MID-COLUMBIA COHO RESTORATION MASTER PLAN

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PREPARED FOR:

NORTHWEST POWER AND CONSERVATION COUNCIL

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Acronyms

AHA	All H's Analyzer (an analytical model)
BPA	Bonneville Power Administration
CCPUD	Chelan County Public Utility District
DCPUD	Douglas County Public Utility District
EDT	Ecosystem Diagnosis and Treatment (an analytical model)
ESA	Endangered Species Act
GCPUD	Grant County Public Utility District
HSRG	Hatchery Scientific Review Group
ISRP	Independent Scientific Review Panel
M&E	Monitoring and Evaluation
MCCRP	Mid-Columbia Coho Restoration Program
NEPA	National Environmental Policy Act
NMFS/NOAA Fisheries	National Marine Fisheries Service/National Oceanic & Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System

NPPC/NPCC	Northwest Power Planning Council/Northwest Power and Conservation Council
NTTOC	Non-Target Taxa of Concern (sensitive species)
ODFW	Oregon Department of Fish and Wildlife
PUD	Public Utility District
TWG	Technical Work Group (Mid-Columbia TWG for this project)
UCSRB	Upper Columbia Salmon Recovery Board
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Nation

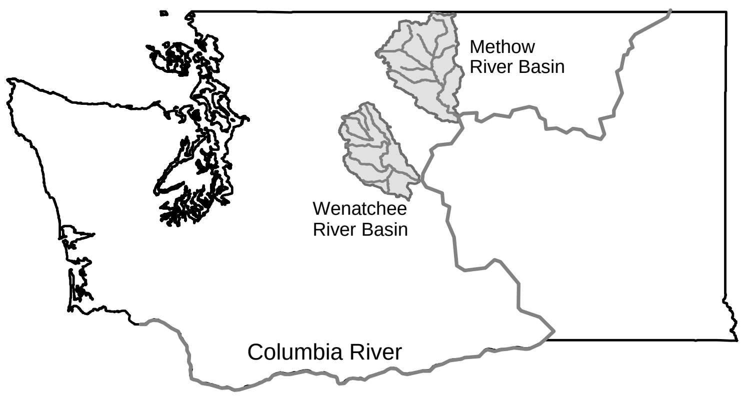
Executive Summary

By the end of the 20th century, indigenous natural coho salmon no longer occupied the mid- and upper-Columbia river basins. Columbia River coho salmon populations were decimated in the early 1900s. For several reasons, including the construction and operation of mainstem Columbia River hydropower projects, habitat degradation, release locations, harvest management, hatchery practices, and genetic guidelines, self-sustaining coho populations were not re-established in mid-Columbia basins. Conditions and practices have changed, and some of the local habitat causes of coho depletion have been corrected, although work is still needed.

The Yakama Nation's long-term vision for coho reintroduction is:

> ***To re-establish naturally spawning coho populations in mid-Columbia tributaries to biologically sustainable levels which provide significant harvest in most years.***

The figure shows the location of the Mid-Columbia Coho Restoration Program within the State of Washington.



Mid-Columbia Coho Restoration Site Map

Restoration approaches are described in terms of a biological objective and numeric goals (metrics).

Biological Objective: Develop a locally adapted, naturally spawning coho stock in the Wenatchee and Methow river basins capable of supporting harvest.

> *Metric 1. The 3-year mean escapement of natural-origin returns in the Wenatchee (upstream of Tumwater Dam) and the Methow river basins exceeds 1,500 per basin.*

> *Metric 2. Achieve a total harvest rate of 23%, which includes a 10% mixed stock harvest, 10% mainstem harvest, and 5% terminal harvest in most years.* [1]

Studies of the feasibility of reintroducing coho in the Wenatchee and Methow basins began in 1996 and demonstrated that the vision of an optimistic future held by Yakama Nation (YN) and

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[1] These three types of harvest do not add up to 25% because the harvests occur sequentially. Harvest on 10% of the mixed stocks would leave the remaining 90% of the run subject to a 10% mainstem harvest; after the mainstem harvest, the remaining 80% of the run would be subject to a 5% terminal harvest..

Washington Department of Fish and Wildlife (WDFW) was possible. The Yakama Nation, along with project participants and the Mid-Columbia Technical Work Group (TWG), developed two goals from which to determine the feasibility of reintroducing coho to mid-Columbia tributaries:

> *1) Determine whether a broodstock can be developed from lower Columbia River coho stocks whose progeny can survive in increasing numbers to return as adults to the mid-Columbia region and*
>
> *2) Initiate natural reproduction in areas of low risk to sensitive species and in other select areas to study the risks and interactions with sensitive species.*

Both feasibility studies goals were achieved. To test whether Feasibility Goal 1 could be met, researchers used as performance indicators coho survival at various stages, the spatial distribution of returning adults, and to a limited degree, reproductive success. A broodstock was successfully developed and transfers of lower Columbia River coho were discontinued. To address Feasibility Goal 2, critical uncertainties regarding species interactions, as planned in the initial project HGMP (2002 [Appendix D of the 2010 Master Plan]) were investigated. The issues identified in the HGMP were as follows: 1) Rate of predation by hatchery coho on spring Chinook fry, 2) rate of predation by hatchery coho on sockeye fry, 3) amount of superimposition of spring Chinook redds by spawning coho, 4) rates of residualism, and 5) amount of competition for space and food during freshwater rearing of naturally produced coho juveniles as measured through micro-habitat use and growth evaluations. The evaluations answered most of the critical uncertainties (see Chapter 3); the ones that remain are addressed in the M&E program (Chapter 7).

The Master Plan builds on the success of the feasibility phase and is designed to achieve coho restoration goals as identified in the Tribal Restoration Plan (*Wy-Kan-Ush-Mi Wa-Kish-Wit*) and in the Wenatchee and Methow subbasin plans.

The conceptual plan for coho in the Wenatchee and Methow basins, as described in detail in Chapter 5, includes five distinct phases. The program is designed to be discontinued after a minimum of five generations of natural production supplementation, unless it can be demonstrated that continued supplementation is needed to prevent extirpation from once again occurring.

