River was 1,825 (Sampson et al. 2013). From 2000 to 2007, an average of 869 adults returned to the American River to spawn. In-basin harvest of natural-origin fish ranged from 25 to 2,806 adults from 1982 to 2007. Since 2001, harvest of hatchery-origin spring Chinook ranged from 12 to 1,865 fish (Yakama Nation 2012). Sport harvest in the Yakima River is mark selective, but tribal harvest is not.



Source: WDFW 2001.

Figure 7-1. Spring Chinook distribution in the Yakima Basin.

Bull Trout

Bull Trout are a species of char (related to salmon and trout) that prefer cold, clean water. They were listed as threatened under the ESA in 1998 and spawn and rear in the upper portions of the Yakima Basin. Bull Trout use the lower mainstem as a migratory corridor. The Yakima River "core area" is designated as critical habitat for Bull Trout. Critical habitat in the core area includes the mainstem Yakima River from its confluence with the Columbia River upstream to the uppermost point of Bull Trout distribution, including most tributaries in the basin. The canal and bypass are not designated critical habitat for Bull Trout. The Yakima River core area is part of the Mid-Columbia Recovery Unit (USFWS 2015a).

The USFWS (2015a) identified 15 "local" Bull Trout populations in the Yakima River core area, including: Ahtanum Creek, Naches River tributaries (American River, Rattlesnake Creek, and Crow Creek), Rimrock Lake tributaries (Indian Creek, South Fork Tieton River, and North Fork Tieton River), Bumping Lake tributaries (Deep Creek and Bumping River), Cle Elum Lake tributaries (Cle Elum River and Waptus), Kachess Lake tributaries (Box Canyon Creek and the upper Kachess River), Keechelus Lake (Gold Creek), and the Yakima River (upper Yakima). The Teanaway River population is potentially extirpated and not currently included as a local population. These 15 local Bull Trout populations spawn in headwater streams and also use lower reaches of the stream and larger rivers and/or connected lakes as foraging, migratory, and overwintering areas.

Known Bull Trout presence extends downstream to the confluence of the Yakima and Naches Rivers, with presumed presence to the mouth of the Yakima River at the confluence with the mainstem Columbia River (Reiss et al. 2012). In the Naches River Basin, a stable Bull Trout population occupies the North and South Forks of the Tieton River; spawning occurs above RM 5 of the South Fork Tieton, and about 5 miles above Clear Lake in the North Fork Tieton (Newsome 2016c). Within the Yakima core area, some populations have access to reservoirs, but many are restricted to habitats upstream or downstream of dams due to a lack of fish passage facilities. Bull Trout throughout the basin often face poor summer habitat conditions due to low flows and high instream temperatures resulting from irrigation withdrawals. Downstream of the confluence with the Cle Elum River, the Yakima River mainstem functions primarily as foraging, migratory, and overwintering habitat for Bull Trout.

Bull Trout are piscivorous and need an abundant supply of forage fish to maintain healthy populations. They require cool water and temperatures: between 44 and 46°F are optimal; sustained temperatures above 59°F begin to stress fish (Bjornn and Reiser 1991). Bull Trout exhibit several life-history strategies in the Yakima Basin. Those populations isolated above dams exhibit resident or adfluvial (migrating between tributary and reservoir/lake) life histories. Those populations below dams are typically fluvial (migrating between mainstem river and tributaries). Most populations spawn from mid-September to mid-October, but several spawn between August and early September or late October to early November (USFWS 2015a). Juveniles typically remain in their natal tributaries, and begin migratory movements as subadults.

Westslope Cutthroat Trout

Westslope Cutthroat Trout occur in the Yakima Basin in areas higher than 3,000 feet in elevation. Ten populations of Westslope Cutthroat Trout have been identified in the Upper Yakima River Basin

(Wydoski and Whitney 2003), although hybridization with other trout species has reduced the number of genetically pure populations.

Westslope Cutthroat Trout exhibit three life history strategies: adfluvial, fluvial, and resident. Adfluvial trout spend from 1 to 4 years as juveniles in tributary streams before moving into lakes where they spawn between March and July. They remain in the lakes after spawning. Fluvial Cutthroat Trout spawn in small upstream tributaries and move downstream to larger river reaches as they grow. The resident form of westslope cutthroat is found in headwater streams and exhibit little movement. Generally, they inhabit shoreline areas of streams during the summer and move into pools during the winter. Sexual maturation typically occurs at age 4 or 5. Adfluvial and fluvial stocks can reach lengths of 12 to 15 inches, while resident forms are generally smaller.

Sockeye Salmon

Four lakes in the Yakima Basin historically supported sockeye salmon production. These lakes became unproductive in the early 1900s when irrigation storage dams were constructed without fish passage. Recent sockeye reintroduction efforts have proven successful, and sockeye juveniles released into the basin since 2009 are now returning as adults. The reintroduced population is not listed under the ESA.

Sockeye salmon restoration feasibility studies conducted by NMFS concluded that sockeye salmon reintroduction was likely to be successful if passage improvements were made at Cle Elum Dam. Following the installation of temporary downstream passage facilities, in 2009, the Yakama Nation began transferring adult sockeye salmon collected at Priest Rapids Dam to Cle Elum Lake. These adults were from two stocks of sockeye salmon in the upper Columbia River–the Okanagan River and Wenatchee Lake. Transferred adults successfully spawned in tributaries above Cle Elum Lake and juveniles were observed migrating downstream through passage facilities at Roza and Prosser Dams in 2011.

In 2014, over 2,500 adult sockeye were counted at Prosser Dam. These adults returned to the Yakima Basin as a result of Yakama Nation reintroduction efforts. Adults transferred to Cle Elum Lake remain in the lake in July and August and spawn in the Cle Elum River from September through November. Juveniles rear in the lake for about 2 years and outmigrate through a wooden flume in the Cle Elum Dam spillway. In an effort to continue these successful efforts, the Yakama Nation is working with Reclamation to restore upstream and downstream fish passage to and from the historic sockeye salmon lakes. Initial efforts are targeting passage facility improvements and construction on the Cle Elum Dam where fish passage facilities have been designed. The initial stages of construction for these facilities are currently underway.

Pacific Lamprey

Pacific lamprey are an important traditional food source for the Yakama Nation and other tribes. From 2002 through 2014, counts at Prosser Dam have ranged from 0 in 2010 to 87 in 2003 (Grote 2015). The Pacific lamprey is considered a species of concern by the USFWS, and is a monitored species in Washington State.

The Pacific lamprey has declined across much of its range in the Pacific Northwest, including the Yakima River. Pacific lamprey hatch as larvae called ammocoetes, and filter feed in fine silts and mud for 4 to 7 years before metamorphosing and migrating from their parent stream to the Pacific Ocean. As young adults, they migrate to the Pacific Ocean from March through July, typically at night during high flows. After metamorphosing into the adult parasitic phase, Pacific lamprey feed on the body fluids of other fish. Adult lamprey migrate to freshwater from March through October, and overwinter before spawning in gravel substrates the following April through July.

Adult lamprey can pass over rocks or dam walls by clinging to surfaces with their sucker-like mouths; however, radio-telemetry studies conducted in the Yakima Basin indicate that the overall passage efficiency at Roza Dam was 0 percent (Grote et al. 2016). These results indicate that, as currently built and operated, Roza Dam is a barrier to adult Pacific lamprey migration. Overall passage efficiency at other dams in the basin, including the Cowiche (Naches River), Wannawish, Prosser, Sunnyside, and Wapato Dams ranged from 48 to 82 percent (Grote 2015).

Other Fish Species

Important resident fish species present in the upper Yakima Basin include Rainbow Trout, Cutthroat Trout, Whitefish, and several species of dace, sculpins, and suckers. In the lower system, species present include Rainbow Trout, Whitefish, Carp, Northern Pikeminnow, Redside Shiner, Chiselmouth and Peamouth Chubs, Largescale, Bridgelip and Longnose Suckers and several species of sculpins and dace.

Three salmonid species (Brook Trout, Lake Trout, and Brown Trout) have been introduced, along with a variety of sunfish, perch, catfish, and minnow species. Before the introduction of exotics, Northern Pikeminnow, sculpin, Bull Trout, Rainbow Trout, Cutthroat Trout, and Burbot were the primary piscivores in the subbasin.

7.1.6.2 Wildlife

Because of its diverse vegetative and geologic features, the Yakima Basin supports a variety of wildlife species, including 22 species of reptiles, 23 species of amphibians, 98 species of mammals, and 241 species of birds. Several species of big game live in the basin, including black bear, black-tailed deer, mule deer, Rocky Mountain elk, bighorn sheep, mountain goats, and cougar. Bighorn sheep were reintroduced over 40 years ago and inhabit areas between Naches and Ellensburg. A small population of mountain goats can be found at high elevations along the western fringe of the subbasin, and wolverines have also been reported in the higher elevations. Federal and state listed species are identified in Table 7-2.

Table 7-2. Federal and State listed species of the Yakima Basin.

Common name	Scientific name	Federal status[1]	State status[2]
Amphibians			
Cascade Torrent Salamander	*Rhyacotriton cascadae*	_	SC
Columbia Spotted Frog	*Rana luteiventris*	_	SC
Dunn's Salamander	*Plethodon dunni*	_	SC
Larch Mountain Salamander	*Plethodon larselli*	_	SS
Oregon Spotted Frog	*Rana pretiosa*	FT	SE
Van Dyke's Salamander	*Plethodon vandykei*	_	SC
Western Toad	*Bufo boreas*	_	SC
Birds			
American White Pelican	*Pelecanus erythrorhynchos*	_	ST
Bald Eagle	*Haliaeetus leucocephalus*	BGEPA	_
Black-Backed Woodpecker	*Picoides arcticus*	_	SC
Burrowing Owl	*Athene cunicularia*	_	SC
Common Loon	*Gavia immer*	_	SS
Ferruginous Hawk	*Buteo regalis*	_	ST
Flammulated Owl	*Otus flammeolus*	_	SC
Golden Eagle	*Aquila chrysaetos*	_	SC
Loggerhead Shrike	*Lanius ludovicianus*	_	SC
Marbled Murrelet	*Brachyramphus marmoratus*	FT	SE
Northern Goshawk	*Accipiter gentilis*	_	SC
Pileated Woodpecker	*Dryocopus pileatus*	_	SC
Sage Sparrow	*Amphispiza belli*	_	SC
Sage Thrasher	*Oreoscoptes montanus*	_	SC
Greater Sage-Grouse	*Centrocercus urophasianus*	FSC	ST
Sandhill Crane	*Grus canadensis*	_	SE
Spotted Owl	*Strix occidentalis*	FT	SE
Vaux's Swift	*Chaetura vauxi*	_	SC
Western Grebe	*Aechmophorus occidentalis*	_	SC
White-Headed Woodpecker	*Picoides albolarvatus*	_	SC
Mammals			
Fisher	Martes pennant	FC	SE
Gray Wolf	*Canis lupus*	FE	SE
Grizzly Bear	*Ursus arctos*	FT	SE
Keen's Myotis	*Myotis evotis*	_	SC
Canada Lynx	*Lynx canadensis*	FT	SE
Townsend's Big-Eared Bat	*Coryhorhinus townsendii*	_	SC
Washington Ground Squirrel	*Spermophilus washingtoni*	FC	SC
Western Gray Squirrel	*Sciurus griseus*	_	ST

Common name	Scientific name	Federal status[1]	State status[2]
White-tailed Jackrabbit	*Lepus townsendii*	_	SC
Wolverine	*Gulo gulo*	FC	SC
Reptiles			
California Mountain Kingsnake	*Lampropeltis zonata*	_	SC
Common Sharptail Snake	*Contia tenuis*	_	SC
Striped Whipsnake	*Masticophis taeniatus*	_	SC
Western Pond Turtle	*Clemmys marmorata*	_	SE

[1] BGEPA: Bald and Golden Eagle Protection Act, FE: Federally Endangered, FT: Federally Threatened, FC: Federal Candidate Species, FSC = Federal Species of Concern.
[2] SE: State Endangered, ST: State Threatened, SS: State Sensitive, SC: State Candidate.
Source: YSFWPB 2004; updated September 2019 based on https://wdfw.wa.gov/sites/default/files/2019-06/threatened%20and%20endangered%20species%20list.pdf.

The Yakima Basin is an important stop in the migratory route for many avian species that traverse the region during the spring and fall migratory period. These species may include warblers, flycatchers, finches, and shorebirds.

Because of the large number of wildlife species and habitats in the area, the Yakima Subbasin Plan assessed specific focal habitats as well as focal species (Table 7-3). Focal habitats were selected based on the amount of decline and sensitivity of the habitat to alteration, and those that were ecologically important for healthy fish and wildlife populations. Focal species were selected because of their status as listed as threatened and endangered at either the federal or state level, their cultural significance, and their value and indicator species.

Table 7-3. Focal wildlife species identified in the Yakima Subbasin Plan.

Common Name	Focal Habitat	Status[1]		Native Species	Priority Habitat Species	Game Species
		Federal	State			
Western Toad	Montane Coniferous Wetlands		C	X	X	
Sandhill Crane			E	X	X	
White-headed Woodpecker	Ponderosa Pine / Oregon White Oak		C	X	X	
Lewis' Woodpecker				X	X	
Western Gray Squirrel			T	X	X	
Mule Deer	Interior (Eastside) Grassland			X	X	X
Greater Sage Grouse		SC	T	X	X	
Brewer's Sparrow	Shrub Steppe			X		
Yellow Warbler	Eastside (Interior) Riparian Wetland			X		
Mallard				X		X
American Beaver	Numerous Habitats			X		X

[1] C = Candidate, SC = Species of Concern, T = Threatened, E = Endangered.
Source: YSFWPB 2004; updated September 2019 based on https://wdfw.wa.gov/sites/default/files/2019-06/threatened%20and%20endangered%20species%20list.pdf.

7.1.6.3 Vegetation

Vegetation across the Yakima Basin is a diverse mix of forest, grassland, and cropland, typically associated with geological and precipitation patterns. In general, the western third of the basin is forested. Forested areas typically have a mix of species, mostly of grand fir, Douglas fir, lodgepole pine, ponderosa pine, and Western larch. Along the eastern edge of the forested zone where precipitation has decreased, a band of Oregon white oak can be found intermingled with ponderosa pine and Douglas fir.

As precipitation and elevation decrease, forested areas meld into shrub/steppe, which occupies the eastern two-thirds of the basin. Due to conversion to cropland and grazing, only five percent of the historical shrub/steppe habitat has been left in relatively undisturbed condition (YSFWPB 2004). Moderately disturbed shrub-steppe communities, those affected by grazing, invasive plant species, and other disturbances, are fairly common. Approximately 26 percent of the undisturbed shrub-steppe habitat is dominated by native grasses and sagebrush, with a thin groundcover layer of moss and lichen. Damaged habitat still provides cover, food, and nesting habitat for many species of wildlife and is particularly important during winter months when cultivated fields provide no vegetative cover.

7.2 SOCIOECONOMIC CONTEXT

The Yakima Basin lies mainly within Yakima County (population 250,193 in 2017), with smaller sections in Kittitas County (population 46,205 in 2017), and Benton County (population 198,171 in 2017). Yakima County covers 4,296 square miles, and is second largest in land area and has the seventh largest population in Washington State. The largest community in the basin is the City of Yakima, with a population of 93,667 in 2017.

Private ownership totals 32 percent or over 1.2 million acres of the 4 million acres in the Yakima Subbasin. The single largest landowner is the US government with 1.5 million acres or 38 percent of the land area largely within the Wenatchee National Forest. Other large federal land holdings include the US Army Yakima Training Center, the Hanford Nuclear Reservation, and Bureau of Land Management lands. State, county, and local government ownership totals over 400,000 acres. The Yakama Reservation covers 1,573 square miles (1,371,918 acres) in southern Yakima County and a smaller part of Klickitat County. The Yakama Nation and its members have over 880,000 acres held in trust; only a small portion is deeded land.