- **Broodstock Development Phase 1 (BDP1)** was designed to develop a mid-Columbia broodstock from lower Columbia River coho, so that they would become increasingly adapted to the longer migration to mid-Columbia tributaries. BDP1 focused on eliminating reliance on lower Columbia stocks and transitioning to a local broodstock. This phase has been completed in both basins.
- **Broodstock Development Phase 2 (BDP2)** is designed to encourage local adaptation of the broodstock by moving adult capture sites further upstream where stamina and run-timing constraints of the current broodstock, created during the BDP1 process, may be reaching their limits (Murdoch et al. 2004). BDP2 goals have been met in the Methow basin; contingency actions have been implemented in the Wenatchee basin in an attempt to meet broodstock collection goals for this phase (see Section 5.2.1).
- **Natural Production Phases** focus on decreasing domestication selection and increasing fitness in the natural environment. Hatchery coho will be introduced to habitat areas

predicted by EDT to be the most successful for coho. Also, hatchery and natural broodstock compositions will be managed to increase the proportionate natural influence (PNI)[2] in the population, with the goal of having a PNI value greater than 0.50; that is, the natural environment must have a greater influence on the population than the hatchery environment. The natural production phases are described below.

- **Natural Production Implementation Phase (NPIP)** proposes initial smolt releases into most habitat areas for one generation (3 years). These initial releases would represent the largest number of smolts released during the reintroduction process. The NPIP seeks to begin the local adaptation[3] process by releasing enough hatchery fish in the natural environment to result in a spawning aggregate in each tributary of sufficient size that natural selection can act upon the population and enough first-generation natural-origin adults will begin to return so that they can be incorporated into the broodstock as the Natural Production phases continue. This phase can begin in the Methow basin as soon as environmental reviews and permitting are completed for acclimation sites in the basin.
- **Natural Production Support Phases 1 and 2** would emphasize further local adaptation and naturalization. Initially, release numbers would be reduced 30% from the numbers released during NPIP. The goal would be to increase the proportion of natural-origin fish in the broodstock (pNOB) to 35% and to limit the proportion of hatchery-origin fish on the spawning grounds (pHOS) to 75%. As we reach this initial goal, we will continue to reduce the hatchery program size, increase the pNOB and decrease the pHOS to the point that we are able to reach a PNI value greater than 0.50 (pNOB = 80%, pHOS < 65%). A PNI > 0.50 is predicted to result in increased natural fitness and survival rates for the population (L. Mobrand pers. comm.). The total expected duration of the Support Phases is a minimum of four generations (12 years).

Chapter 6 discusses the variety of facilities and operating procedures that would be employed to reduce risks, minimize impacts to natural populations, speed reintroduction, and test alternative strategies. These include:

- Trapping adults at hatchery and acclimation return sites, existing dams, and existing tributary weirs.
- Rearing fish in existing hatcheries and one small new in-basin hatchery.
- Acclimating and releasing smolts primarily from multiple small existing and constructed natural ponds while also including alternative facilities and methods, including adult plants.
- Acclimating fish over the winter at sites where cold weather operation is possible and for shorter periods where it is not.

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[2] If pNOB is the percent natural-origin fish in the hatchery broodstock and pHOS is the percent hatchery-origin fish among natural spawners, then PNI= pNOB/(pNOB+pHOS).
[3] We use the term "local adaptation" to refer to the process of naturalization: addressing the loss of fitness that occurs with hatchery stocks by emphasizing selection in the natural environment so that the population becomes adapted to habitats within each subbasin and ultimately achieves PNI > 0.5. "Local adaptation" is distinguished from "broodstock development" which selects for coho that can return to the Wenatchee and Methow rivers but does not address loss of fitness and adaptation to the natural environment.

Fish produced for the broodstock development phases are captured at existing adult traps, produced from existing hatcheries, and released from acclimation sites that do not require new rearing unit construction. However, modifications to a few facilities were necessary in order to meet project goals.

In the natural production phases, the plan proposes to continue rearing most program fish at existing hatcheries, although one small new in-basin hatchery is proposed. During these phases, plans call for acclimation in a combination of existing and new sites. The release tributaries were identified using the EDT model; actual sites were identified using a variety of engineering and ownership siting criteria (see Section 6.3). Most acclimation sites have existing pools or small, constructed ponds.

The M&E program (Chapter 7) is designed to monitor and evaluate the results of reintroduction so that operations can be adaptively managed to optimize hatchery and natural production while minimizing any negative ecological impacts. Data collection and analysis are structured to: 1) demonstrate when the reintroduction program is meeting the established phased restoration goals; 2) determine whether the status of sensitive species is changing and whether it is a result of coho reintroduction; and 3) provide science-based recommendations for management consideration. The M&E plan is closely coordinated with other monitoring efforts in the Wenatchee and Methow basins, which results in cost sharing and prevents duplication of efforts.

Planning and construction schedules and costs as estimated in 2010 are described in Chapter 8. Yakama Nation Fisheries Resource Management has primary responsibility for implementing the reintroduction plan. Some activities, including fish rearing and transportation, are contracted to U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW), and WDFW. Bonneville Power Administration (BPA) is the lead agency for National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) analyses.

Funding for the program comes from multiple funding sources, including BPA, Grant County PUD, and Chelan County PUD. The current program also shares rearing costs with National Oceanic and Atmospheric Administration (NOAA) through the Mitchell Act, with the USFWS through the Grand Coulee Fish Maintenance Project, and shares monitoring and evaluation costs with WDFW. This cost sharing is expected to continue.

2017 Update: *The Mid-Columbia Coho Restoration Program Final Environmental Impact Statement (USDOE/BPA 2012) and Record of Decision (BPA 2012) were published in 2012. Some acclimation sites and the proposed new hatchery site identified in the 2010 Master Plan were eliminated for various reasons either during the review of the EIS or after the EIS was published. Chapter 6 in this version of the Master Plan identifies sites currently in use and now proposed. While a few new sites must still complete NEPA reviews, the currently proposed sites have been reviewed and approved by NMFS and USFWS as part of Section 7 consultations under the Endangered Species Act.*

The need to find, evaluate, and permit new facilities after publication of the Record of Decision has delayed the schedule as shown in Chapter 8 of the Master Plan, which has not been updated from the 2010 version. Cost estimates are expected to be updated when Yakama Nation begins Step 3 of the Northwest Power and Conservation Council's process.

CHAPTER 1.
BACKGROUND

Photo courtesy of Shafer Museum, Winthrop, WA.
From Mullan. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams.

Chapter 1. Background

1.1 Purpose of this Plan

This Master Plan presents a proposal for the future of coho reintroduction efforts in two mid-Columbia subbasins[4], the Wenatchee and the Methow. The contents of the plan follow guidelines for master plans as defined by the Northwest Power and Conservation Council (NPCC) (NPCC 2004).