Nearly 40 percent of the basin is forested, 40 percent is rangeland, and 15 percent is cropland. The remaining acreage includes other land uses and water bodies. Major land uses include grazing (2,900 square miles), timber harvest (2,200 square miles), irrigated agriculture (1,000 square miles), and urbanization (50 square miles).

The 2,900 square miles of rangelands are primarily used and managed for grazing, military training, wildlife habitat, and tribal cultural activities. The 2,200 square miles of forested areas in the northern and western portions of the basin are primarily used and managed for timber harvest, water quality, fish and wildlife habitat, grazing, tribal cultural activities, and recreation. About one-fourth of the forested area is designated as wilderness. The 1,000 square miles of irrigated agriculture includes pasture, orchards, grapes, hops, and field crops. Diverse recreation activities, including hunting, fishing, and camping, occur across much of the subbasin. Major urban areas have developed in Yakima and Richland.

The people of the Yakama Nation have lived on the central Washington plateau and along the Columbia River since the beginning of time (www.yakamanation-nsn.gov). The Cascade Mountains and the Yakima River form the eastern and western borders of the Yakama's historic territory. The Yakama people spent the coldest months in villages generally located on the valley floor, where the climate was relatively moderate. This area provided reliable sources of wood and water and protection from the cold winds. Villages were located near waterways where resources could be obtained, including deer, elk, fish, riparian and desert plants, and animal resources. In springtime, tribal people moved across the countryside for fresh food resources. Edible roots were collected as they matured. Some tribal people would remain along rivers to fish, while others followed maturing plans upslope, ending with huckleberry harvest in the fall in the mountains. At that time, food would either be stored or transported back to the winter village to be used until fresh food was available the next spring.

In the Treaty of 1855, the federal government ceded more than 12 million acres of land to the Yakama Nation, with 1,130,000 acres declared reservation land. Fourteen tribes and bands were confederated in the Yakama Nation at the signing of the treaty: Kah-miltpah, Palouse, Klickitat, See-ap-Cat, Klinquit, Sk'in-pah, Li-ay-was, Oche-Chotes, Wenatchapam, Pesquose, Yakama, Shyiks, Kow-was-say-ee, and Wish-ham. Tribal leaders reserved the right to fish, hunt and gather all of the tribe's traditional foods on the reservation as well as the more expansive ceded area. One month after the treaty was signed, the territorial governor declared that all ceded lands were open and available for white settlement.

The Tribe's aboriginal territory was a diverse ecosystem with abundant fish and wildlife that were relied upon by the Yakama people for subsistence and cultural uses. Over the last century, those once abundant resources have declined as the complex ecosystem has been altered. The social and economic benefits of harvesting salmon are significant to Tribal members, as well as to the commercial and recreational fisheries that have evolved. The proposed Chinook and Coho programs would contribute substantial numbers of salmon to marine, Columbia River and Yakima River fisheries. The Independent Economic Analysis Board (IEAB 2005) estimated annual income from existing Columbia Basin harvest and production strategies, stating that "economic impact can be significant in some communities with close ties to the fishing industry". Although the IEAB made no estimate of the economic value of ceremonial or substance use, such harvests are of immeasurable cultural importance to the Tribe and the social fabric of the Yakama Nation.

7.3 RELATIONSHIP OF THE COHO, CHINOOK AND STEELHEAD PROGRAMS TO REGIONAL PLANS AND PROGRAMS

As shown in Table 7-4, the measures proposed in this Master Plan are just one of many efforts contributing to the protection and restoration of steelhead, Coho and summer/fall Chinook salmon in the Yakima River Basin. Table 7-4 lists fishery and habitat projects in the Yakima River Basin funded by BPA.

Table 7-4. Fishery and habitat restoration projects in the Yakima River Basin.

Contractor	Title/Project No.	Purpose	Summary
Yakama Nation	Yakima River Management, Data and Habitat - Yakima/Klickitat Fisheries Project (YKFP)/ 1988-120-25	Habitat	The Yakima/Klickitat Fisheries Project (YKFP) is split into several sub-projects (Monitoring and Evaluation, Operations and Maintenance, and Construction) under the overall program umbrella. The Management, Data and Habitat Project includes overall management and administration, as well as the data management, and habitat protection and restoration components of the YKFP program.
Yakama Nation	Lower Yakima Valley Riparian Wetlands Restoration/1992-062-00	Habitat	The purpose of this project is to continue implementation of the YN Lower Yakima Valley Wetlands and Riparian Wildlife Mitigation work that began in 1991 (Contract Number 94BI12521). The goals are as follows: 1) To permanently protect 27,000 acres of floodplain lands along the Yakima River, Toppenish and Satus creeks within the agricultural portion of the Yakama Reservation. 2) To enhance those lands to increase native fish and wildlife habitat values. 3) To adaptively manage those lands to ensure permanent fish and wildlife value. 4) To monitor the habitat conditions to ensure the desired habitat value is reached and maintained.
Yakama Nation	Yakima River Monitoring and Evaluation -Yakima/Klickitat Fisheries Project (YKFP)/1995-063-25	Artificial Production	This project funds the monitoring and evaluation activities for the Yakima River Basin assigned to the Yakama Nation fisheries staff.
Yakama Nation	Yakama Reservation Watershed Project/1996-035-01	Habitat	Stream channel, floodplain and vegetation restoration projects addressing habitat related limiting factors (i.e., flow, key habitat quantity, habitat diversity, temperature, sediment load, channel stability) that were identified in the Yakima Subbasin Plan Supplement (pp. 11-13) form the core of this project. This project and the complementary Yakama Nation Riparian/Wetlands Restoration Project (199206200) are the only comprehensive vehicles for recovering two of the four steelhead populations in the Yakima Major Population Grouping. The goal is to restore the natural hydrologic function of the watersheds as much as possible without burdening economic interests (i.e., timber harvest, agriculture) on the Reservation. This in turn will increase steelhead spawning success and

Contractor	Title/Project No.	Purpose	Summary
			juvenile survival to outmigration. In addition to steelhead, restoration work will likely benefit other anadromous and resident fish species (e.g., Coho salmon, Chinook salmon, Bull Trout, and Westslope Cutthroat Trout) and many wildlife species as well. The YRWP conducts comprehensive watershed restoration activities including (1) headwater wetland rehabilitation; (2) adult and juvenile fish passage restoration; (3) stream channel and riparian area restoration including bringing stream channels back to grade, reconnecting side channels and floodplains, planting native vegetation in conjunction with riparian and range fencing; (4) minimum instream flow implementation and modification of irrigation water sources and uses; along with (5) physical monitoring that includes precipitation, groundwater, discharge from streams, canals and drains, temperature, water quality, fish habitat structure and quality according to accepted protocols; and (6) biological monitoring including spawning ground surveys, snorkel surveys and smolt trapping.
Yakama Nation	Yakima River Operations and Maintenance - YKFP/1997-013-25	Artificial Production	The Upper and Lower Yakima Supplementation and Research Facilities are maintained and operated by the Yakama Nation. This project rears and releases 810,000 spring Chinook smolts from three acclimation sites, determines the feasibility of re-establishing a naturally-spawning Coho population, and tests the application of supplementation principles to the two lower Yakima River fall Chinook stocks, the mainstem and Marion Drain stocks.
Yakama Nation	Yakima Basin Side Channels Land Acquisition/1997-051-00	Habitat	The Yakima Side Channels Project is a fish habitat acquisition program. Habitat acquisition criteria includes a willing seller, land characterized by connection to or a restorable floodplain, prime spawning and/or rearing habitat, and critical habitat for listed Mid-Columbia steelhead. Preference is given to properties that have a water right, and/or are adjacent to protected lands.
Yakama Nation	Coho Nutrient Supplementation/2008-459-00	Habitat	This project uses hatchery carcasses to increase productivity in spawning/rearing tributaries. This will increase egg-to-smolt survival in areas where marine-derived nutrients have been absent for decades.

Contractor	Title/Project No.	Purpose	Summary
Yakama Nation	Coho Production Facility and Marking/2008-465-00	Artificial Production	This project funds construction of a small-scale hatchery to rear 300,000 Coho pre-smolts intended to distribute hatchery production to habitats that can support natural spawning. Another component of the project marks hatchery smolts to exclude them from broodstock as returning adults.
Yakama Nation	Prosser Hatchery Reform and Upgrades/2008-466-00	Artificial Production	The goal of this project is to reform and upgrade the infrastructure of the Prosser Hatchery. This included replacing the chiller with a more productive one in order to increase egg viability/survival, allow for synchronization of egg hatch time and increase survival of broodstock. An automated alarm system was installed to monitor water conditions throughout the hatchery. This included flow meters on the river intake system, wells on all fish holding vessels, dissolved oxygen/temperature probes and float meters on all holding vessels. A larger pump was installed in one of the current wells. Lights were installed throughout the hatchery for night time checks and emergencies.
Yakama Nation	Yakama Nation Ceded Lands Lamprey Evaluation and Restoration/2008-470-00	Programmatic	The goal of the lamprey restoration project is to restore natural production of Pacific lamprey in the in the Yakama Nation ceded lands of the Wind, White Salmon, Klickitat, Yakima, Methow, Entiat rivers and streams. Very little information exists about lamprey abundance and distribution throughout the Ceded lands and essentially no information has been collected concerning known or potential limiting factors. One of the primary objectives is to survey key habitats and collect baseline information that will be used to develop a long-term restoration strategy. Other key objectives are to evaluate potential artificial propagation and translocation of adult lampreys. These latter objectives would be used as tools to help jump start natural production in selected watersheds.
Mid-Columbia Fisheries Enhancement Group	Salmon & Steelhead Habitat Restoration and Protection in the Yakima Basin	Habitat	This project will implement a non-regulatory, basin-wide effort to involve landowners in restoration and protection projects in priority areas identified in Yakima Subbasin Plan. Work includes riparian planting, fencing, fish passage, and instream habitat improvements.
Pacific NW National Laboratory	Yakima/Huntsville Screen Evaluation/1985-062-00	Habitat	Assess if sites are properly equipped to provide safe, efficient fish bypass by reviewing design drawings, operating procedures, and components install and in use at 26 facilities in the Yakima River Basin.

Contractor	Title/Project No.	Purpose	Summary
South Central Washington Resource Conservation & Development	Yakima Tributary Access and Habitat Program/2002-025-01	Habitat	The Yakima Tributary Access and Habitat Program (YTAHP) works on Yakima River tributaries to re-establish fish passage, screen diversions, increase in-stream flow and enhance riparian and in-stream habitat. Section 2.1.2 of the Yakima Subbasin Plan Supplement (Nov. 26, 2004. pg.8) speaks to limiting factors in the Yakima Basin and attributes the declines of aquatic species to "low flows; obstruction to fish migration and entrainment; diminished habitat quantity, quality and diversity; high temperatures; altered sediment transport; and degraded channel stability".
S. Central Washington Resource Conservation and Development	Yakima Basin-wide Tributary Passage and Flow/2007-398-00	Habitat	The Manastash Flow Enhancement project is part of a larger restoration project in the Manastash Creek watershed to provide fish screens, remove fish passage barriers and improve in-stream flow.

Source: Columbia Basin Fish & Wildlife Program Projects & Portfolios (available online at http://www.cbfish.org/Portfolio.mvc/Index/).

7.3.1 Yakima Basin Integrated Plan

The Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) was developed by the U.S. Bureau of Reclamation and the Washington State Department of Ecology in conjunction with the Yakama Nation and Yakima River basin stakeholders. The goals of the Integrated Plan are to protect, mitigate, and enhance fish and wildlife habitat; provide increased operational flexibility to manage instream flows to meet ecological objectives, and improve the reliability of the water supply for irrigation, municipal supply and domestic uses. A Final Programmatic Environmental Impact Statement (PEIS) analyzing broad effects of the Integrated Plan on environmental resources was completed in 2012.

The Integrated Plan is being funded by nine federal agencies with additional support from state agencies and local entities. To date, 17 of 26 habitat projects and 8 of 16 water conservation projects have been completed at a total cost of about $200 million. When the Plan was being developed, the total cost to completion was estimated at between $4 billion and $5.6 billion (excluding costs of land acquisition). Half to three quarters of this expected cost is associated with five projects: Wymer Reservoir with Thorp Intake and Roza delivery - $1.6 billion; enhanced agricultural conservation - $0.4 billion; Bumping Lake enlargement - $0.4 billion; fish passage at Tieton, Kachess, and Keechelus Dams - $0.3 billion; and mainstem floodplain restoration program - $0.27 billion.

Federal sources of funding include:

- Reclamation – YRBWEP
- BIA – Wapato Irrigation Project improvements
- USFWS – Partners for Fish and Wildlife and Yakama Nation Fish Passage Program
- BLM – Water Conservation
- BPA – Northwest Power and Conservation Council's Fish and Wildlife Program
- NMFS – Pacific Coastal Salmon Recovery Fund NRCS – Regional Conservation Partnership Program USFS – Land and Water Conservation
- USACE – Flood Plain Restoration

An update on the Yakima Basin Integrated Plan provided by the U.S. Forest Service on April 11, 2018 estimated total FY 2017 federal funding for the Plan of approximately $50M (U.S. Forest Service, Portland, OR). A fiscal year 2018 budget brief published by the U.S. Bureau of Reclamation estimates 2016-2018 expenditures for YRBWEP alone to be in excess of $91M. U.S. Senate Report 115-107 estimates increased spending of $65M for YRBWEP during 2018-2022 subject to appropriation.

Clearly, the Yakima Basin Integrated Plan has broad support at both the local and federal levels. There has been substantial funding of the Plan since at least 2011 and funds are already being committed well into the future. Figure 7-2 summarizes habitat and water enhancement projects completed with this funding during the 2013-2017 period. There is broad support in the literature that actions such as these provide benefits to fish, with many of the studies specifically citing benefits to Coho (White et al. 2011; Carah et al. 2014; Pierce et al. 2015; Roni et al. 2015; O'Neal et al. 2016; Clark and Roni 2018).

Figure 7-2. Spring Chinook distribution in the Yakima Basin.

7.3.2 Yakima/Klickitat Fisheries Project

The Yakima/Klickitat Fisheries Project (YKFP) is an adaptive management and research project designed to restore anadromous fish and the habitats that support them in the Yakima and Klickitat subbasins. The stated purpose of the YKFP is to "test the hypothesis that new supplementation techniques can be used in the Yakima River Basin to increase natural production and to improve harvest opportunities, while maintaining the long-term genetic fitness of the wild and native salmonid populations and keeping adverse ecological interactions within acceptable limits" (BPA 1996). The project was designed as an "all stocks" initiative with initial emphasis on spring Chinook and Coho salmon in the Yakima Subbasin.

The YKFP is conducted by fishery managers, biologists and technicians from the Yakama Nation and WDFW. An adaptive management framework guides the planning, implementation, and evaluation of the YKFP. The YKFP is sponsored in large part by the BPA with oversight and guidance from the NPCC.

The YKFP has four biological objectives:

1. **Ecological interactions:** Monitor and evaluate ecological impacts of supplementation on non-target species, and impacts of interacting species on productivity of targeted stocks;

2. **Genetics:** Monitor and evaluate genetic change due to domestication and potential genetic change due to in-basin and out-of-basin stray rates;

3. **Harvest:** Monitor and evaluate changes in harvest of YKFP targeted stocks; and

4. **Natural production:** Determine if supplementation and habitat actions increase natural production. Evaluate changes in natural production with specified statistical power.

The Coho, summer/fall and URB Chinook, and wild steelhead kelt programs would contribute to meeting these biological objectives. Specifically, the Coho and Chinook programs would be consistent with the genetics objective by transitioning the current programs to local broodstock, which may reduce the number of out-of-basin strays in the long term. The proposed programs include both harvest and conservation elements. Hatchery-origin adults returning to the basin from the integrated Coho and summer/fall Chinook programs will be available for harvest and hatchery broodstock, and the remainder will be allowed to spawn naturally in the Yakima subbasin. The segregated Coho and URB Chinook programs are primarily designed to produce fish for harvest in the Zone 6 and terminal fisheries. The wild steelhead kelt reconditioning program is designed to increase the number of repeat spawners in the Yakima subbasin and increase the number of naturally-spawning adults in the system. In the long-term, the kelt program may increase harvest opportunities. The proposed Master Plan also includes an extensive monitoring and evaluation component. Thus, the plan is consistent with the biological objectives of the YKFP.

The YKFP is an integral part of the Yakima Subbasin and Recovery Plans. The strategies presented in this Master Plan are an essential component of the intent and vision of the YKFP. Additional information is contained in NPCC project proposal documents for YKFP projects[15].

7.3.3 Yakima Subbasin Plan

The Yakima Subbasin Plan was developed as part of the NPCC's process to guide the selection of projects funded by BPA for the protection, restoration, and enhancement of fish and wildlife affected by the Federal hydropower system. The plan was submitted to the NPCC in 2004 and further clarified later that year (YSFWPB 2004). The Yakima Subbasin Plan and Supplement was adopted by NPCC into its Fish and Wildlife Program. The supplement identifies key factors limiting the biological potential of representative ('focal') species, biological objectives to address each limiting factor, and management strategies to achieve success for each objective. The plan's vision for the year 2020 is as follows:

> *Yakima River Basin communities have restored the Yakima River basin sufficiently to support self-sustaining and harvestable populations of indigenous fish and wildlife while enhancing the existing customs, cultures, and economies within the basin. Decisions that continuously improve the river basin ecosystem are made in an open and cooperative process that respects different points of view and varied statutory responsibilities, and benefits current and future generations. (YSFWPB 2004).*

Its stated mission is to:

> *Restore sustainable and harvestable populations of salmon, steelhead, and other at-risk species through collaborative, economically sensitive efforts, combined resources, and wise resource management of the Yakima Basin. (YSFWPB 2004).*

The integrated Coho program proposed in this Master Plan is consistent with the objectives of the Yakima Subbasin Plan, which recommends continued Coho reintroduction efforts wherever passage, habitat, and potential habitat productivity are sufficient to support viable populations over the long term. The proposed integrated and segregated Coho programs will provide meaningful harvest opportunities and will transition to using local broodstock.

The summer/fall Chinook and URB Chinook programs presented in this Master Plan are designed to contribute to goals in the Subbasin Plan. The Subbasin Plan recommends continued hatchery releases to provide Tribal and sport harvest opportunities. The proposed integrated summer/fall Chinook program will increase releases of the summer component of the summer/fall Chinook life history that has been extirpated in the Yakima Basin. This reintroduction will reestablish traditional harvest opportunities in the Yakima Basin, while rebuilding and spatially and temporally diversifying the naturally-spawning population of summer/fall Chinook.

[15] http://www.cbfish.org/Project.mvc/Display/1988-120-25, http://www.cbfish.org/Project.mvc/Display/1995-063-25 and http://www.cbfish.org/Project.mvc/Display/1997-013-25

The wild steelhead kelt reconditioning program proposed in this Master Plan will contribute to objectives in the subbasin plan, including increasing the number of natural spawners.

7.3.4 Yakima River Salmon Recovery Plan

The Yakima Basin Fish & Wildlife Recovery Board developed the Yakima River Salmon Recovery Plan to guide salmon and steelhead recovery efforts in the Yakima Basin. The Board is a locally based organization governed by representatives of Yakima, Benton, and Kittitas counties, the Yakama Nation, and cities in the basin. The Board's mission is "to restore sustainable and harvestable populations of salmon, steelhead, Bull Trout, and other at-risk fish and wildlife species through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Yakima River Basin." It is recognized by the State of Washington as one of the regional organizations at the heart of the state's salmon recovery efforts.

The Board and its partners followed guidance from NOAA Fisheries, WDFW and the Washington Governor's Salmon Recovery Office in developing this plan. Local planners also provided information and feedback to the Interior Columbia Technical Recovery Team (ICTRT) that NOAA Fisheries convened to develop science-based assessments of the status of steelhead populations.

The salmon and steelhead recovery plans were built on the belief that healthy salmon and steelhead populations can be rebuilt in a manner that coexists with vibrant human communities and the local economies that support them. The plans emphasize that salmon and steelhead recovery should build on existing fish and wildlife recovery programs and should rely on voluntary, non-regulatory approaches to habitat improvement. While the plan focuses on recovery efforts in the Yakima Basin, it acknowledges the need for ongoing recovery actions in the Columbia River, its estuary, and the Pacific Ocean.

Recovery of Coho, Chinook, and steelhead in the Yakima Basin will not occur in a vacuum. Strategies in the Yakima Subbasin Salmon Recovery Plan are expected to complement goals in this Master Plan. Implementation of the measures proposed in the plan, including improving flow conditions and restoring habitat quality and quantity, will benefit these populations as well as other fish populations in the subbasin.

7.3.5 Wy-Kan-Ush-Mi Wa-Kish-Wit

Wy-Kan-Ush-Mi Wa-Kish-Wit is the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes that provides a framework to restore the Columbia River salmon stocks. This tribal salmon restoration plan outlines the cultural, biological, legal, institution and economic context within which the region's salmon restoration efforts are taking place. The long-term plan addresses virtually all causes of salmon decline and roadblocks to salmon restoration for all anadromous fish stocks.

Wy-Kan-Ush-Mi Wa-Kish-Wit has four goals:

- Restore anadromous fishes to the rivers and streams that support the historical cultural and economic practices of the tribes.
- Emphasize strategies that rely on natural production and healthy river systems to achieve this goal.

- Protect tribal sovereignty and treaty rights.
- Reclaim the anadromous fish resource and the environment on which it depends for future generations.

The Wy-Kan-Ush-Mi Wa-Kish-Wit Plan provides recommended actions for the Yakima River system. These actions include restoring riparian areas, providing smolt flushing flows and summer and winter rearing flows though storage releases, retaining woody debris, restoring riparian vegetation, eliminating or restricting logging, grazing and riparian development, constructing passage facilities on tributary irrigation diversions, implementing water conservation programs to reduce silt and pesticides, providing instream flows, and implementing new broodstock programs, release programs, and production programs for anadromous salmonids and lamprey. The plan developed adult return goals to the Yakima Subbasin of 5,000 Coho, 12,000 summer Chinook, 8,400 fall Chinook, and 30,000 steelhead. Adult returns include both spawning escapement and terminal harvest.

The proposed Coho, Chinook and steelhead programs fulfill the recommended action of implementing new broodstock programs for Coho and Chinook, and are one of the steps toward meeting the adult return goals for Coho, Chinook and steelhead presented in the Wy-Kan-Ush-Mi Wa-Kish-Wit Plan.

7.3.6 FCRPS Biological Opinion and 2008 Yakama Nation Columbia Basin Fish Accords

The proposed Coho, Chinook and steelhead programs are consistent with the 2008 Columbia Basin Fish Accords Memorandum of Agreement between the Yakama Nation and other Lower Columbia River treaty tribes and the FCRPS Action Agencies (BPA, USACE and USBR 2008). Specifically, the Accords state that over a ten-year period (2008-2017), BPA and other action agencies will make funds available for projects that benefit fisheries affected by the FCRPS. The Accords have been extended for 5 years (2018-2022). Projects focus on habitat and artificial production initiatives that benefit ESA-listed populations and other target resident fish species. The Accords target improvements to existing hatchery facilities such as those proposed in this Master Plan at Prosser (and a new summer-run Chinook facility above the Naches/Yakima confluence) as well as measures to restore Coho. In addition, under the Accords, the Yakama Nation is improving tributary habitat where Chinook spawn and rear. A new Coho production facility is specifically identified in the Accords to distribute hatchery production to reaches of the upper Yakima system to increase adult returns to underutilized areas. Finally, the Accords identify an expanded kelt reconditioning facility as critical to continuing efforts to restore the four Yakima Basin wild steelhead populations.

Several conditions are associated with this funding: (1) biological benefits are to be confirmed by experts; (2) NOAA must determine that the hatchery programs will not impede recovery; and (3) all necessary permits must be obtained for hatchery construction and operation. This Master Plan is being submitted to meet conditions (1) and (2).

7.4 RELATIONSHIP OF PROGRAMS WITHIN THE LOCAL AND REGIONAL HABITAT MANAGEMENT CONTEXT

7.4.1 Fish Management and Recovery

The Yakima Basin Steelhead ESU, which consists of four populations, is listed as threatened under the ESA. Specific recovery goals have been developed for each of the populations and for the ESU (NMFS 2009). Yakima Coho and summer/fall Chinook populations are not listed under the Endangered Species Act; therefore, recovery goals have not been established. However, neither population is currently self-sustaining without hatchery releases. In their 2009 review of Columbia River Basin salmon and steelhead populations, the HSRG provided recommendations that would benefit the Yakima populations.

The HSRG's recommendations for Yakima Coho include transitioning to using local broodstock for both the integrated and segregated programs, and developing additional in-basin facilities for incubation and rearing. The facility improvements and program modifications included in the proposed program will meet both of these recommendations. Once the Master Plan is approved, Prosser Hatchery will be retrofitted to accommodate the segregated program. The integrated program will reside at the Melvin R. Sampson Hatchery, which is under construction. The proposed program will also follow the HSRG's recommended Coho marking strategy: integrated program fish will be marked with a CWT to distinguish it from the natural population, but not adipose fin-clipped to relieve fishing pressure on the population. Fish from the segregated program will be 100 percent adipose clipped to maximize harvest and identify broodstock; a portion of releases will receive CWTs to evaluate straying onto the spawning grounds.

For Yakima summer/fall Chinook, the HSRG (2009a) recommended developing the capability to collect local broodstock and mark all juveniles. As described in this Master Plan, fall Chinook from out of basin will no longer be used as broodstock. The program will transition to using broodstock collected locally at Prosser Dam. Also, all juveniles will be marked with an adipose fin clip, a CWT, or both. Following the HSRG recommendations will increase the likelihood of meeting harvest and conservation goals, and make it possible to identify and manage the origin of broodstock and monitor the natural-origin population.

The HSRG's recommendations for Yakima Basin ESU steelhead are limited because there are no hatchery releases in the Yakima subbasin. The HSRG (2009a) recommended continuing to monitor reconditioned kelts to determine their spawning success.

7.4.2 Habitat

The Yakima River Basin encompasses over 6,100 square miles, bordered on the west by the crest of the Cascade Mountains, on the north by the Wenatchee Mountains, on the east by the breaks of the Columbia River, and on the south by the Simcoe Mountains and the Horse Heaven Hills. A multitude of landforms exist in the basin. The glaciated Cascade Mountains have peaks exceeding 8,000 feet and deep valleys. Moving east and south from the crest of the Cascades, elevation decreases, opening onto the broad valleys and lowlands of the Columbia Plateau. The lowest elevation in the basin is 340 feet at the confluence of the Yakima and Columbia rivers at Richland.

As described in Section 7.1.2, precipitation is highly variable across the basin, ranging from approximately 7 inches per year in the eastern portion to over 140 inches per year along the western border near the crest of the Cascades. Total runoff averages approximately 3.4 million acre/feet per year, ranging from a low of 1.5 to a high of 5.6 million acre/feet.

Nearly 40 percent of the basin is forested, another 40 percent is rangeland, 15 percent cropland, and the remaining acreage includes other land uses and water bodies. Rangelands are primarily used for grazing, military training, wildlife habitat, and tribal cultural activities. Forested areas in the northern and western portions of the basin are primarily managed for timber harvest, water quality, fish and wildlife habitat, grazing, tribal cultural activities, and recreation. About one-fourth of the forested area is designated as wilderness. The 1,000 square miles of irrigated agriculture includes pasture, orchards, grapes, hops, and field crops. Diverse recreational activities such as hunting, fishing, and camping, occur across much of the basin. Major urban areas include the cities of Yakima and Richland.

The basin contains a variety of aquatic habitats associated with the mainstem of the Yakima River and its primary tributaries, the upper Yakima, Cle Elum, and Naches rivers as well as by many smaller tributaries such as the Little Naches River, Satus, Ahtanum, and Taneum creeks.

The Yakima River originates at the outlet of Lake Keechelus and flows for 214 miles in a southeasterly direction to its confluence with the Columbia River at Richland (Figure 1-1). With its tributaries, the Yakima River drains about 6,150 square miles or 4 million acres. The headwaters originate in the high Cascade Mountains, with numerous tributaries draining subalpine regions within the Snoqualmie National Forest and the Alpine Lakes, Norse Peak, and William O. Douglas Wilderness areas. Major tributaries include the Kachess, Cle Elum and Teanaway rivers in the northern part of the subbasin. The Swauk, Taneum, Umtanum, Manastash, and Wenas creeks drain into the upper and middle Yakima River. The Naches River in the west is formed by the confluence of the Bumping and Little Naches rivers at RM 44.6. Tributaries of the Naches include the Tieton River and Rattlesnake and Cowiche creeks. Ahtanum, Toppenish, and Satus creeks join the Yakima in the lower subbasin from the west.

Six major reservoirs are located in the basin and form the storage component of the federal Yakima Project, managed by the USBR: Keechelus Lake (157,800 acre feet); Kachess Lake (239,000 acre feet); Cle Elum Lake (436,900 acre feet); Rimrock Lake (198,000 acre feet); Bumping Lake (33,700 acre feet); and Clear Lake (5,300 acre feet). Total storage capacity of all reservoirs is approximately 1.07 million acre/feet. With the exception of Rimrock and Clear Lake, all reservoirs were natural lakes prior to the construction of dams near their respective outlets. The non-federal Wenas Dam, located on Wenas Creek, stores irrigation water for use in the lower Wenas Valley. The construction and operation of irrigation reservoirs altered the natural seasonal hydrograph of all downstream reaches (Eitemiller et al. 2000).

The Washington Department of Ecology (WDOE) placed 72 stream and river segments throughout the Yakima Basin on the 303(d) list of threatened and impaired water bodies (DOE 1996, candidate list for 1998, Federal Clean Water Act 1977). Of these segments, 83 percent were cited as exceeding temperature standards. Specifically, temperatures exceeded 70°F in the Yakima River and tributaries from the Columbia River confluence to the Cle Elum River, and 61°F in the upper Yakima, American, and Bumping rivers.

A summary of existing habitat limiting factors in the basin (by reach) from the Yakima River Subbasin Plan (YSFWPB 2004) is provided in Table 7-5. Additional detail regarding the Yakima Basin's geography, topography, hydrology, habitat, and land use is available in Chapter 1 of the Yakima Subbasin Plan (YSFWPB 2004).

Table 7-5. Aquatic habitat limiting factors in the Yakima River Basin.