1.1.1 Problem this Program Addresses

The proposed plan seeks to restore coho salmon to the Wenatchee and Methow river basins at biologically sustainable levels that will support harvest in most years. Challenges to coho reintroduction include:

1) the absence of locally adapted populations,

2) in-basin habitat degradation,

3) survival through the migration corridor

4) variability of ocean environmental conditions, and

5) ocean and freshwater harvest.

The proposed reintroduction program directly addresses the first of the five challenges.

To overcome the absence of a locally adapted population, we built on the feasibility studies that were conducted beginning in 1996 and present a phased approach to reintroducing coho into the Wenatchee and Methow basins. In this plan, the initial broodstock development phases, begun during feasibility studies, seek to establish a local coho stock, originating from lower Columbia River hatchery stocks, which can return to mid-Columbia tributaries with increasing survival rates. In 2009, 100% of the coho smolts released in both basins were progeny of second and third generation mid-Columbia broodstock. After broodstock development goals are met (see Section 4.3 and Chapter 5), the natural production phases develop the program to a point where eventually the percent of natural-origin fish in the hatchery broodstock will exceed the percent of hatchery-origin fish on the spawning grounds (Mobrand et al. 2004). The coho restoration program is designed to be terminated when a self-sustaining naturally reproducing population is established (natural-origin return escapement of more than 1,500 coho to each basin, with a terminal and mainstem harvest in most years). This goal is expected to be achieved within a minimum of five generations of supplementation.

Through all the phases, project staff will work with other entities in the basins to implement habitat improvement and protection projects as identified in several major programs, including Habitat Conservation Plans of three public utility districts, projects funded by the Upper

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[4] Years after this project began (and was named), many entities in the region began using the term “upper Columbia” to refer to the region in which the Wenatchee and Methow subbasins lie. We have chosen to continue using “mid-Columbia” to refer to this project in order to demonstrate the continuity of the project from the feasibility studies onward. As well, because the Columbia River originates hundreds of miles upstream in Canada, the term “mid-Columbia” seems to be more geographically accurate**.**

Columbia Salmon Recovery Board (UCSRB), and Yakama Nation's habitat improvement projects funded under the 2008 Memorandum of Agreement between Bonneville Power Administration, Bureau of Reclamation, and Army Corps of Engineers. These habitat projects will benefit coho as well as ESA-listed species (spring Chinook, steelhead, and bull trout) and are expected to be a significant effort towards remedying the second challenge to coho reintroduction.

In addition to these efforts, YN works with many other entities in the Columbia basin and beyond to address the challenges of migration corridor survival and variable ocean conditions, which are challenges to many, many species besides salmonids.

1.1.2 Mid-Columbia Coho History

Mid-Columbia coho salmon populations were decimated in the early 1900s by impassable dams, harmful forestry practices, and unscreened irrigation diversions in the tributaries, along with an extremely high harvest rate in the lower Columbia River. The loss of natural stream flow degraded habitat quality and further reduced coho productivity. Over the years, irrigation, livestock grazing, mining, timber harvest, road and railroad construction, development, and fire management also contributed to destruction of salmon habitat.

Mullan (1983) estimated historical mid-Columbia River adult coho populations as follows:

- Wenatchee—6,000 - 7,000
- Entiat—9,000 - 13,000
- Methow—23,000 - 31,000
- Okanogan—Presence documented but no numbers specified

By the end of the 20th century, indigenous natural coho salmon no longer occupied the mid-Columbia river basins. Since Priest Rapids Dam was completed in 1960, the peak escapement of adult coho upstream of the dam was probably never greater than 10,000 coho and, as of 1998, had not exceeded 1,300 since 1974 (WDFW/ODFW 1998). From 1988 to 1994, adult counts at Priest Rapids Dam averaged only 16 coho, probably a result of releases from Turtle Rock Hatchery, which annually produced about 600,000 coho smolts until the program was terminated in 1994 (WDFW/ODFW 1995).

For several reasons, natural coho populations were not established in mid-Columbia basins despite plantings of 46 million fry, fingerlings, and smolts from Leavenworth, Entiat, and Winthrop National Fish Hatcheries between 1942 and 1975:

- The construction and operation of mainstem Columbia River hydropower projects were detrimental to mid-Columbia River salmonid populations. Coho had to pass through a number of dams and reservoirs, leading to deaths from turbines, predation, migration delays, gas bubble trauma, and so forth.
- A substantial amount of critical physical fish habitat was lost or severely degraded (Tyus 1990; Petts 1980; Diamond and Pribble 1978).
- Existing coho programs were unsuccessful or lower priority than programs for other salmonid species. For example, the most recent coho hatchery program in the mid-Columbia region was at Turtle Rock Hatchery, funded by Chelan Public Utility District (CCPUD). The coho program was terminated due to poor adult returns, thought to be caused in part by pathogenic water supplies resulting in disease problems at the hatchery. Because fall

Chinook and steelhead were higher priority species, they were given priority use of the limited supply of high quality hatchery water. These species currently constitute the program at Turtle Rock. The last coho releases were in 1994.

- Fish culture practices in general resulted in poor adult return rates. Rearing at high densities in concrete raceways, an incomplete understanding of fish health and nutritional needs, the use of water supplies with unnatural temperature profiles, and non-acclimated, forced releases directly from hatcheries into the wild environment produced smolts with low survival rates.
- Release locations did not support returns to high quality coho habitat. Releases from hatcheries did not imprint smolts with migratory clues that would encourage them to populate habitats that were far upstream of the release sites.
- Hatchery spawning protocols did not support the development of coho stocks that would be successful in the natural environment and migrate long distances to the upper Columbia basin.
- Harvest was not managed for the protection of weak stocks. Open ocean troll and gill net fisheries, the lack of near real-time catch monitoring, and the limited ability to predict run sizes resulted in over-harvest of wild fish and weak hatchery stocks.

Since that time, conditions and practices have changed to a certain degree. Some of the local habitat causes of coho depletion have been corrected, although there is still work to be done. For example, many irrigation diversions have been screened, tributary dams have been removed, harvest and harvest management techniques are more capable of protecting upriver stocks, logging practice regulations provide increased environmental protection, mining has ended, and grazing practices have been improved. A few specific examples of projects designed to improve habitat conditions for fish in the target basins include:

Wenatchee Basin:

- improvements in fish passage at Tumwater and Dryden dams
- irrigation diversion fish screens at Dryden Dam
- reconnection of disconnected oxbows and floodplain on Nason Creek
- connection of off-channel rearing habitat on the lower Wenatchee River
- replacement of multiple culverts blocking fish passage on Chumstick Creek, Beaver Creek, and small tributaries to the Chiwawa River.