Limiting Factor	Description
Floodplain Habitat	The loss of floodplain habitat, especially side channels and springs adjacent to the mainstem Naches and Yakima rivers, is a significant limiting factor for the productivity of aquatic habitat in the subbasin. Actions recommended in the Yakima Subbasin Plan to reverse this habitat loss are to relocate infrastructure (where possible) to allow natural processes to operate and to reconnect side channels by removing obstructions.
Riparian Habitat	Riparian zone degradation includes a lack of shade and large woody debris (LWD), bank instability, and the inability of black cottonwood to reproduce under existing flow regimes. The Yakima Subbasin Plan calls for restoration of riparian zones and reduction of chronic bed instability through revegetation, introduction of LWD, protection of riparian areas by purchase or easement, improved riparian area management, and restoration of natural flow regimes.
Channel Confinement	Channel confinement by levees, bridges and roads alters floodplain functions and causes habitat loss. Multi-jurisdictional floodplain restoration and flood hazard reduction projects are necessary to reconnect floodplain side channels and to restore "unmanaged" or natural floodplain habitats.
Flow Regime	The presence of reservoirs in the system has reduced peak flows and may have either increased or decreased energy available for sediment transport. Altered flows and changes in the sediment transport and water temperature regimes (mostly summer increases) severely reduce the quantity and quality of aquatic habitats.
Predation	There is a high predation risk for juvenile salmonids in the Basin. To reduce the effect of elevated predation, the Subbasin Plan recommends increasing the number of spawning fish, reducing populations of smallmouth bass in the lower Yakima River, improving cover and off-channel habitats, and implementing further control on predator populations in mainstem reservoirs.
Fish Passage	Passage barriers and unscreened diversions and pumps have significant negative effects on salmon productivity. Related objectives of the plan are to improve passage and design of irrigation diversions to allow fish and sediment to pass through diversion points.

7.4.3 Hatchery Programs

As described in Section 7.3.1, the Yakima-Klickitat Fisheries Project is co-managed by the Yakama Nation and WDFW. The project includes collection of salmonid broodstock, incubation of eggs and rearing of fry in hatcheries, acclimation and release of smolts, and related ecological studies of natural production. Currently, there are four primary hatchery facilities operating in the basin producing Chinook, and Coho, and reconditioning wild steelhead kelts. Each of these facilities is described below.

7.4.3.1 Prosser Hatchery

Prosser Hatchery is located on the left bank of the Yakima River at RM 46.8. Currently, Prosser is used to incubate, rear, and hold Yakima fall Chinook as well as Coho and to recondition wild steelhead kelts. Existing facilities at Prosser are described in Section 6.1.2 and 6.2.1; proposed modifications are described in Section 6.1.3 and 6.2.2. Under this Master Plan, facilities at Prosser Hatchery would be upgraded to support in-basin incubation and rearing of segregated program Coho, the late component of the integrated summer/fall Chinook program, URB fall Chinook, and the expanded wild steelhead kelt reconditioning program.

7.4.3.2 Marion Drain Hatchery

The Marion Drain Hatchery is a part of the Yakima/Klickitat Fisheries Project and operates under the Lower Yakima River Supplementation and Research Project. Artificial production programs using naturally-spawned Yakima fish as broodstock began in 1997 at Marion Drain. Under this Master Plan, the facilities and program at Marion Drain would be upgraded to support rearing of the summer-run component of the integrated Yakima summer/fall Chinook program during the transition phase until a new upstream facility is constructed to support the summer-run program.

7.4.3.3 Melvin R. Sampson Hatchery

The Melvin R. Sampson (MRS) Hatchery is currently under construction and is located at Holmes Ranch on the Yakima River. Under this Master Plan, the integrated Coho program would be operated at the MRS Hatchery.

7.4.3.4 Cle Elum Supplementation and Research Facility

The YKFP began a spring Chinook (*O. tshawytscha*) salmon hatchery program at the Cle Elum Supplementation Research Facility (CESRF) near Cle Elum on the upper Yakima River (river mile 184.7, measuring from the confluence with the Columbia River) in 1997. The CESRF has multiple goals including harvest augmentation, mitigation, restoration, research, and education/ outreach. This program is a supplementation effort targeting the upper Yakima River spring Chinook population and is designed to test whether artificial propagation can be used to increase natural production and harvest opportunities while limiting ecological and genetic impacts (RASP 1992). It is an integrated hatchery program (Mobrand et al. 2005) because only natural-origin broodstock are used and returning hatchery-origin adults are allowed to spawn in the wild. The program employs “best practice” hatchery management principles (see Cuenco et al. 1993, Mobrand et al. 2005) including reduced pond densities, strict disease management protocols, random broodstock selection, and factorial mating (Busack and Knudsen 2007) to maximize effective population size. Fish are reared at the central facility, but released from three acclimation sites located near the central facility at: Easton, approximately 15.5 miles upstream of the central facility; Clark Flat, about 15 miles downstream of the central facility; and Jack Creek, about 7 miles upstream from the Teanaway River’s confluence with the Yakima River. The CESRF collected its first spring Chinook broodstock in 1997, released its first fish in 1999, and age-4 adults have been returning since 2001. The first generation of offspring of CESRF and wild fish spawning in the wild returned as adults in 2005. The program uses the adjacent, un-supplemented Naches River population as an environmental and wild control system.

7.4.4 Hydropower

Three small federal hydroelectric projects are located on the Yakima and Naches rivers: the Roza and Chandler power plants and the Naches Drop project on Wapato Canal. Roza Power plant is on Roza Canal northeast of the City of Yakima (Figure 2-1). Water is diverted into the canal at Roza Dam (RM 127.9) about 10 miles north of the city and returns to the river below the power plant (RM 113.3). The power plant has an 11,250 kilowatt (kW) capacity. Chandler Power plant (RM 35.8) diverts water from the Chandler Power Canal which has a capacity of 1,500 cfs. Flows are diverted at Prosser Dam (RM 47.1) and conveyed across the Yakima River into the Kennewick Main Canal for irrigation purposes. The residual capacity remaining from irrigation needs, including when the pumps are not run for irrigation, is used for power production. Wapato Power Plant is located on the Naches River (RM 9.7) has been purchased by the Bureau of Reclamation for the purpose of returning up to 450 cfs previously used for power generation to instream flows in the Naches River.

In addition to the above hydroelectric projects, the Bureau of Reclamation owns and operates six reservoirs (Bumping, Rimrock, Kachess, Keechelus, and Cle Elum) located in the headwaters of the Yakima Basin as part of the Yakima Reclamation Project, with a combined storage capacity of 1.07 million acre/feet. These reservoirs exert a fundamental influence on the floodplains and riparian zones downstream. In general, flows are lower in the fall, winter, and spring, and higher in the summer and early fall than they would be without the reservoirs. Most importantly, the reservoirs significantly reduce flood flows during flood events (YSFWPB 2004).

One of the most significant factors contributing to the abundance of anadromous salmonids in the Yakima River Basin is the number of dams in the mainstem Columbia River that smolts and returning adults must pass to complete their life cycle. The construction of Bonneville (1938), The Dalles (1957), John Day (1968), and McNary (1953) dams all reduced the number of adults returning to the Yakima Basin and the number of smolts successfully migrating to the ocean. Since the completion of the federal hydropower system, the Corps of Engineers constructed fish passage facilities at all dams, which has increased both upstream and downstream passage survival (NOAA 2008). The Biological Opinion (NOAA 2008) for the FCRPS identified operational trade-offs with survival improvements and also noted that mortality rates vary by facility. The BiOp includes potential biological triggers for conservation measures if listed populations fail to reach benchmark levels. System improvements will continue over time, but it is uncertain how successful they may be in continuing to reduce dam-related mortality on Chinook, Coho and steelhead. The proposed hatchery programs will help mitigate dam effects on populations by increasing the number of juvenile fish leaving the system. It should be noted that one of the YKFP's primary objectives is to increase knowledge about hatchery supplementation for resource managers and scientists throughout the Columbia River Basin, and to determine if it may be used to mitigate effects of hydroelectric operations on anadromous fisheries.

7.4.5 Harvest

7.4.5.1 Yakima River Coho

One of the goals of the proposed integrated and segregated Coho programs is to reestablish traditional harvest opportunities for Coho in the Yakima Basin. Because hatchery fish provide most of the harvestable fish throughout the Columbia River system, the proposed program is structured to balance potential hatchery impacts to the population with harvest benefits. This program will contribute Coho salmon to fisheries in the Pacific Ocean and Columbia River before adults return to the Yakima River (Table 7-6). In Phase 4 of the programs, total harvest of Coho (all fisheries) is expected to be approximately 11,000 fish, with 40% of fish (4,700) harvested in the Zone 6 and Yakima River fisheries. Terminal sport harvest is negligible.

Table 7-6. Estimated harvest rates of Yakima River Coho salmon under the proposed integrated and segregated programs.

Fishery	Integrated Program	Segregated Program
Phase 3		
Ocean Harvest Rate	11%	30%
Lower Columbia Harvest Rate	7%	24%
Upper Columbia Harvest Rate	20%	35%
Terminal Harvest Rate	1%	1%
Total Exploitation Rate	34%	66%
Phase 4		
Ocean Harvest Rate	11%	30%
Lower Columbia Harvest Rate	7%	24%
Upper Columbia Harvest Rate	35%	35%
Terminal Harvest Rate	1%	1%
Total Exploitation Rate	47%	66%

The State of Washington is expected to continue mark-selective harvest practices for Coho in marine and most recreational fisheries in the Columbia River below McNary Dam. Above McNary Dam where relatively minor harvest levels occur, state recreational fisheries may not be mark-selective. Tribal fisheries will be regulated using traditional time, area, and gear restrictions. The Yakama Nation may encourage release of unmarked fish.

Tribal subsistence fisheries occur throughout the Columbia and Yakima rivers. Tribal harvest is monitored by sampling fisheries below Bonneville Dam and at Cascade Locks, The Dalles Dam, John Day Dam, and McNary Dam on the mainstem Columbia River. Tribal fisheries in the Yakima River are also sampled.

7.4.5.2 Yakima River Summer/Fall Chinook and URB Fall Chinook

The primary purpose of the proposed integrated summer/fall Chinook program and segregated URB fall Chinook programs is reestablishing traditional harvest opportunities in Zone 6 and the Yakima Basin. The proposed programs are sized to consistently meet or exceed treaty harvest obligations on a sustainable basis, and to maintain or increase recreational harvests consistent with *U.S. v Oregon* agreements.

The total number of adult summer/fall Chinook returning to the Yakima subbasin has averaged about 5,100 adults (hatchery and natural origin) from 1998-2018 (Table 3-4)[16]. Recreational fishers harvest about 14 percent of the annual Chinook returns to the basin each year (Table 3-8). Because of the quantity and relatively higher quality of summer and fall Chinook available to

[16] Because hatchery fish are not marked, it has not been possible to determine the proportion of the run that is of natural origin.

tribal fishers in Zone 6 Columbia River fisheries, historical Yakima River Tribal harvest is typically less than 2 percent of the total run each year.

This program will contribute Yakima summer/fall Chinook and URB fall Chinook to fisheries in the Pacific Ocean and Columbia River before adults return to the Yakima River (Table 7-7). The long-term harvest goal for the Chinook program is an average annual harvest of 18,000 Chinook salmon in all fisheries, of which 5,000 adults would be harvested in the Zone 6 and terminal fisheries. Terminal and Zone 6 harvest is currently estimated to be 1,800 adults by Yakama Nation biologists.

Table 7-7. Estimated long-term harvest rates of hatchery-origin Yakima summer and fall Chinook salmon under the proposed programs.

Fishery	Segregated URB Fall Chinook	Integrated Yakima Summer/Fall Chinook	
		Summer Component	Fall Component
Ocean Harvest Rate	31%	43%	31%
Lower Columbia Harvest Rate	8%	9%	8%
Upper Columbia Harvest Rate	16%	20%	16%
Terminal Harvest Rate	14%	14%	14%
Total Exploitation Rate	54%	64%	54%

State recreational fishery regulations for the Yakima River vary from year to year and by river location, but generally require that all salmon caught with an intact adipose fin must be released. Typically, the Yakima River regulation states:

> *"The lower Yakima River, from the Highway 240 bridge upstream to 400 feet below Prosser Dam, is generally open to sport fishing from late September through October. Fishing is allowed according to regulations promulgated annually by WDFW. "*

Tribal fisheries are regulated using traditional time, area, and gear restrictions. Yakima River tribal harvest is typically at or near zero due to the general preference of tribal fishers to fish in Zone 6 Columbia River fall season fisheries. Fall Chinook typically are numerous and relatively higher quality at this location. Tribal harvest will be monitored by sampling fisheries below Bonneville Dam and at Cascade Locks, The Dalles Dam, John Day Dam, and McNary Dam on the mainstem Columbia River. Tribal fisheries in the Yakima River will also be sampled.

7.4.5.3 Yakima River Steelhead

The Yakima River Basin was closed to steelhead fishing in 1994. In 1990, WDFW incorporated catch-and-release and selective gear restrictions for trout fishing in important Rainbow Trout/steelhead spawning and rearing habitats in the Yakima River mainstem between Roza Dam and Easton Dam. Selective gear rules during trout fishing have been implemented in tributaries to reduce incidental impacts on listed steelhead.

Fisheries for Coho salmon and fall Chinook salmon occur during a portion of the steelhead migration. The areas at the mouths of Satus Creek and Toppenish Creek are closed to fishing to protect steelhead staging prior to entering the tributaries to spawn. Spring Chinook salmon fisheries in the Yakima River are closed and only open by special rule changes. In all of these fisheries, all steelhead must be immediately released unharmed and cannot be removed from the water prior to release.

Tribal harvest has remained very low and it is estimated that fewer than 10 steelhead are harvested annually in combined treaty and recreational Yakima Basin terminal fisheries. Harvest of steelhead in areas outside the Yakima River also occurs. Impacts from mainstem treaty and non-treaty fisheries have been estimated to be less than 10% of the Yakima River MPG natural-origin return (NMFS 2008).

7.4.6 Climate Change

The following discussion of climate change in the Columbia River Basin is largely adapted from Climate Change Impacts on Columbia River Basin Fish and Wildlife (ISAB 2007).

Warming of the global climate is unequivocal. Evidence includes increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. Eleven of twelve years (1995 -2006) rank among the 12 warmest years since 1850. The linear warming trend over the last 50 years (0.13 +/- 0.03°C per decade) is nearly twice that for the last 100 years.

Climate records show that the Pacific Northwest has warmed about 1.0 °C since 1900, or about 50 percent more than the global average warming over the same period. The warming rate for the Pacific Northwest over the next century is projected to be in the range of 0.1-0.6˚C/decade. Projected precipitation changes for the region are relatively modest and unlikely to be distinguishable from natural variability until late in the 21st century. Most models project long-term increases in winter precipitation and decreases in summer precipitation.

Mantua et al. (2010) evaluated the effects of these changes on the freshwater habitat for salmonid populations in Washington. Hydrology in the Yakima River watershed is affected by a mixture of direct runoff from fall rains and spring snowmelt, and is the type of watershed Mantua et al. (2010) predict will be most affected by climate change. Likely effects to fisheries are predicted to be:

- Increased air temperatures would increase water temperatures
- Elevated water temperatures would increase thermal barriers to migration
- Increased winter flooding would reduce egg-to-fry survival rates in streams
- Reduced spring snowmelt and summer/fall flows would affect migrating salmonids
- Pre-spawn mortality of summer run salmonids would increase due to reduced flows and elevated water temperatures

Several projections of the potential impact of climate change on cool and cold water fishes have been completed. One of these analyses suggests that temperature increases alone will render 2 to 7 percent of current trout habitat in the Pacific Northwest unsuitable by 2030, 5 to 20 percent by 2060, and 8 to 33 percent by 2090. Salmon habitat may be more severely affected, in part because these fishes can only occupy areas below barriers and are thus restricted to lower and warmer elevations within the region. Salmon habitat loss would be most severe in Oregon and Idaho, potentially exceeding 40 percent by 2090. Loss of salmon habitat in Washington would be less severe, with the worst case predicted to be about 22 percent by 2090. These estimates do not consider the associated impact of changing hydrology.