Methow Basin:

- improvements to the Methow Valley Irrigation District system
- restoration of salmonid habitat in Early Winters and Goat creeks

Similar improvements have been made on the mainstem Columbia.

Another significant change in regional conditions is that the ESA listings of several salmonid species that migrate through the lower Columbia River have curtailed coho fisheries that once over-harvested the mid-Columbia stocks of coho. These fisheries restrictions are likely to be in effect for a number of years. ESA listings also have resulted in actions to improve survival of all species through the hydro system.

Recent improvements in artificial production methodology will also improve efforts aimed at supporting natural production. Supplementation techniques, featuring refined genetic objectives, the production of "natural-like" hatchery smolts, and acclimation and release in wild habitat, are being used.

Legally binding Habitat Conservation Plans (HCPs) have been negotiated between fisheries resource managers and Mid-Columbia Public Utility Districts (PUDs). The HCPs have strict performance standards (survival criteria) for both project passage and hatchery compensation so that the hydroelectric projects associated with each HCP can be considered to have No Net Impact (NNI) on anadromous species.

1.1.3 Local Adaptation

The lack of a locally adapted population may be one of the biggest challenges to coho reintroduction in mid-Columbia tributaries. The Wenatchee Subbasin Plan "Guiding Principle 11" states that reintroduction or supplementation programs should select an appropriate stock or locally adapt a donor stock where a local stock no longer exists (NPCC 2004a). The proposed project is designed to locally adapt a donor stock. While there is an increasing body of literature surrounding the genetic risks of supplementation programs (Busak and Currens 1995; Miller and Kapuscinski 2003; Ford et al. unpublished manuscript), we continue to find very little research documenting naturalization or local adaptation of a domesticated hatchery stock, and the jury is still out on how this project's transition to a broodstock with more influence from naturally produced fish affects survival and productivity.

The lower Columbia River coho stocks originally used during the feasibility phase (BPA project #1996-040-00) are considered a non-local, domesticated hatchery stock. A domesticated hatchery stock is defined as a hatchery stock that has been perpetuated for numerous generations through artificial spawning of returning adult hatchery fish, juvenile rearing, and release (Berejikian and Ford 2004). A domesticated stock has evolved to become more fit in an artificial environment at the expense of survival or reproductive success in the natural environment (Ford et al. unpublished manuscript).

Domestication is expressed as changes in qualitative traits. Three types of domestication selection have been recognized:

1) intentional or artificial domestication selection,

2) biased sampling during some stage of culture, and

3) unintentional selection (Busak and Currens 1995).

Intentional selection can be reduced by discontinuing selective practices (e.g., using only the early spawners). Control of domestication due to biased sampling depends upon the ability to incorporate random sampling into hatchery procedures.

Reduction of unintentional selection can be more difficult. Busak and Currens (1995) identify two means of reducing unintentional domestication selection.

a) Selection potentials can be decreased by minimizing the time fish are exposed to the hatchery environment; for example, only wild fish can be used as broodstock so that hatchery fish are regularly cycled through the natural environment (Busak and Currens 1995);

b) hatchery environments can be made more similar to wild environments (Maynard et al. 1995).

The proposed reintroduction program uses methods to reduce all three types of domestication selection, including those identified by Busak and Currens (1995).

Researchers have demonstrated reduced reproductive success of hatchery fish in natural environments (Miller and Kapuscinski 2003). For steelhead, success of naturally spawning hatchery returns in producing smolt offspring was reported to be 28% of that for wild spawners (Chilcote et al. 1986). Reisenbichler and McIntyre (1977) compared early survival of two-generation-old hatchery stock of steelhead with the wild stock from the same stream. Hatchery fish exhibited a statistically significant survival advantage over wild fish in the hatchery environment, but the situation was reversed in the natural environment. Swain and Riddell (1990) noted that hatchery juvenile coho salmon exhibited more agonistic behavior than wild juveniles. Berejikian and Ford (2004) reviewed 18 studies that directly estimated the relative fitness of hatchery and natural anadromous salmonids; based on this review, the authors concluded that domesticated steelhead, coho, and Atlantic salmon stocks will have low (<30%) lifetime relative fitness in the wild compared to native natural populations.

Without a natural population of coho in mid-Columbia tributaries, the opportunities to incorporate "wild, locally adapted" fish into the broodstock do not exist. To overcome this, we present a phased approach, where the initial broodstock development phases seek to develop a hatchery stock which can return to mid-Columbia tributaries with increasing survival rates. Next, the natural production phases move toward an integrated hatchery program where ultimately the percent of natural-origin fish in the hatchery broodstock (pNOB) will exceed the percent of hatchery-origin fish on the spawning grounds (pHOS) (Mobrand et al. 2004).

The All H's Analyzer (AHA) was used to address the loss of fitness that occurs with many hatchery programs. The overarching principles of the proposed management strategy emphasize adherence to genetic, evolutionary and ecological principles, which will result in greater selection pressures from the natural environment than from the hatchery environment (Proportion of natural influence > 0.50) (Mobrand Biometrics).

We are aware of the need for caution when using the AHA or any other single model to generate specific objectives, numerical or otherwise, as described by the ISRP and ISAB (2005). However, project proponents have found minimal literature or empirical data to guide the transition from a non-local domesticated hatchery stock to a population locally adapted to the natural environment. The AHA model provides a framework from which the loss of fitness, or domestication, can be addressed in the form of a working hypothesis. We believe the proposed mid-Columbia coho reintroduction plan presents a unique opportunity to test some of the assumptions of the AHA model, as they pertain to domestication and local adaptation, in the absence of genetic risk[5] to a native coho population.

[5] Genetic risk is the probability of an event or activity having an adverse genetic consequence. Adverse consequences include 1) extinction, 2) loss of within population genetic diversity, 3) loss of among-population genetic diversity, and 4) domestication (Busak and Currens 1995).

1.2 Program Vision, Objective, and Guiding Principles

1.2.1 Vision

The following is the long-term vision for the Mid-Columbia Coho Restoration program.