Increased frequency and severity of flood flows during winter can affect over-wintering juvenile fish and incubating eggs in the streambed. Eggs of fall and winter spawning fish, including Chinook, Coho, Chum, and Sockeye Salmon and Bull Trout, may suffer higher levels of mortality when exposed to increased flood flows. Warmer winter water temperatures also could accelerate embryo development and cause premature emergence of fry. Bull Trout require very cold, headwater streams for spawning; therefore, a warming climate may disproportionately impact this species. Recent projections of the loss of habitat suitable for Bull Trout in the Columbia Basin as a result of climate warming range from 22 to 92 percent.

Changes in mainstem flows due to hydropower operations are substantially greater than the natural runoff changes projected to be caused by climate warming in the 21st century; however, water temperature increases in the mainstem may affect Columbia River salmon in several ways. Water temperature increases will accelerate the rate of fall Chinook egg development (mainstem spawners), and lead to earlier emergence at a smaller average size than historically. Smaller sized fry are likely to have lower survival due to increased vulnerability to predators.

Changes in freshwater flow into the Columbia River estuary caused by climate change will be less than those caused by the hydropower system. Nonetheless, some changes in estuary habitats may occur.

Scientific evidence also strongly suggests that global climate change is already altering marine ecosystems from the tropics to polar seas. Physical changes associated with warming include increases in ocean temperature, increased stratification of the water column, and changes in the intensity and timing of coastal upwelling. These changes will alter primary and secondary productivity, the structure of marine communities, and, in turn, the growth, productivity, survival, and migrations of salmonids. Changing ocean temperatures may also alter salmon behavior, distribution, and migrations, increasing the distance to migrations from their home streams to ocean feeding areas. If salmon migrate farther to the north and/or food is less available, longer times may be required to reach maturity, delaying the usual times of adult migrations into coastal water and rivers.

As climate and streams warm, tributary habitats will become increasingly important because they usually provide the cool waters for salmonids and other cool-water species in a watershed. Ongoing habitat restoration efforts in the Yakima River and its tributaries are consistent with tributary habitat restoration measures recommended in ISAB (2007) and may help to offset some of the local negative effects of future climate change. Habitat improvement projects in the system may improve the natural river channel characteristics, floodplain function, hydraulic and sediment regimes, and habitat connectivity. Restoring Yakima tributaries to more natural conditions will create a healthy, functioning riparian community providing numerous benefits to fish and wildlife (including reduced water temperatures and improved habitat connectivity). Expected outcomes would benefit salmonids through a healthy, functioning floodplain and riparian community, an increase in spawning and rearing habitat for salmonids, an increase in instream habitat diversity, and upslope stabilization.

7.4.7 Population Growth

The following discussion of population growth in the Columbia River Basin is adapted from Human Population Impacts on Columbia River Basin Fish and Wildlife (ISAB 2007b).

Population is growing in the Columbia River Basin, increasing in all four Basin states and the Province of British Columbia. Regional population growth is projected to continue at least through 2030, although the rate of growth is expected to stabilize or decline. Some rural areas are experiencing rapid population growth, especially those with recreational and scenic amenities

Population density has also changed significantly in the past several decades. The highest densities of people in the Columbia River Basin live west of the Cascade Mountains along the I-5 corridor, a pattern that persisted from 1970-2000. In this same period, population density increased in and around the major urban areas in the basin (Portland–Vancouver, Spokane and Boise). Even more significant to fish and wildlife have been the increases in population densities in central Oregon (Bend–Redmond area) and central Washington (Yakima-Kennewick-Pasco-Richland area).

Population growth increases demand for land, water, and hydroelectricity which in turn generates greater pressure on fish and wildlife. Human development requires water for residential, irrigation, waste water assimilation, recreational, commercial, and industrial uses. Continued population growth will increase demand for these uses and heighten competition for limited water supplies. The effect of increasing water demand will be exacerbated by the effect of climate change on the quantity and temperature of summer stream flows in many subbasins. Limited controls over groundwater leave it vulnerable to intensified use.

Freshwater withdrawals for domestic and public uses are projected to increase by 71 to 85 percent by 2050. In the Canadian portion of the Okanagan Basin, per-capita water use is among the highest in Canada. Freshwater withdrawals for irrigation are projected to decline but will be more than offset by increases in withdrawals for public, domestic, industrial, and commercial uses. These increases will have significant implications for instream flow and for maintenance of riparian and aquatic habitats for fish and wildlife.

Urban development causes marked changes in the physical, chemical, and ecological characteristics of stream ecosystems. In most cases, these changes are detrimental to native aquatic biota, including salmonids. Exurban development (low density, semi-rural residential) has been the dominant settlement trend in the West since 1970, with a high proportion of homes built in areas of productive soils and proximity to water. The rate of exurban development appears to be increasing. This type of development tends to result in degraded habitat for fish and wildlife through direct habitat conversion and loss, alteration of habitat near roads and buildings, and fragmentation of habitats and landscapes. Exurban development has led to decreased species diversity, decreased abundance and local extirpation of some species, as well as increased conflict between wildlife and people.

8.0 ENVIRONMENTAL COMPLIANCE FOR ALL PROGRAMS

Under the NPCC step review process for aquaculture facilities, project proponents are asked to describe the status of their comprehensive environmental assessment. Upon approval of this Master Plan Addendum, the Yakama Nation/BPA will initiate preparation of a detailed environmental assessment that meets the criteria of the National Environmental Policy Act (NEPA). This assessment will provide a foundation for compliance with a number of other environmental and regulatory requirements. This chapter provides an overview of the most significant environmental compliance steps to be undertaken during the next planning and implementation stages of the program.

8.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) of 1969, as amended (42 USC 4321 et seq.), requires federal agencies to assess and disclose the effects of a proposed action on the environment prior to funding, approving, or implementing an action.

This program is a component of a broad suite of studies, research and artificial production ongoing in the Yakima River Basin. BPA analyzed the environmental impacts of research and supplementation projects in an Environmental Impact Statement (EIS) completed in 1996 (BPA 1996). This EIS addressed the impacts of construction, operation and maintenance of anadromous fish production facilities. Several supplemental analyses have been performed in subsequent years to address specific implementation measures associated with upgrades and modifications to the Yakima Klickitat Fisheries Project Chinook and Coho facilities at Prosser and Marion Drain hatcheries (list of supplemental analysis:

We assume, one or more Supplemental Analyses would be completed to assess the environmental consequences of implementing the Yakima URB fall Chinook, summer/fall Chinook and Coho hatchery programs would be prepared to address NEPA requirements.

8.2 ENDANGERED SPECIES ACT

Section 7 of the Endangered Species Act (ESA) directs federal departments and agencies to ensure that actions authorized, funded, and/or conducted by them are not likely to jeopardize the continued existence of any federally proposed or listed species, or result in destruction or adverse modification of critical habitat for such species. Neither Yakima River Coho nor fall Chinook are listed species; however, the effect of the proposed programs on species that are listed would be evaluated, which would be conducted as part of the NEPA Supplemental Analysis process.

Regarding construction, Section 7(c) of the ESA requires that federal agencies contact the USFWS and/or the National Marine Fisheries Service (NMFS) before beginning any construction activity to determine if federally listed threatened and endangered species or designated critical habitat may be present in the vicinity of a proposed project. A Biological Evaluation/Assessment must be prepared if actions by a federal agency or permits issued by a federal agency will result in construction (i.e., actual action on the ground) and if the Services determine that threatened and endangered species may occur in the vicinity of a proposed project. ESA consultation documentation will be prepared as necessary to meet Section 7 consultation requirements.

8.3 CLEAN WATER ACT

U.S. Army Corps of engineers Section 404 permits for the placement of dredged or fill material may be necessary to construct the new intake and outfall of the proposed acclimation sites, as well as to replace the Marian Drain intake screens. The authority to review the programs for consistency with Section 401 is the responsibility of the Washington Department of Ecology (WDOE) with regard to certifying any Section 404 permits that may be necessary to authorize in-water work issued by the U.S. Army Corps of Engineers. The National Pollution Discharge Elimination System review for hatchery effluent and construction stormwater management are also administered by WDOE, which may be necessary depending on fish production levels and construction site disturbance area (respectively).

8.4 NATIONAL HISTORIC PRESERVATION ACT

Funding this project is considered an undertaking within Section 106 of the National Historic Preservation Act of 1966, as amended (P.L.89-665, 16 U.S.C. 470). Section 106 requires that every federal agency take into account how each of its undertakings could affect historic properties. Historic properties are districts, sites, structures and traditional cultural places that are eligible for inclusion on the National Register of Historic Places. The Yakama Nation would take all necessary steps to evaluate potential effects on listed properties.

8.5 STATE AND LOCAL APPROVALS

Developing the proposed aquaculture facilities would require various regulatory approvals and permits from State of Washington agencies and county departments. It is expected that the Yakama Nation would lead this effort, which would be based on environmental and engineering analyses of potential project construction and operational effects. Permitting requirements would be verified during Step 2 planning and preliminary design; approvals will be sought during Step 3, final design. Among the permits the Tribe anticipates would be required are new surface and groundwater water rights, and potentially a National Pollution Discharge Elimination System permit for hatchery operation if production reaches a regulated level. A Hydraulic Project Approval from the Washington Department of Fish and Wildlife would be required for in-water work. An aquatic use authorization from the Washington Department of Natural Resources to occupy/use aquatic beds owned by the state. In addition, new construction at some sites may be within the jurisdiction of the County's Shoreline Master Program, Critical Areas Ordinance, and Floodplains Regulations, intended to protect shoreline ecology, public access, and water-dependent uses and to require mitigation of impacts where appropriate.

9.0 ESTIMATED COSTS FOR ALL PROGRAMS

The costs presented in this section are consistent with the Council's Step Review for conceptual, preliminary and final design phase requirements (NPCC 2006). These conceptual costs are a planning baseline from which to refine cost estimates, evaluate alternatives and protect against budget expansion as the proposed project progresses through the preliminary (Step 2) and final design (Step 3) phases and implementation. Construction cost estimates in Section 9.2.4 are considered to be at a concept level (+/- 35 to 50%). The operations and monitoring and evaluation cost estimates shown for Fiscal Year 2019 in Sections 9.2.7 and 9.2.8 are considered to be preliminary costs (+/- 25 to 35%). Operating costs are based on currently contracted amounts and include estimated increases once facilities and improvements are implemented for the proposed new programs described in Section 1.2.

Project cost estimates are based on the proposed programs summarized in Section 1.2 and conceptual designs presented in Section 6. As described in Section 6 of this document, the Yakama Nation is proposing to construct new facilities and improvements at the Prosser Hatchery for the Chinook, Coho and Steelhead Kelt programs. Cost estimates for facility planning and design, construction, acquisition of capital equipment, environmental compliance, monitoring and evaluation, and operations and maintenance are presented in the following sections for the proposed hatchery programs and facilities. A tabular summary of project costs is provided and a 10-year summary of all costs projected from FY 2019 through FY 2028 is presented for each site.

It should be noted that no cost estimates are presented for the construction of Melvin R. Sampson Hatchery and the Coho programs associated with those future facilities that are currently being implemented. The monitoring and evaluation costs for Coho provided in Section 9.2.8.2 do have some overlap with the programs that will reside at this facility.

9.1 FUNDING

The proposed facilities are identified in the 2018 Fish Accord Extension as an unfinished hatchery action that was part of the original 2008 Fish Accord. A summary of the background to the Fish Accords is presented below.

The 2008 Columbia Basin Fish Accord developed through good faith negotiations between Bonneville Power Administration (BPA), U.S. Army Corps of Engineers, U.S. Bureau of Reclamation (the “Action Agencies”) and the lower Columbia River Treaty Tribes, which include the Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, and the Columbia River Inter-Tribal Fish Commission. It committed BPA to fund hatchery actions to mitigate for impacts to fish from the configuration and operation of the Federal Columbia River and Snake River Dams. It further provided for the consideration of additional funding for the Yakima River Summer/Fall Chinook Hatchery Facilities. This commitment was an exception to the general agreement in the 2008 Accord to forego new proposals for hatchery construction for a 30-year period. The 2018 Fish Accord Extension updates and extends the 2008 Fish Accord commitments and identifies the proposed facilities as unfinished actions included in the 2008 agreement.

Reasons for the 2018 Extension include:

- To resolve issues between the Action Agencies and Treaty Tribes regarding compliance with the Pacific Northwest Electric Power Planning and Conservation Act and the Clean Water Act;

- To address the Action Agencies' and Treaty Tribes' mutual concerns for certainty and stability in the funding and implementation of projects for the benefit of fish affected by the FCRPS and Upper Snake Projects, affirming and adding to the actions proposed in the FCRPS and Upper Snake Biological Opinions; and

- To foster a cooperative and partnership-like relationship in implementation of the mutual commitments in the Agreements.

9.2 PROSSER AND MARION DRAIN (CHINOOK, COHO AND STEELHEAD KELTS)

9.2.1 Cost Sharing / Program Areas / Major Milestones

9.2.1.1 Cost Sharing with Other Organizations and Entities

Cost sharing will be an important aspect of funding the proposed programs. Conceptual costs take into consideration cost sharing occurring in current programs and expected to continue into the future.

Most cost sharing identified for the Yakama Nation's Prosser Hatchery Coho and Chinook programs relate to operations and maintenance for the Prosser and Marion Drain facilities. Cost sharing includes both direct funding and in-kind support. Table 9-1 shows the cost sharing entities involved, including the Yakama Nation, Bureau of Reclamation, and funding from the Mitchell Act. While these cash and in-kind contributions are not shown as direct deductions from the estimated line item budgets presented in this document, they were considered when developing cost estimates if they potentially affected a cost area in the future.

Table 9-1. Summary of cost sharing, Yakima Summer/ Fall and URB Chinook programs, Yakima segregated and integrated Coho programs and Steelhead Kelt programs.