> ***To re-establish naturally spawning coho populations in mid-Columbia tributaries to biologically sustainable levels which provide significant harvest in most years.***

1.2.2 Biological Objective

Biological Objective: Develop a locally adapted, naturally spawning coho stock in the Wenatchee and Methow river basins capable of supporting harvest.

We propose to increase the fitness of reintroduced coho salmon by reducing domestication selection and emphasizing local adaptation. The program will use strict broodstock collection protocols which will incorporate natural-origin fish in the broodstock and limit the proportion of hatchery-origin adults on the spawning ground. The broodstock collection protocols are intended to manage the broodstock composition to increase the proportion of natural influence (PNI)[6] in the population with the goal of having a PNI value greater han 0.50; that is, the natural environment must have a greater influence on the population than the hatchery environment. The objective will be considered successful when the following numeric goals have been achieved:

> *Metric 1. The 3-year mean escapement of natural-origin returns in the Wenatchee (upstream of Tumwater Dam) and the Methow river basins exceeds 1,500 per basin.*
>
> This metric indicates the abundance and effective population size required to satisfy the restoration goal without further hatchery supplementation. The figure of 1,500 per basin is supported by results of the AHA calculations which predict a level of sustainability based upon Ecosystem Diagnosis and Treatment (EDT) inputs, estimated capacity, harvest rates, and hydro-system and marine survival.
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> *Metric 2. Achieve a total harvest rate of 23%, which includes a 10% mixed stock harvest, 10% mainstem harvest, and 5% terminal harvest in most years.*[7]

1.2.3 Approaches to Achieving the Restoration Objective

The proposed plan seeks to achieve the restoration objective through the following actions, which are summarized in Chapter 4 and detailed in Chapters 5 – 7:

- After initially releasing "domesticated" hatchery fish for reintroduction, the program seeks to increase the fitness of reintroduced coho salmon by reducing domestication selection and emphasizing local adaptation. The program would use strict broodstock protocols that maximize natural-origin adults in the hatchery program and would place a limit on the proportion of hatchery-origin returns on the spawning grounds. The AHA model was used as a guide to address the fitness loss that commonly occurs with hatchery

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[6] If pNOB is the percent natural-origin fish in the hatchery broodstock and pHOS is the percent hatchery-origin fish among natural spawners, then PNI= pNOB/(pNOB+pHOS).

[7] These three types of harvest do not add up to 25% because the harvests occur sequentially. Harvest on 10% of the mixed stocks would leave the remaining 90% of the run subject to a 10% mainstem harvest; after the mainstem harvest, the remaining 80% of the run would be subject to a 5% terminal harvest.

programs and that presumably occurred in the lower Columbia River hatchery source stock (see Section 5.4).

- In cooperation with other fisheries managers, develop a harvest management plan for the terminal harvest to ensure that exploitation rates are based on survival and abundance forecasts and escapement goals, and that are appropriate to changes in abundance caused, for example, by fluctuations in ocean conditions.

1.2.4 Guiding Principles and Mandates

In achieving the vision and restoration goals, the project is guided by the following principles and mandates:

- **Tribal restoration goals.** The Columbia River tribes recognize that fisheries are a basic and important natural resource, of vital concern to them, and that conservation of this resource depends on effective and progressive management. They further believe that by unity of action they can best accomplish these things, not only for the benefit of their own people but for all the people of the Pacific Northwest. The Columbia River treaty tribes believe *Wy-Kan-Ush-Mi Wa-Kish-Wit*, the tribal restoration plan, provides an adaptive management framework to restore the Columbia River salmon, simply stated: **put the fish back into the rivers**.

- **A holistic approach to salmon recovery.** This guideline incorporates the scientific principles of the Council's 2000 Fish and Wildlife Program (NPPC 2000). The program includes restoring extirpated species and collaboration with others to improve habitat. A restored ecosystem will benefit all species. Specifically, restoring coho salmon may provide much-needed nutrients for aquatic and terrestrial animals at the onset of winter when food sources may be scarce. Restored habitats should result in increased productivity for all salmonid species.

- **Northwest Power and Conservation Council principles, objectives and strategies for artificial production projects.** NPCC recommends artificial production under the proper conditions including:

  1) complementing habitat improvement by supplementing fish populations up to the sustainable carrying capacity with fish that are as similar as possible in genetics and behavior to wild native fish, and

  2) replacing lost salmon or steelhead populations.

  Further, the NPCC supports an "experimental adaptive management approach that includes an aggressive program to evaluate the risks and benefits and addresses scientific uncertainties." (NPPC 2000)

- **The principles, objectives, and processes defined in the Treaty of 1855 and *U.S. v. Oregon*.** In the Treaty of 1855, bands and tribes of the Yakama Nation reserved "[t]he exclusive right of taking fish in all the streams running through or bordering [their] reservation...and…taking fish at all usual and accustomed places…" The *United States versus Oregon* treaty fishing rights case affirmed that the 1855 treaty reserved for the tribes a fair share of the harvest, which was subsequently determined to be 50% of the harvestable portion of runs destined to pass the tribes' usual and accustomed fishing areas. The *U.S. v. Oregon* decision also established guidelines and procedures by which the tribes could function as self-regulating fishery co-managers together with the state and federal fishery agencies. The Yakama Nation views the *U.S. v. Oregon* process as the expression of its co-management authority and, therefore, the primary forum through which the tribe's management goals and priorities should be advanced.

- **The principles and process requirements of environmental laws, including the Endangered Species Act and National Environmental Policy Act.** Program proponents seek to meet coho restoration goals without harming natural or human resources. A key focus of the program is to minimize potential competitive impacts with sensitive species—Non-Target Taxa of Concern or NTTOC. These species are defined as spring Chinook salmon, steelhead, and bull trout—species listed under the Endangered Species Act (ESA)—and sockeye salmon. The program would meet these principles by emphasizing local adaptation that results in self-sustaining natural coho populations and by monitoring the size, abundance and distribution of sensitive species as they relate to coho reintroduction activities. Before site-specific decisions are made, the program's effects on species and resources of all kinds are analyzed under NEPA and ESA processes.
- **Visions and goals of the Wenatchee and Methow subbasin plans.** Coho are identified as a focal species in both subbasin plans. In the Wenatchee plan, Goal 3 is to "[r]estore, maintain, or enhance fish and wildlife populations to sustainable and harvestable levels, while protecting biological integrity and the genetic diversity of the species." (NPCC 2004a) In the Methow plan, "[t]he goal for coho salmon includes re-establishment of run sizes that provide for species recovery, mitigation of hydro-system losses, and harvestable surpluses." (NPCC 2004b)
- **The need to minimize program costs while ensuring sufficient resources to meet program goals effectively.** The Yakama Nation recognizes that many fish restoration projects throughout the region compete for limited funds. Therefore we present a plan that emphasizes the use of existing facilities to restore coho salmon while partnering with other programs, sharing resources with other agencies, and adapting the program in response to monitoring and evaluation.