Funding Source or Organization	Date / Fiscal Year	Item or Service Provided	Cash or In-Kind Contribution	Amount
Yakama Nation Gaming Revenue	Annual	Operating expenses	Cash	$30,000
Mitchell Act	Annual	Acclimation for Coho and Fall Chinook	Cash	$189,000
BOR	Annual	Electrical, utilities	In Kind	$50,000
			Totals	$269,000

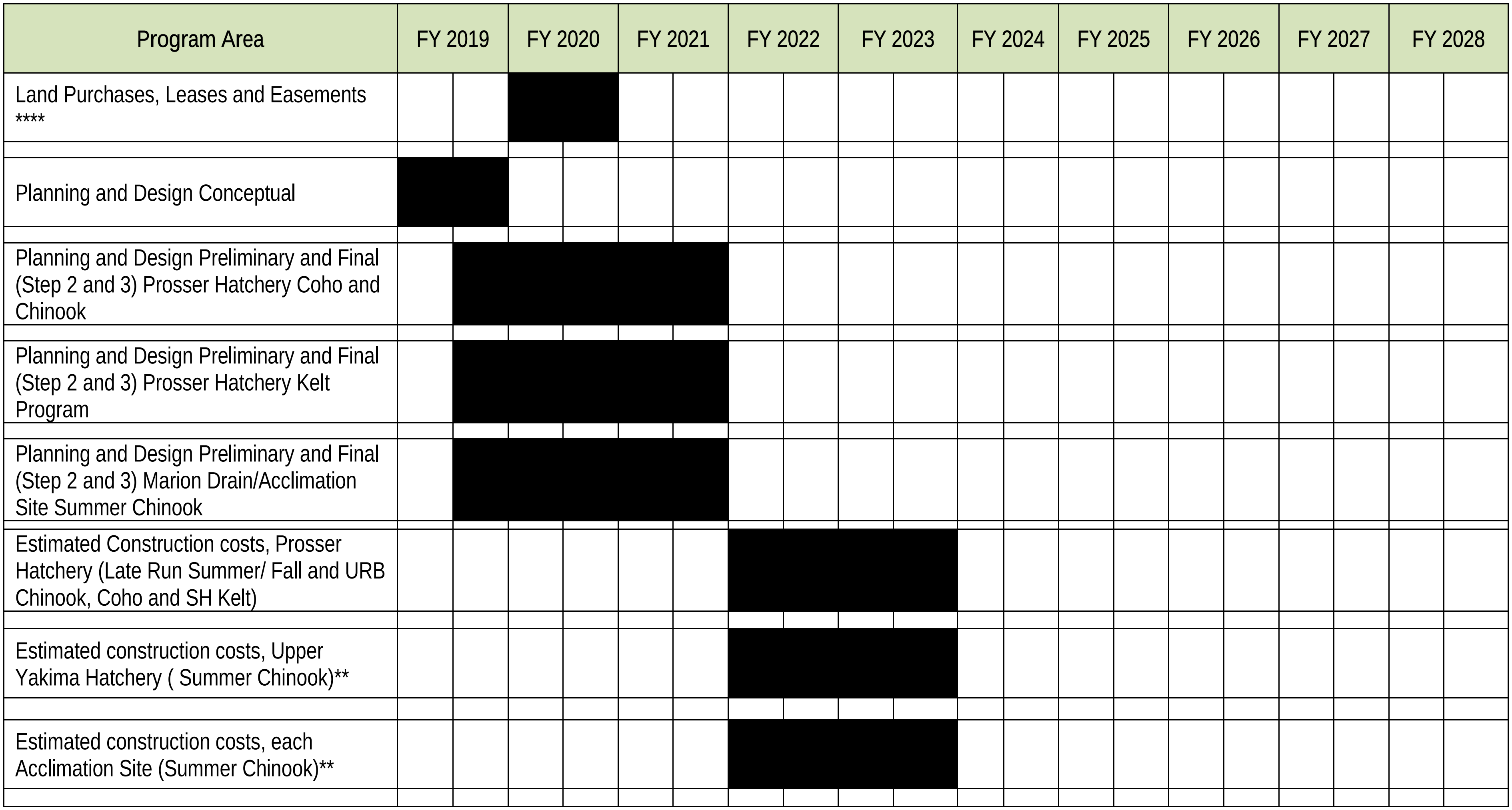
Notes and Assumptions:
Cost Share is shown in 2019 dollars
Cost share provides $44,856 in labor and fringe costs and $4500 in operating supplies
Figures provided are consistent with Project No. 198812025, 199701325, 199506325
Estimated cost shares are accounted for in all budgets presented

9.2.1.2 Program Areas and Major Milestones

For the programs and facilities described here, considerable planning and design, environmental compliance, operations and maintenance and monitoring and evaluation has occurred and was funded within the previous Accord (2008 – 2017). More funding to cover these activities will be required as the Master Planning process proceeds through Step 3 and into implementation. Capital construction funding for upgraded facilities at Prosser and Marion Drain and a new long-term summer-run facility is anticipated to be needed in FY 2022 and 2023.

A generalized list of program areas and a preliminary time line linking costs to planning, construction, capital equipment, environmental compliance, operations and maintenance and research, monitoring, and evaluation is presented in Figure 9-1 for FY 2019 through FY 2028. A cost summary by program area is shown in Table 9-2. Cost estimates for each program area are presented in the year in which they are expected to occur and are shown in Table 9-15; costs are escalated from FY 2019 to the year they would be expended.

Figure 9-1. General timeline for key milestones and expenditures, Prosser and Upper Yakima Hatchery, Acclimation Summer Chinook.



Program Area	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023		FY 2024		FY 2025		FY 2026		FY 2027		FY 2028	
Capital Equipment Costs, Prosser Hatchery (for new Operations, Production)									■	■										
Capital Equipment Costs, Summer/ Fall Chinook Marion Drain Hatchery and new Acclimation									■	■										
Environmental Compliance Step 2 (Permitting, EA, Other)			■	■	■	■	■													
Yakima Natural Production and Enhancement Program Annual Yakima Management & Data	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Current Annual Operations and Maintenance - Prosser and Marion Drain Hatchery Programs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Annual Operations and Maintenance - Prosser Steelhead Kelt	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Future additional Operations and Maintenance for Prosser Hatchery Programs									■	■	■	■	■	■	■	■	■	■	■	■
Future additional Operations and Maintenance for Upper Yakima Hatchery summer Chinook Program and New acclimation									■	■	■	■	■	■	■	■	■	■	■	■
Future additional Annual Operations and Maintenance - Prosser Steelhead Kelt									■	■	■	■	■	■	■	■	■	■	■	■

Program Area	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
Annual Monitoring & Evaluation Expenses, S/F and URB Chinook Programs										
Annual Monitoring & Evaluation Expenses, Coho Programs										

Notes & Assumptions:

- Assumes that site for Summer Chinook Acclimation development is available on this timeline
- Assumes proposed Step 2 (preliminary) and Step 3 (final) funding is available on this schedule
- Assumes a design/build or modified design/build approach is utilized after approval to start Step 2 and Step 3 (preliminary and final planning and design)
- Assumes construction starting in FY 2022 (less than a two-year schedule dependent on a Spring 2022 construction start)
- Assumes all proposed facilities and improvements are built in two construction seasons (during FY 2022 and FY 2023)
- Assumes no major environmental compliance issues are identified beyond what is described in Section 8.0
- O&M expenditures (funded under BPA project numbers 1988-120-25 and 1977-013-25) will increase during the last phases of construction (FY 2023) allowing for training and handoff of new facilities and equipment and increase utility expenses
- M&E expenditures may increase after the last phases of construction (FY 2023), funded under BPA Project No. 1995-063-25

Table 9-2. Summary of key expenditures by program area, Yakima Summer/ Fall and URB Chinook programs, Yakima segregated and integrated Coho programs and Steelhead Kelt programs.

Program Area	Estimated Cost	Occurrence	Level of Certainty
Land Purchases, Leases and Easements *	TBD	One Time	TBD
Planning and Design Conceptual		One Time	Master Plan was completed in 2012, Addendum to the Master Plan (this document) completed in 2019
Planning and Design Preliminary and Final (Step 2 and 3) Prosser Hatchery Coho and Chinook	$2,475,000	One Time	Concept (+/- 35% to 50%) (escalated to 2021 dollars) Includes both planning and engineering design
Planning and Design Preliminary and Final (Step 2 and 3) Prosser Hatchery Kelt Program	$400,000	One Time	Concept (+/- 35% to 50%) (escalated to 2021 dollars) Includes both planning and engineering design
Planning and Design Preliminary and Final (Step 2 and 3) Upper Yakima Hatchery/Acclimation Sites Summer Chinook	$611,000	One Time	Concept (+/- 35% to 50%) (escalated to 2021 dollars) Includes both planning and engineering design
Estimated Construction costs, Prosser Hatchery (Late Run Summer/ Fall and URB Chinook, Coho and SH Kelt)**	$34,453,448	One Time	Concept (+/- 35% to 50%) (escalated to 2022 dollars) from Table 9-3
Estimated construction costs, Upper Yakima Hatchery (Summer Chinook)**	$4,461,509	One Time	Concept (+/- 35% to 50%) (escalated to 2022 dollars) from Table 9-4
Estimated construction costs, Acclimation Site(s) (Summer Chinook)**	$2,571,828	One Time	Concept (+/- 35% to 50%) (escalated to 2022 dollars) from Table 9-5
Capital Equipment Costs, Prosser Hatchery (for new Operations, Production)	$132,838	One Time	Concept (+/- 35% to 50%) (escalated to 2023 dollars) from Table 9-6
Capital Equipment Costs, Summer/ New Upper River Hatchery and Acclimation	$1,846,112	One Time	Concept (+/- 35% to 50%) (escalated to 2023 dollars) from Table 9-6
Environmental Compliance Step 2 (Permitting, EA, Other)	$222,054	One Time	Concept (+/- 35% to 50%) Completed during Step 2 and 3 (2021 dollars)
Current Annual Operations and Maintenance - Prosser	$2,224,668	Annual	Current O&M costs from project 1988-120-25 (Contract #56662 Rel 168) (escalated at 2.0% annually to FY 2023)

Program Area	Estimated Cost	Occurrence	Level of Certainty
and Marion Drain Hatchery Programs			
Annual Operations and Maintenance - Prosser Steelhead Kelt	$201,325	Annual	Current O&M costs contracted (escalated at 2.0% annually to FY 2022)
Future additional Operations and Maintenance for Prosser Hatchery Programs***	TBD	Annual	Estimated additional O&M costs after implementation of improvements in FY 2022
Future additional Operations and Maintenance summer/ Chinook Program and New acclimation Upper Yakima Hatchery***	TBD	Annual	Estimated additional O&M costs after implementation of improvements in FY 2022
Future additional Operations and Maintenance - Prosser Steelhead Kelt***	TBD	Annual	Estimated additional O&M costs after implementation of improvements in FY 2022
Annual Monitoring & Evaluation Expenses, S/F and URB Chinook Programs	$609,839	Annual	Current M&E costs from project 1988-063-25 (Contract 56662 Rel 185) (escalated at 2.0% annually to FY 2023) Table 9-12
Annual Monitoring & Evaluation Expenses, Coho Programs	$734,673	Annual	Current M&E costs from project 1988-063-25 (Contract 56662 Rel 185) (escalated at 2.0% annually to FY 2023) Table 9-13

Notes and Assumptions:
*Lands costs are applied to this project are a placeholder estimate for the Summer Chinook Acclimation
**Shows an estimated placeholder cost estimate based on the conceptual construction cost
***Future additional Operations and Maintenance costs that will start to be uncured upon completion of the proposed construction improvements
Budget figures assume that work would proceed on the timeline shown in Figure 9-1 and Table 9-15 Ten Year Future Cost Summary

9.2.2 Land Acquisition Cost Estimates

The property associated with the Prosser site is owned by US Bureau of Reclamation, and land purchase costs for are not expected for the proposed improvements to this site. All land associated with the current Marion Drain Chinook Hatchery program has been acquired and no new property or lands are planned to be purchased or require expenditures for the proposed improvements.

Acclimation sites for summer-run Chinook are being investigated at this time in the upper Yakima. One site is owned by Washington Department of Fish and Wildlife and it is expected that they will retain ownership. The property and lands associated with the potential Nelson Springs acclimation site is also not expected to require land acquisition expenditures.

9.2.3 Planning and Design Cost Estimates

9.2.3.1 Master Plan, Conceptual Planning and Design

Concept level planning and design consists of the expended budget for the revised Master Plan completion.

9.2.3.2 Preliminary and Final Planning and Design

Preliminary design costs are estimated as a percentage of total construction costs for producing a 30% design, plus additional costs for special studies. These studies include geotechnical investigations, wetlands/ordinary high-water delineations, and additional topographic surveys if needed, etc. For this project, geotechnical investigations and ordinary high-water delineations should be performed at Prosser and Marion Drain Hatcheries, and at the selected summer Chinook acclimation site. A wetlands delineation and topographic survey will be needed at the acclimation site. Topographic surveys at Prosser and Marion Drain were completed in 2011 as part of the original Master Plan, and a small allowance is included for updates to capture changed conditions.

A placeholder of $2,475,000 for Chinook and Coho and $400,000 for the Kelt program (Table 9-2) has been identified for preliminary planning, site investigations and design and final design. Initiation of this work is proposed in late FY 2019 through FY 2021 (Figure 9-1). This budget includes costs to refine the monitoring and evaluation program to meet NPCC requirements and to develop planning submittals. The budget may need further refinement depending on the outcome of the addendum to the Master Plan (this document) approval process.

The project sponsor may choose to include both the preliminary and final design, or final design only as part of a larger construction contract, such as an engineer-procure-construct (EPC) contract. The final planning and design component of the contract typically includes several design review submittals, final design drawings and specifications, construction cost estimates, and design report with supporting calculations. A placeholder budget figure noted above includes the final design component of this project.

9.2.4 Capital Construction Cost Estimates

Capital construction costs are concept estimates based on a conceptual design in 2019 dollars, and are informed by recent hatchery construction costs in the Columbia Basin. Due to the level of uncertainty at the conceptual design level, a contingency of 20 percent is applied to each construction cost line item. Such a contingency is largely dependent on the number of uncertainties associated with the project and the amount of pre-investigation work completed. An annual construction cost escalation due to inflation and market conditions is then applied at a rate of 4 % per year. Mark-ups for mobilization/demobilization, general conditions, bonding and overhead and profit are them applied to the construction cost subtotal. A Washington state sales tax of 8.2% on permanent materials used in construction is accounted for as well.

Costs are broken down into major infrastructure and facility components and are based on the scope and conceptual descriptions presented in Section 6. Details of these estimates are found in Tables 9.3, 9.4, 9.5 and Appendices H-1 and H-2. Phasing construction over multiple years and/or construction contracts would significantly increase overall costs.

9.2.4.1 Prosser Hatchery

The current estimate for capital construction at Prosser is based on the descriptions of facilities and infrastructure provided for Chinook programs in Section 6.1.2. Existing Facilities and Sections 6.1.3 and 6.1.7 Proposed Facilities, and for Coho Programs in Section 6.2.1. Existing Facilities and Section 6.2.2. Proposed Facilities. Section 6.3 describes the facilities for the proposed expansion of the Steelhead Kelt program. Figure 6-10 shows the preliminary layout of proposed improvements at Prosser Hatchery.

Construction costs associated with renovating and/or demolishing existing facilities are included in Table 9.3. This table provides a summary of the estimated construction costs for each component of the Prosser Hatchery. Costs are broken down into major infrastructure and facility components and are based on the scope and conceptual descriptions presented in Chapter 6. Details of these estimates are provided in Appendix H-1. The estimated construction budget for Prosser Hatchery is $30,629,000 in 2019 dollars. When inflated at 4% to the proposed year of construction in 2022, the total cost would be $34,453,000.

The Yakama Nation proposes to implement all components of the Prosser Hatchery as a single project. Due to the need to maintain continuous operations at this hatchery, construction will need to be phased over at least two years.

Table 9-3. Summary of estimated construction costs, Prosser Hatchery (SF and URB Chinook, Coho and SH Kelt).

Description	Costs
Process Water Supply and LOX to Head Boxes	$381,120
Effluent and Drain System	$304,080
Site Work and Utilities	$969,600
FC Hatchery Bldg	$10,919,045
FC Iso Inc Bldg	$466,570
Coho Hatchery Bldg	$7,265,574
Kelt Bldg	$2,134,758
Adult Holding	$607,396
Admin Building	$501,749
Construction Cost Subtotal - 2019 $	$23,549,892
Mob/Demob, Bonding, General Conditions- 10%	$2,354,989
Subtotal	$25,904,881
Overhead and Profit - 16%	$4,144,781
Taxes 8.2% on Permanent Materials	$579,327
Probable Total Cost - 2019 Dollars	$30,628,990
Probable Total Cost - 2022 Dollars	$34,453,448

Notes & Assumptions:
Costs estimate in 2019 Dollars
Inflation/escalation at 4% to Mid-Point Construction date of 2022
Mob/Demob., General Conditions includes inflation/escalation at 4% to Mid-Point Construction date of 2022
Costs should be considered conceptual (+/- 35% to 50%)
See Details in Appendix H-1

9.2.4.2 Upper Yakima Hatchery for Summer Chinook

The current estimate for capital construction at Upper Yakima hatchery is based on the descriptions of facilities and infrastructure provided in Section 6.1.6. Existing Facilities and Section 6.1.7. Proposed Facilities. As noted in Section 6.1.6, the Tribe proposes to develop a new facility for adult holding, incubation and early rearing of the summer Chinook program.