1.3 Mid-Columbia Coho Master Plan History

Since 1996, the Bonneville Power Administration (BPA) has been funding ongoing studies and artificial production of coho salmon (*Oncorhynchus kisutch)* in the Wenatchee and Methow river basins, in the state of Washington. The initial purpose was to determine the feasibility of reintroducing self-sustaining coho populations in the mid-Columbia region. The work is being conducted primarily by the YN, with significant assistance from other state, federal, and public utility participants.

At the request of the NPCC, the mid-Columbia coho program has been reviewed numerous times over the years by the Independent Science Review Panel (ISRP). The ISRP reviews include annual reviews of proposals for funding through the Fish and Wildlife Program for fiscal years 1998, 1999, and 2000; a partial step review in 2000 (ISRP 2000-5[8]); a provincial review[9] for

[8] ISRP 2000-5: www.nwcouncil.org/library/isrp/isrp2000-5.pdf
[9] See the project under CBFWA's proposal finder: www.cbfwa.org/solicitation/components/forms/Proposal.cfm?PropID=223

fiscal years 2003-2005 funding; a concurrent Step One master plan review and FY 2007-09 proposal review in 2006 (ISRP 2006-5[10]); a March 2009 Step One review (ISRP 2009-6[11]) of a revised master plan that was updated in response to the ISRP's 2006 review. In the March 2009 review, the ISRP found the revised Master Plan did not meet scientific review criteria. Discussions between the ISRP and the YN led to further revision of the Master Plan; unfortunately, the ISRP was not provided a completely updated version in September 2009 and thus continued to state (November 24, 2009) that the revised Master Plan, dated September 23, 2009, did not meet scientific review criteria. The mistake was discovered in early 2010, and on March 10, 2010, the NPCC approved continued funding for the program pending the outcome of a Step Two review and an environmental impact statement (EIS) to be prepared by BPA.

2017 Update: *The 2010 Master Plan provided the basis for the proposed action and alternatives considered in the EIS. The Final EIS (March 2012) evaluated more facility sites for the Proposed Action than were presented in the 2010 Master Plan, including back-up sites should any of the proposed primary sites become unavailable. The subsequent Record of Decision (July 2012) selected some, but not all, of the proposed primary sites because several did indeed become unavailable; and the backup hatchery site was selected rather than the proposed site at Dryden. Chapter 6 lists the facilities currently in use or proposed for the program, including the hatchery site at Natapoc (see Chapter 4, Section 4.3.2 and Chapter 6). As of fall 2016, new proposed sites or sites where modifications are being considered that were not evaluated in the EIS have been and are the subject of additional NEPA and ESA reviews.*

Chapter 10 of this plan lists key policy, analytical, and research documents directly associated with this project, by year. The list includes NEPA and ESA-related documents that have been prepared to date.

1.4 Consistency with Council's Requirements

1.4.1 Master Planning Guidelines

In accordance with Section 7.4B of the Fish and Wildlife Program (NPPC 1994), this master plan addresses Council master planning guidelines as follows.

Council Requirement 1

Address the relationship and consistencies of the proposed project to the eight scientific principles.

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

Project proponents expect that re-establishing coho into the ecosystem as a naturally reproducing species will improve the abundance, productivity, and diversity of many organisms in the target basins and beyond. Spawned-out coho carcasses will add nutrients to streams at a critical time for a variety of species as they approach winter. Adult and juvenile coho provide a food source for other listed and sensitive species such as grizzly bears and bald eagles. The habitat improvements being undertaken as part of other projects will increase the ability of coho, as well as other fish and wildlife species, to re-establish self-sustaining populations.

[10] ISRP 2006-5: www.nwcouncil.org/library/isrp/isrp2006-5.htm
[11] ISRP 2009-6: www.nwcouncil.org/library/isrp/isrp2009-6.htm

Principle 2. Ecosystems are dynamic, resilient and develop over time.

During feasibility studies, project proponents tested the hypothesis that a lower Columbia River coho population could, over time, become adapted to certain new environmental conditions—specifically, much longer migration distances. The coho reintroduction program has taken, and will continue to take, the time to develop a locally adapted coho population. The proposed project has been designed to recognize the current limitations of the ecosystem and to respond to improvements as they are made.

Project facility design and operation will allow the reintroduction effort to adapt to ecosystem changes. The use of a variety of fish production and release methods and the emphasis on existing natural ponds for acclimation adds program flexibility. Rearing methods, release locations, and release numbers can efficiently be altered to adapt to a number of inputs, including changes at ecosystem levels.

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

The project recognizes that a number of factors affect the viability of coho populations in the mid-Columbia region, factors that exist beyond the target basins and during periods of time when the project is not directly managing coho. As we state in Section 1.1.1, challenges to coho reintroduction include the absence of locally adapted populations, in-basin habitat degradation, survival through the migration corridor, harvest, and variability of ocean environmental conditions. The proposed reintroduction program directly addresses the first of the five challenges, but the project proponents are actively working both directly and indirectly to help improve local habitat, as well as help make improvements on a larger scale in the region. At the same time, we recognize that the local improvements made by our project can positively influence a wider environment and can have cumulative biological effects over the long term.

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

The project as currently proposed relies on the physical improvements to habitat that have been made, and will continue to be made, by other projects and entities in the region. In some cases, the proposed facilities will themselves contribute to developing and maintaining habitat for other species of fish and wildlife as well as for coho. At the same time, project proponents recognize that the process of reintroducing coho into the habitat is contributing to biological changes in that habitat due to the presence of increased biomass in basin streams and changes in nutrient levels of streams resulting from the presence of coho carcasses.

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

This project recognizes the role both juvenile and spawning coho might play in providing food sources for other species, as well as changing nutrient levels and other ecological conditions in streams. See Section 4.5, among others.

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

The coho reintroduction program has already increased the biological diversity in the region with its increasing numbers of coho adapted to the long migrations required to return to mid-Columbia basins to spawn, which they are doing naturally, also in increasing numbers. While numbers have fluctuated from year to year, depending in many cases on environmental conditions beyond the control of project managers, the coho have continued to return—an excellent demonstration of Principle 6.

Principle 7. Ecological management is adaptive and experimental.

The proposed project has been an experiment in adaptive ecological management from its inception. Beginning with the hypothesis that a lower Columbia river stock of coho salmon could be gradually adapted to the much longer migration times required for them to reproduce naturally in mid-Columbia river basins, the project has monitored, documented, and changed broodstock collection, spawning, rearing, and acclimation practices over the years, and in the process, has demonstrated success where previous attempts had failed. The proposed project would continue the adaptive, experimental approach to achieving the long-term goal of reintroducing harvestable numbers of naturally reproducing coho in mid-Columbia basins.

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

This project has recognized, and will continue to recognize, the importance of human actions on both success and failure of ecosystems and the biological performance of reintroduced coho, while at the same time keeping in mind the goal of minimizing or eliminating human intervention in the long term. The original hypothesis tested by the project, as well as its proposed future as described in this master plan, demonstrate that recognition. Program benefits and risks, many of which depend on human actions, are discussed in Sections 4.4 and 4.5; they were evaluated in detail during the NEPA/Environmental Impact Statement process (USDOE/BPA 2012) and in the analyses and consultations required under the ESA. Site-specific changes continue to be evaluated under NEPA, ESA, and other state, federal, and local processes.

Council Requirement 2

Describe the link of the proposal to other projects and activities in the subbasin and the desired end state condition for the target subbasin.

Section 1.5 discusses the links between the proposal and other activities in the target subbasins. In brief, project proponents are partnering with numerous entities in the subbasins, not only to reintroduce coho and protect listed and sensitive species in these basins, but, as part of other programs, to make substantial improvements to habitat.

The desired end state condition is re-established naturally spawning coho populations in mid-Columbia tributaries at biologically sustainable levels which provide significant harvest in most years (Section 1.2.1).

Council Requirement 3

Define the biological objectives with measurable attributes that define progress, provide accountability and track changes through time associated with this project.

Section 1.2.2 defines the following biological objective and measures of success:

Biological Objective: Develop a locally adapted, naturally spawning coho stock in the Wenatchee and Methow river basins capable of supporting harvest.

Metric 1. The 3-year mean escapement of natural-origin returns in the Wenatchee (upstream of Tumwater Dam) and the Methow river basins exceeds 1,500 per basin.

Metric 2. Achieve a total harvest rate of 23%, which includes a 10% mixed stock harvest, 10% mainstem harvest, and 5% terminal harvest in most years.

Council Requirement 4

Define expected project benefits (e.g. preservation of biological diversity, fishery enhancement, water optimization, and habitat protection).

Cultural, socioeconomic, and ecological benefits are expected to result from the return of this species to areas where it once occurred in abundance. Section 4.5 defines the benefits in detail.

Council Requirement 5

Describe the implementation strategies as they relate to the current conditions and restoration potential of the habitat for the target species and the life stage of interest.

Habitat in the target basins is evaluated and described using several methods. Section 2.4.1 summarizes habitat descriptions from the Wenatchee and Methow subbasin plans. Using these descriptions, Section 2.4.2 evaluates habitat using the NPCC habitat condition criteria (NPCC 2000). Section 2.4.3 presents the EDT analysis of the Wenatchee and Methow basins. The EDT analysis identifies the tributaries that initially appear to be most suitable for coho reintroduction.

AHA model predictions for each release tributary provide natural production goals and expected results as the program transitions from a domesticated hatchery stock to a fully integrated supplementation program, and finally to a self-sustaining, naturally reproducing population. A summary of the AHA calculations for each tributary targeted for coho restoration is in Section 5.4.

The EDT model was used as a first assessment of production potential of each basin's tributaries. These models were used to identify acclimation and release sites for the majority of high ranking tributaries. The EDT analysis serves as a guide to inform where high-quality coho habitat exists. In addition to locations identified during the EDT analysis, we also included a few sites lower in the basin that historically produced coho salmon in order to better understand where coho will be successful. These additional sites are an important part of the reintroduction contingency plan (see Chapter 4, Section 4.3.5). This approach is expected to best address the uncertainties in the available literature and coho response in interior systems.

The AHA model provides a framework from which the loss of fitness, or domestication, can be addressed in the form of a working hypothesis. The proposed mid-Columbia coho restoration plan presents a unique opportunity to test some of the assumptions of the AHA model, as they pertain to domestication and local adaptation, in the absence of genetic risk[12] to a native coho population.

Council Requirement 6

Address the relationship to the habitat strategies.

Proposed habitat improvement programs in the basins are described in various subsections of Section 1.5; discussions include how the project proposed in this master plan will contribute to or benefit from those habitat activities.

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[12] Genetic risk is the probability of an event or activity having an adverse genetic consequence. Adverse consequences include 1) extinction, 2) loss of within population genetic diversity, 3) loss of among-population genetic diversity, and 4) domestication (Busak and Currens 1995).

Council Requirement 7

Ensure that cost-effective alternate measures are not overlooked and include descriptions of alternatives for resolving the resource problem, including a description of other management activities in the subbasin, province and basin.

Section 1.5 describes other management activities that affect this project. Section 4.2, Chapter 6, and the B and C appendices to the 2010 Master Plan all describe at various levels of detail the alternatives considered for this project. In addition, the EIS (USDOE/BPA 2012) evaluated facility sites other than those described in the 2010 Master Plan, as well as the alternative of not funding the program beyond 2018 as agreed to in the 2008 Columbia Basin Fish Accords. Chapter 6 in this revised master plan presents the facilities and sites currently in use and being considered. Most of these sites were evaluated in the EIS; a few replacement sites are still being evaluated under NEPA and ESA.

Council Requirement 8

Provide the historical and current status of anadromous and resident fish and wildlife in the subbasin most relevant to the proposed project.

Section 2.2 describes the historical and current status of coho; Section 2.3 discusses those issues for steelhead, spring Chinook, sockeye, summer/fall Chinook, and bull trout.

Council Requirement 9

Describe current and planned management of anadromous and resident fish and wildlife in the subbasin.

Sections 1.5.6 through 1.5.15 describe various fish management activities in the target subbasins and in other nearby regions. Section 2.3 includes a section on the current management strategy for each of the species listed above under Council Requirement 8.

Council Requirement 10

Demonstrate consistency of the proposed project with NOAA Fisheries recovery plans and other fishery management and watershed plans.