Construction costs associated with renovating and/or demolishing existing facilities are included in Table 9.4. This table provides a summary of the estimated construction costs for each component of the Upper Yakima Hatchery. Costs are broken down into major infrastructure and facility components and are based on the scope and conceptual descriptions presented in Chapter 6. Details of these estimates are provided in Appendix H-2. The estimated construction budget for Upper Yakima Hatchery is $3,966,000 in 2019 dollars. When inflated at 4% to the proposed year of construction in 2022, the total cost would be $4,462,000.

The Yakama Nation proposes to implement all components of the Upper Yakima Hatchery as a single project.

Table 9-4. Summary of estimated construction costs, Upper Yakima Hatchery (Summer Chinook).

Description	Total
Water Supply Improvements	$627,600
Effluent and Drain systems	$160,200
Site Work and Utilities	$231,936
Hatchery Building (5,000 SF)	$1,791,420
Adult Holding Ponds	$238,410
Construction Cost Subtotal - 2019 $	$3,049,566
Mob/Demob, Bonding, General Conditions - 10%	$304,957
Subtotal	$3,354,523
Overhead and Profit - 16%	$536,724
Taxes 8.2% on Permanent Materials	$75,019
Probable Total Cost - 2019 Dollars	$3,966,266
Probable Total Cost - 2022 Dollars	$4,461,509

Notes & Assumptions:
Costs estimate in 2019 Dollars
Inflation/escalation at 4% to Mid-Point Construction date of 2022
Mob/Demob., General Conditions includes inflation/escalation at 4% to Mid-Point Construction date of 2022
Costs should be considered conceptual (+/- 35% to 50%)
See Details in Appendix H-2

9.2.4.2 Acclimation Site for Summer Chinook

Future acclimation sites are proposed for the summer Chinook program in the Upper Yakima River. The current estimate for capital construction for construction of each acclimation site is based on a brief description of facilities and infrastructure provided in Section 6.1.7, Proposed Facilities. A more detailed site selection and planning process will be conducted separately from this Master Plan update.

The concept cost provided in Table 9-5 are based on the scope and conceptual descriptions presented in Chapter 6. The proposed improvements at each site have identical improvements based on acclimating 500,000 sub-yearlings each. Actual costs will vary somewhat due to site specific conditions that will need to be addressed in future planning and design phases. Details of these estimates are provided in Appendix H-2. The estimated construction budget for each proposed acclimation site is $2,286,000 in 2019 dollars. When inflated at 4% to the proposed year of construction in 2022, the total cost would be $2,572,000 for one facility.

The Yakama Nation proposes to implement the acclimation sites as part of the Upper Yakima Hatchery improvements as they are critical components of the summer Chinook program.

Table 9-5. Summary of estimated construction costs, each acclimation site (Summer Chinook).

Description	Total
Water Supply Improvements	$843,600
Effluent and Drain Systems	$193,500
Site Work and Utilities	$202,896
Acclimation Tanks and Cover (2,940 SF)	$517,920
Construction Cost Subtotal – 2019 $	$1,757,916
Mob/Demob, Bonding, General Conditions - 10%	$175,792
Subtotal	$1,933,708
Overhead and Profit - 16%	$309,393
Taxes 8.2% on Permanent Materials	$43,245
Probable Total Cost - 2019 Dollars	$2,286,346
Probable Total Cost - 2022 Dollars	$2,571,828

Notes & Assumptions:
Costs estimate in 2019 Dollars
Inflation/escalation at 4% to Mid-Point Construction date of 2022
Mob/Demob., General Conditions includes inflation/escalation at 4% to Mid-Point Construction date of 2022
Costs should be considered conceptual (+/- 35% to 50%)
See Details in Appendix H-2

9.2.5 Capital Equipment Cost Estimates

The new facilities and improvements to meet the goals for the Chinook, Coho and steelhead kelt programs at Prosser and Marion Drain Hatcheries will require investment in various types of equipment, to support office, communications, changed rearing facilities (partial re-use), fish transport, tagging, laboratory equipment, water systems etc. Table 9-6 lists the potential types of equipment by functional area of the proposed operations for both Prosser, Marion Drain and the acclimation site and probable costs by operational area. A conceptual estimated budget for the programs at Prosser totals $132,800 (escalated at 2.0 percent from FY 2019 to FY 2023, when equipment would be needed). A conceptual estimated budget of the programs for Marion Drain and associated acclimation site totals $280,000 (escalated at 2.0 percent from FY 2019 to FY 2023, when equipment would be needed). Note that with the added expense of new tagging equipment of $1,446,600, expenses total about $1,846,000.

Table 9-6. Capital equipment budget by facility/hatchery functional area, Prosser, Marion Drain Hatcheries and Future Upper Yakima Hatchery, Acclimation.

	Prosser Hatchery (All programs)		Marion Drain Hatchery (Existing Programs)		Future Upper Yakima Hatchery and Acclimation (Summer Chinook Program)	
Description	Total Cost (FY 2019 Dollars)	Total Cost (FY 2023 Dollars)	Total Cost (FY 2019 Dollars)	Total Cost (FY 2023 Dollars)	Total Cost (FY 2019 Dollars)	Total Cost (FY 2023 Dollars)
Office Equipment	$10,568	$13,140	$10,568	$11,439	$10,568	$11,439
Computers / Printers	$21,113	$26,251	$21,113	$22,853	$21,113	$22,853
Office Furniture and Cabinets	$13,899	$17,282	$13,899	$15,045	$13,899	$15,045
Communications Equipment	$37,594	$46,744	$37,594	$40,693	$37,594	$40,693
Housing Equipment and Furniture / Permanent Staff Housing						
Housing Equipment and Furniture / Temporary Staff Housing						
Shop Equipment						
Buildings / Facilities Needs						
Transportation						
Water System Operation						
Incubation						
Fish Transport			$173,452	$187,750	$173,452	$187,750
Chinook / Coho Rearing at Hatchery	$23,663	$29,422				
Chinook / Coho Rearing at Acclimation Ponds						$0
Coho Rearing at Hatchery						$0
Coho Rearing at Acclimation Ponds						$0
Tagging / Marking					$1,446,600	$1,565,846
M&E Equipment						$0
Technical / Lab Equipment						$0
Disinfection Equipment (Other Disease and Pathology Needs)			$2,297	$2,486	$2,297	$2,486
Other						
TOTAL	$106,837	$132,838	$258,923	$280,266	$1,705,523	$1,846,112

9.2.6 Environmental Compliance Cost Estimates

Developing the proposed changes and improvements to the Prosser Hatchery, Marion Drain Hatchery and the new acclimation site programs will incur environmental compliance costs subsequent to this additional master planning stage. Compliance steps for the proposed program could include the National Environmental Policy Act (NEPA), a Biological Assessment under the Endangered Species Act, and other laws and regulations that are discussed in Section 8. Table 9-7 presents the estimated cost by potential permit or other compliance requirement. Costs are estimated to be approximately $222,000 (when escalated to FY 2020) to meet all potential requirements to implement the project.

Table 9-7. Estimated cost of environmental compliance, Prosser, New Upper Yakima Hatchery and Acclimation.

Project Area/Permit/Requirement	Prosser Hatchery		Upper Yakima Hatchery		Acclimation Site(s)	
	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)
Water Supply/ Quality						
Groundwater Right - new wells (WDOE)	$5,000	$5,100	$5,000	$5,100	$0	$0
NPDES - Upland Fin-fish Hatching and Rearing Permit (WDOE) - update/new permit need TBD	$10,000	$10,200	$7,000	$7,140	$5,000	$5,100
Surface Water Right - acclimation sites (WDOE) - need TBD	$8,000	$8,160	$0	$0	$10,000	$10,200
Planning Approvals						
NEPA Supplemental Analysis (including ESA review) on Program Implementation (BPA) - need TBD - covers all program and improvement changes	$25,000	$25,500	$25,000	$25,500	$0	$0
Aquatic Use Authorization (WDNR) - need TBD	$0	$0		$0	$5,000	$5,100
ESA Section 7 Consultation Documentation (CWA Section 404 permitting) - need TBD	$0	$0	$5,000	$5,100	$7,000	$7,140
SEPA - adopt NEPA determination (where applicable) or complete SEPA Checklist - need TBD	$5,000	$5,100	$5,000	$5,100	$5,000	$5,100
Section 106 Cultural Resources Survey and SHPO Consultation	$1,500	$1,530	$1,500	$1,530	$5,000	$5,100
Critical Areas Study (CWA Section 404 permit and local CAO/Shorelines compliance) - need TBD	$5,000	$0	$5,000	$5,100	$7,000	$7,140
Environmental Compliance Permits for Construction						
JARPA - Includes CWA Section 404 and 401, RHA Section 10, HPA (Corps, WDOE, WDFW)	$0	$0	$5,000	$5,100	$5,000	$5,100
Aquatic Use Authorization (WDNR) - need TBD	$0	$0	$0	$0	$7,000	$7,140
Critical Areas Ordinance Permit/Shorelines Substantial Development Permit/Flood Hazard Determination (County) - need TBD	$5,000	$5,100	$5,000	$5,100	$5,000	$5,100

Project Area/Permit/Requirement	Prosser Hatchery		Upper Yakima Hatchery		Acclimation Site(s)	
	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)	Estimated Cost to Complete (2019 Dollars)	Estimated Cost to Complete (2020 Dollars)
NPDES 1200-C Construction General Permit & Stormwater Pollution Prevention Plan for projects with one or more acres of construction ground disturbance (WDOE/EPA) - need TBD	$5,000	$5,100	$5,000	$5,100	$5,000	$5,100
Yakima County Commercial Building Permits	$3,750	$3,825	$3,750	$3,825	$0	$0
County Road Permits	$800	$816	$800	$816	$0	$0
NPDES General Construction Stormwater & Storm Water Pollution Prevention Plan (EPA)	$4,800	$4,896	$4,800	$4,896	$0	$0
Total	$78,850	$75,327	$77,850	$79,407	$66,000	$67,320

Notes & Assumptions:
Assumes majority of expenditures occur in FY 2020 and 2021
Costs are escalated at 2.0% annually
Costs should be considered conceptual (+/- 35% to 50%)

Upgrades to existing Prosser Hatchery
*No work below the ordinary high-water mark or wetlands is necessary at the Prosser Hatchery.
*All construction and staging would be within existing disturbed/built environments.
*Assumes supplemental NEPA analysis (and program ESA review) is completed in one effort for all (listed under Prosser Hatchery budget total).

Upper Yakima Hatchery, Acclimations Sites
*New facility to be constructed on undeveloped land.
*In-water work would be necessary to construct the intake and outfall structures.
*New water right is needed.
*At least one acre of land would be disturbed (permanent + temporary construction access and staging).

9.2.7 Operations and Maintenance Costs

The current budget for the Yakima Natural Production and Enhancement Program Management & Data project and a proposed estimate for increased support is provided in Section 9.2.7.1. The current annual operating costs for both Prosser and Marion Drain hatcheries and an estimate for increased operating needs once the proposed facility improvements and associated programs on implemented are provided in Section 9.2.7.2. The current annual subcontracted operating cost for the steelhead kelt program at Prosser Hatchery and an estimate for increased operating needs once the proposed facility improvements are implemented are provided in Section 9.2.7.3. Expenses for all operating budgets include such items as payroll, utilities, vehicles, supplies, maintenance, and potential subcontracted support services.

9.2.7.1 Annual Operating Costs, Prosser and Marion Drain Hatcheries

Annual operating expenses include such items as payroll, utilities, vehicles, supplies, maintenance, and needed subcontracted support services.

The currently contracted budget for operations and maintenance of the Prosser and Marion Drain hatcheries for the Chinook and Coho programs is $2,055,250 annually. When this estimate is escalated from FY 2019 to FY 2023 dollars when the new improvements are implemented, operational expenses would be about $2,424,688 annually. A revised estimate for utilities is included in this average to account for increased pumping and upgraded facilities. These estimated costs are provided in Table 9-8.

The current operating expenses that support specific expense areas associated with the steelhead kelt program at Prosser Hatchery total $186,000. When new facilities and improvements are completed at both facilities, the annual operations and maintenance costs are estimated to increase to $201,000 when this estimate is escalated from FY 2019 to FY 2023 dollars. A revised estimate for utilities is included in this average to account for increased pumping and upgraded facilities. These estimated costs are provided in Table 9-9.

Table 9-8. Annual operating expenses, Prosser and Marion Drain Hatcheries (Summer Fall and URB Chinook, Coho).

Expense Area	Total Current Estimated Operations Costs for Prosser and Marion Drain (2019 dollars)	Total estimated increases in operations costs for Prosser improvements and Upper Yakima Summer Chinook (2019 Dollars)	Total Estimated Operations costs for Prosser and Marion Drain (2023 dollars)
I. Payroll (Taxes, Benefits, Mark-ups)	$1,027,123	TBD	$1,111,791
II. Materials, Supplies Services / Office	$3,000		$3,247
II. Materials, Supplies Services / Supplies, Equipment	$27,700		$29,983
II. Materials Supplies Services / Operating	$123,230		$133,388
II. Materials Supplies Services /Insurance, vehicles, YN Property	$7,365		$7,972
II. Materials Supplies Services / Utilities (phone, Garbage, Electric, Septic, Propone	$45,300		$49,034
II. Materials Supplies Services / Repairs and Maintenance	$53,500		$57,910
II. Materials Supplies Services/ Rent and Lease (GSA Vehicles)	$63,336		$68,557
II. Materials Supplies Services/ Vehicle Gas and Oil	$7,282		$7,882
II. Materials Supplies Services Travel and Per diem	$7,002		$7,579
Subtotal (Areas I and II)	*$1,364,837*		*$1,477,344*
III. Indirect on Labor and Direct Expenses (18.57%) (Areas I and II) / $1,364,837	$253,450		$274,342
IV. Capital Costs and Equipment / Facility: Field Equipment 1	$0		$0
IV. Capital Costs and Equipment / Facilities: Infrastructure (repair, replacement, upgrades) 2	$7,250		$7,848
IV. Capital Costs and Equipment / (leasehold/equipment)	$82,200		$88,976
IV. Capital Costs and Equipment / Emergency Reserve	$93,327		$101,020
V. Subcontracts (over $5,000)			$0

Expense Area	Total Current Estimated Operations Costs for Prosser and Marion Drain (2019 dollars)	Total estimated increases in operations costs for Prosser improvements and Upper Yakima Summer Chinook (2019 Dollars)	Total Estimated Operations costs for Prosser and Marion Drain (2023 dollars)
V. USFWS/LCRFHC: Yakama Nation (YKFP) Fish Health Services	$59,435		$64,335
V. Revise & Update: Master Plan for Summer and Fall Run Chinook (Step-1 Review)	$85,000		$92,007
V. Perimeter Security Fencing - Access Gate (Prosser)	$25,000		$27,061
Subtotal	*$1,970,500*		*$2,132,932*
Electricity (direct pay): BPA (FY2018)			
Marion Drain (Yakama Power)	*$23,500*		*$25,437*
Prosser (Benton PUD)	*$61,250*		*$66,299*
Total	*$2,055,250*		*$2,224,668*

Notes & Assumptions:
2019 costs are actual (BPA Project No. 1991-013-25 EXP YKFP (Lower Yakima Supplementation Complex O&M)
Current annual operating costs are on-going, costs estimated increases in 2023 with site modifications and revisions are reflected for reference
Costs are escalated from 2019 to 2023 at 2.0% annually
Costs in out years should be considered preliminary (+/- 25% to 35%)
Costs shown consider both Coho and Chinook Programs
Estimated costs for existing operations program do not include M&E Costs
Tagging costs are included in M&E (Project No. 199506325)

Table 9-9. Annual operating expenses, Prosser Hatchery (Steelhead Kelt Program).

Expense Area	Total estimated operations costs for Prosser (2019 Dollars)	Total estimated increased operations costs for Prosser and Marion Drain (2023 Dollars)
Payroll (Taxes, Benefits, Mark-ups)	$128,830	$139,450
Services and Supplies	$18,498	$20,023
Repairs and Maintenance	$2,000	$2,165
GSA Vehicle and Mileage	$7,536	$8,157
Subtotal Labor Direct Costs	*$156,864*	*$169,794*
Indirect on Labor and Direct Expenses (18.57%)	$29,130	$31,531
TOTAL	*$185,993*	*$201,325*

Notes & Assumptions:
2019 costs are actual (BPA Project No. 1991-013-25 EXP YKFP)
Current annual operating costs are on-going, costs estimated increases in 2023 with site modifications and revisions are reflected for reference
Costs are escalated from 2019 to 2023 at 2.0% annually
Costs in out years should be considered preliminary (+/- 25% to 35%)
Costs shown consider only costs associated with the Prosser Kelt Program
Estimated costs for existing operations program do not include M&E Costs

9.2.7.2 Projected Operating Costs

These types of costs tend to be more stable historically than construction costs. Operating expenses from FY 2019 to FY 2028 are shown in Table 9-10. It is expected that the new facilities would be constructed in FY 2022 and FY 2023. Cost estimates for ongoing facility operations are escalated at 2.0 percent annually from FY 2019 through FY 2028.

Table 9-10. Annual operating expenses, 10-year projection, Prosser and Marion Drain Hatcheries and acclimation (all programs).

Operations Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Annual operating expenses, Prosser and Marion Drain Hatcheries (Summer Fall and URB Chinook, Coho)	$2,055,250	$2,096,355	$2,138,282	$2,181,047	$2,224,668	$2,269,162	$2,314,545	$2,360,836	$2,408,052	$2,456,213
Annual operating expenses, Prosser (SH Kelt Program)	$185,993	$189,713	$193,507	$197,378	$201,325	$205,352	$209,459	$213,648	$217,921	$222,279
Future additional Operations and Maintenance for Prosser Hatchery Programs***	TBD									
Future additional Operations and Maintenance for Up River Yakima summer Chinook Program and acclimation ***	TBD									
Future additional Operations and Maintenance - Prosser Steelhead Kelt***	TBD									
Totals	*$2,241,243*	*$2,286,068*	*$2,331,789*	*$2,378,425*	*$2,425,993*	*$2,474,513*	*$2,524,003*	*$2,574,484*	*$2,625,973*	*$2,678,493*

Notes & Assumptions:
Estimated costs are escalated at 2.0% annually in all operational areas

9.2.8 Research, Monitoring and Evaluation Costs

9.2.8.1 Annual Monitoring and Evaluation Chinook and Coho Programs

Current research, monitoring and evaluation activities are funded under the 2018 Fish Accord Extension. The monitoring and evaluation activities supported by these agreements were determined by consensus of the scientists from the Yakama Nation and the WDFW. Project M&E activities have been subjected to rigorous scientific and technical review by the YKFP's STAC and the MIPT. STAC is responsible for the conceptual design of the project's M&E programs, and MIPT must transform the conceptual design into the tasks identified in this agreement.

A conceptual framework for the proposed monitoring and evaluation plan is designed to ensure that the program achieves the performance standards established for natural production and in-hatchery culture practices and operations. Costs associated with research, monitoring and evaluation are described in Project 1955-063-025. The specific monitoring and evaluation costs associated with the Chinook programs are provided in Table 9-11 totaling $463,000 in FY 2019 dollars. M&E costs for the Coho programs are shown in Table 9-12 totaling $579,000 in FY 2019 dollars. Estimated increases are also provided in 2023 dollars when implementation of the improved facilities and changes to the programs would be completed.

Table 9-11. Annual monitoring and evaluation expenses, Prosser and Marion Drain Hatcheries (Summer and URB Chinook Programs).

Expense Area	Total Current Estimated Costs for Chinook Monitoring and Evaluation (2019 dollars)	Total Estimated Increased Costs for additional Production Summer Chinook (2023 dollars)
I. Payroll (Taxes, Benefits, Mark-ups)	$245,908	$266,179
II. Materials, Supplies Services / Sensitive Equipment	$7,250	$7,848
II. Materials Supplies Services / Repairs and Maintenance	$2,250	$2,435
II. Materials Supplies Services / Operating	$5,100	$5,520
II. Materials Supplies Services/ Rent and Lease (GSA Vehicles)	$18,984	$20,549
II. Materials Supplies Services / Utilities (Electric)	$900	$974
II. Materials Supplies Services / Utilities (Cell phone)	$2,770	$2,998
II. Materials Supplies Services /Insurance, vehicles	$1,500	$1,624
II. Materials Supplies Services Travel and Per diem	$1,620	$1,754
Subtotal (Areas I and II)	$286,282	$309,881
III. Indirect on Labor and Direct Expenses (20.99%) (Areas I and II) / $286,182	$60,091	$65,044
Subtotal	$346,373	$374,925

Expense Area	Total Current Estimated Costs for Chinook Monitoring and Evaluation (2019 dollars)	Total Estimated Increased Costs for additional Production Summer Chinook (2023 dollars)
Tags (direct pay): BPA (FY2018)		
Pit Tags (75,500 @$1.55 each)	$117,025	$126,672
Coded Wire Tags Needed		$108,243
TOTAL	$463,398	$609, 839

Notes & Assumptions:
Current annual M&E costs are on-going, costs estimated increases in 2019 with site modifications and revisions are reflected in 2023 on for reference
Costs are escalated from 2019 to 2023 at 2.0% annually
Costs in out years should be considered preliminary (+/- 25% to 35%)
Tagging costs are included in M&E (Project No. 199506325)

Table 9-12. Annual monitoring & evaluation expenses, Coho programs.

Expense Area	Total Current Costs for Coho Monitoring and Evaluation (2019 Dollars)	Total Estimated Increased Costs for Additional Production Coho (2023 Dollars)
I. Payroll (Taxes, Benefits, Mark-ups)	$312,551	$338,315
II. Materials, Supplies Services / Agreements (Landowner)	$3,200	$3,464
II. Materials, Supplies Services / Sensitive Equipment	$7,250	$7,848
II. Materials Supplies Services / Repairs and Maintenance	$2,250	$2,435
II. Materials Supplies Services / Operating	$22,500	$24,355
II. Materials Supplies Services/ Rent and Lease (GSA Vehicles)	$26,630	$28,825
II. Materials Supplies Services / Utilities (Electric)	$900	$974
II. Materials Supplies Services / Utilities (Cell phone)	$2,950	$3,193
II. Materials Supplies Services /Insurance, vehicles	$1,750	$1,894
II. Materials Supplies Services/ Vehicle Gas and Oil		$0
II. Materials Supplies Services Travel and Per diem	$1,620	$1,754
Subtotal (Areas I and II)	*$381,601*	$413,057
III. Indirect on Labor and Direct Expenses (20.99%) (Areas I and II) / $381,601	$80,098	$86,701
Subtotal	*$461,699*	*$499,758*

Expense Area	Total Current Costs for Coho Monitoring and Evaluation (2019 Dollars)	Total Estimated Increased Costs for Additional Production Coho (2023 Dollars)
Tags (direct pay): BPA (FY2018)		
Pit Tags (75,500 @$1.55 each)	*$117,025*	$126,672
Coded Wire Tags Needed (direct pay)		$108,243
TOTAL	*$578,724*	*$734,673*

Notes & Assumptions:
Current annual M&E costs are on-going, costs estimated increases in 2019 with site modifications and revisions are reflected in 2023 on for reference
Costs are escalated from 2019 to 2023 at 2.0% annually
Costs in out years should be considered preliminary (+/- 25% to 35%)
Tagging costs are included in M&E (Project No. 199506325)

9.2.8.3 Projected Research Monitoring and Evaluation Costs

Estimated costs to operate the monitoring and evaluation programs for the Chinook and Coho programs for 10 years, from FY 2019 through FY 2028, are presented in Table 9-13. These types of costs tend to be more stable historically than construction costs. It is projected that program changes will occur when new facilities are constructed in FY 2022, which may increase these expenses. Cost estimates for current monitoring and evaluation are escalated at 2.0 percent annually from FY 2019 through FY 2028. Note that in 2023, increased coded-wire tag expenses add about $108,000 to both the Chinook and Coho budgets.

Table 9-13. Monitoring and evaluation Expenses, 10 Year Projection (all programs).

Expense Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Annual ME expenses, Prosser and Marion Drain Hatcheries (Summer and URB Chinook Programs)	$463,398	$472,666	$482,119	$491,761	$609,839	$622,036	$634,477	$647,167	$660,110	$673,312
Annual ME expenses, Prosser and Holmes (Coho Programs)	$578,724	$590,299	$602,105	$614,147	$734,673	$749,366	$764,353	$779,640	$795,233	$811,138
Totals	*$1,042,122*	*$1,062,964*	*$1,084,223*	*$1,105,908*	*$1,344,512*	*$1,371,402*	*$1,398,830*	*$1,426,807*	*$1,455,343*	*$1,484,450*

9.2.9 Ten–Year Future Cost Summary

Estimated costs to operate the Yakima Chinook and Coho salmon programs and the steelhead kelt program for 10 years, from FY 2019 through FY 2028, are presented in Table 9-14. Planning costs for implementation are shown from FY 2019 – FY 2021. Estimated costs are summarized for construction, program equipment, potential environmental compliance, operations and maintenance and monitoring and evaluation. Costs for each program area are escalated to the year in which they are expected to occur. This summary reflects planning and implementation of new hatchery facilities occurring from FY 2019 through 2023.

As previously noted, consistent with planning principles, cost estimates at this stage are concept to preliminary depending on the area. This 10-year estimated cost summary is designed to be a planning tool and will be updated if costs change and/or are refined.

Table 9-14. Ten-year summary of future costs, FY 2019 - FY 2028, Prosser and Marion Drain Hatcheries and Acclimation.

Program Area	Fiscal Year									
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
A. Land Purchases, Leases and Easements (to be determined)										
A.1. Land Purchase, Leases and Easements										
B. Planning and Design										
B.1. Step 1: Conceptual Engineering, Planning										
B.2. Preliminary and Final (Step 2 and 3) Prosser Hatchery Coho and Chinook		$1,237,500	$1,237,500							
B.3. Preliminary and Final (Step 2 and 3) Prosser Hatchery Kelt Program		$200,000	$200,000							
B.4 Preliminary and Final (Step 2 and 3) Upper Yakima Hatchery /Acclimation Site Summer Chinook		$305,500	$305,500							
C. Construction										
C.1. Prosser Hatchery (Late Run Summer/ Fall and URB Ch, Coho and SH Kelt)**				$13,781,379	$20,672,069					
C.2. Estimated construction costs, Upper Yakima (Summer Chinook)**				$1,784,604	$2,676,906					
C.3. Estimated construction costs, each Acclimation Site (Summer Chinook)**				$1,028,731	$1,543,097					
D. Capital Equipment										
D.1. Prosser Hatchery (for new Operations, Production)					$57,822	$57,822				
D.2. Summer Chinook New Hatchery and Acclimation					$1,476,890	$369,222				
E. Environmental Compliance										
E.1. Environmental Compliance Step 2 (Permitting, EA, Other)		$111,027	$111,027							
F. Operations and Maintenance										
F.1. Current Annual Operations and Maintenance - Prosser and Marion Drain Hatchery Programs	$2,055,250	$2,096,355	$2,138,282	$2,181,047	$2,224,668	$2,269,162	$2,314,545	$2,360,836	$2,408,052	$2,456,213
F.2. Annual Operations and Maintenance - Prosser Steelhead Kelt	$185,993	$189,713	$193,507	$197,378	$201,325	$205,352	$209,459	$213,648	$217,921	$222,279
F.3. Future additional Operations and Maintenance for Prosser Hatchery Programs***	TBD									
F.4. Future additional Operations and Maintenance Upper Yakima Summer Chinook Program and New acclimation***	TBD									

F.5. Future additional Operations and Maintenance - Prosser Steelhead Kelt***	TBD									
G. Monitoring and Evaluation										
G.1. Annual Monitoring & Evaluation Expenses, S/F and URB Chinook Programs	$463,398	$472,666	$482,119	$491,761	$609,839	$622,036	$634,477	$647,167	$660,110	$673,312
G.2. Annual Monitoring & Evaluation Expenses, Coho Programs	$578,724	$590,299	$602,105	$614,147	$734,673	$749,366	$764,354	$779,641	$795,233	$811,138
Total Estimated Capital Costs	$0	$1,854,027	$1,854,027	$16,594,714	$26,426,783	$427,044	$0	$0	$0	$0
Total Estimated O&M Costs	$3,283,365	$3,349,032	$3,416,012	$3,484,333	$3,770,505	$3,845,915	$3,922,834	$4,001,290	$4,081,316	$4,162,943
Total Estimated Costs	*$3,283,365*	*$5,203,059*	*$5,270,039*	*$20,079,047*	*$30,197,288*	*$4,272,960*	*$3,922,834*	*$4,001,290*	*$4,081,316*	*$4,162,943*

Notes and Assumptions:

A.1. Land Purchase, Leases and Easements (assumes no costs are allocated to this project)
B.1. Step 1: Conceptual Engineering, Planning, assume these expenses are for the Addendum to the Master Plan (this document)
B.2. Preliminary and Final (Step 2 and 3) Prosser Hatchery Coho and Chinook (assumes these expenses occur in 2020 and 2021)
B.3. Preliminary and Final (Step 2 and 3) Prosser Hatchery Kelt Program (assumes these expenses occur in 2020 and 2021)
B.4 Preliminary and Final (Step 2 and 3) Upper Yakima /Acclimation Site Summer Chinook (assumes these expenses occur in 2020 and 2021)
C.1. Construction, Prosser Hatchery (Late Run Summer/ Fall and URB Ch, Coho and SH Kelt)** (Assumes 40% expended in 2022 and 60% 2023)
C.2. Construction, Upper Yakima Hatchery (Summer-Chinook)** (Assumes 40% expended in 2022 and 60% 2023)
C.3. Construction Acclimation Site (Summer Chinook)** (Assumes 50% expended in 2022 and 60% 2023)
D.1. Prosser Hatchery (for new Operations, Production) (Assumes 50% expended in 2024 and 50% 2024)
D.2. Summer Chinook Upper Yakima Hatchery and new Acclimation (Assumes 80% spent in 2023 and 20% spent in 2024)
E.1. Environmental Compliance Step 2 (Permitting, EA, Other) (assume expenditures occur in 2020 and 2022)
F.1. Current Annual Operations and Maintenance - Prosser and Marion Drain Hatchery Programs (escalated at 2% annually from existing budget in project 1997-013-25)
F.2. Annual Operations and Maintenance - Prosser Steelhead Kelt (escalated at 2% annually from existing budget)
F.3. Future additional Operations and Maintenance for Prosser Hatchery Programs***
F.4. Future additional Operations and Maintenance for Upper Yakima summer Chinook Program and New acclimation***
F.5. Future additional Operations and Maintenance - Prosser Steelhead Kelt***
G.1. Annual Monitoring & Evaluation Expenses, S/F and URB Chinook Programs (escalated at 2% annually from existing budget)
G.2. Annual Monitoring & Evaluation Expenses, Coho Programs (escalated at 2% annually from existing budget)

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