See Section 1.5.

Council Requirement 11

Describe the status of the comprehensive environmental assessment.

An Environmental Assessment and Finding of No Significant Impact were prepared for the feasibility phase of this project in 1999. Before subsequent changes to the program or additional project facilities were developed, supplemental analyses evaluating effects of those actions were prepared (see Chapter 10 for a detailed list of those documents).

2017 Update: *A draft Environmental Impact Statement on the project proposed in the 2010 Master Plan was published in June 2011; the Final EIS was published in March 2012 and the Record of Decision in July 2012. The EIS evaluated the impacts of proposed construction, operation, and monitoring actions as well as the effects of increased numbers of coho in the subbasins. These documents are described in Chapter 10.*

The Record of Decision authorizes BPA to implement the Proposed Action as described in the Final EIS, subject to certain conditions. Since publication of the Final EIS, several acclimation sites have been removed from the Proposed Action; however, the need, purposes, and goals *presented in the Final EIS have not changed, nor have the locations of the majority of the project sites. Biological Assessments were submitted to NMFS and USFWS in December 2011 and February 2012, respectively, to initiate the Endangered Species Act (ESA) Section 7 consultation process on construction and use of new facilities. The assessments were based on the sites identified in the Final EIS. Due to the subsequent uncertainty about which sites would be used, consultations with these agencies were delayed, except for the Gold Creek acclimation site in the Methow basin; revised BAs on sites proposed for use by 2014 were submitted to NMFS and USFWS in December 2012 and February 2013, respectively. Biological Opinions on the revised BAs were received from USFWS in March 2014 and from NMFS in June 2014. Addenda to these BAs discussing additional changes to proposed sites were submitted to USFWS in September 2015 and NMFS in October 2015. A Biological Opinion from USFWS addressing the addendum was received July 18, 2016; a Biological Opinion is expected from NMFS in December 2016. Terms, conditions, and conservation measures included in the Biological Opinions on the sites have been within the range of alternatives and impacts addressed in the Final EIS.*

A Hatchery and Genetics Management Plan (HGMP) was submitted to NMFS on program operations in July 2009, with updates provided in January and February 2010. A revised HGMP was submitted in March 2016; the Biological Opinion expected in December 2016 will also respond to the HGMP.

Council Requirement 12

Describe the monitoring and evaluation plan.

Section 4.3.3 summarizes the M&E plan; Chapter 7 describes it in detail.

Council Requirement 13

Describe and provide specific items and cost estimates for 10 Fiscal Years for planning and design (i.e. conceptual, preliminary and final), construction, operation and maintenance and monitoring and evaluation.

Chapter 8 details cost estimates made before the Step 2 process began. Because BPA's decision to fund the proposed program was made in 2012, this chapter of the Master Plan has not been updated. Revised cost estimates will be presented to the Council during Step 3.

Council Requirement 14

Address the relation and link to the Council's artificial production policies and strategies.

The existing and proposed coho restoration program follows HSRG guidelines, upon which the Council's Artificial Production Review and Evaluation process was based (see Section 4.3.2). The HSRG Recommendations/Observations for the Wenatchee and Methow coho program include:

> *This appears to be a well-thought-out reintroduction program that emphasizes developing locally adapted populations, first in the hatchery and then in the natural environment. Preliminarily, the program appears to be successful. However, planning to allow a high proportion of hatchery spawners in the second support phase provides no opportunity for the population to adapt to the local environment. A PNI greater than 0.5 is necessary for the natural environment to drive adaptation and increase fitness.* (HSRG 2008)

These recommendations have been incorporated into the Mid-Columbia Coho Restoration Program (MCCRP).

Council Requirement 15

Provide a completed Hatchery and Genetic Management Plan (HGMP) for the target population(s).

Appendix D in the 2010 Master Plan. The latest version is attached to this Master Plan.

Council Requirement 16

Describe the harvest plan.

In Section 5.4, tables show expected harvest rates for the various target tributaries.

Council Requirement 17

Provide a conceptual design of the proposed facilities, including an assessment of the availability and utility of existing facilities.

2017 Update: *As noted in several places, some of the sites described in the original Chapter 6 and appendices to the 2010 Master Plan are no longer proposed. See Chapter 6 of this revised Master Plan for the current list of proposed sites and a conceptual design for the proposed new hatchery. The Final EIS evaluated proposed facilities in more detail, as have subsequent Supplement Analyses and Biological Assessments (see Chapter 10 for a list). Appendices B.1, B.2, C.1 – C.4 of the 2010 Master Plan provide the initial assessment of the availability and utility of existing facilities at that time.*

1.4.2 Partial Step Review

This section discusses where the Master Plan addresses the information needs identified in the partial step review that ISRP conducted in 2000[13]. As stated in the July 12, 2002 memorandum: "The results of Phase I [feasibility studies] will be used to address program areas pertaining to master planning as well as other aspects including National Environmental Policy Act documents. Before initiation of Phase II, this information will be used for a Step 2 review." (M. Fritsch, NPPC, memorandum to Council, July 12, 2000). The following four categories of information (in boldface type) were requested for the next Council review of the Mid-Columbia coho project. The location of this information in the Master Plan follows each category (in regular typeface).

1) Provide a specific statement of goals in terms of numbers of coho adults and/or of smolt to adult return rates that are expected to constitute success in reestablishment or at least to render unnecessary further hatchery plants or supplementation with artificially reared coho.

Section 1.2.2, Chapters 4 and 5.

2) Modify monitoring and evaluation procedures to clarify how time-limited objectives will be measured.

Chapter 7.

3) Discuss the possibility that further facilities may not be needed and the conditions that would enter into making that decision.

Chapter 6 and Appendices B.1, B.2, C.1 - C.3 to the 2010 Master Plan. ***2017 Update:*** *The final EIS also discusses alternatives, including the alternative of BPA discontinuing funding after 2018 (No Action Alternative).*

[13] ISRP 2000-5: www.nwcouncil.org/library/isrp/isrp2000-5.pdf

4) Respond to the general and specific comments relating to:

- **harvest rates as limiting factors** (Chapter 5, AHA calculations; Section 7.1.10; Appendix E of the 2010 Master Plan)
- **the monitoring and evaluation plan** (Chapter 7)
- **issues (i.e. ecological interactions, quality of rearing habitat and case studies of successes in similar endeavors).**
  - Ecological interactions: Sections 3.2, 7.2
  - Quality of rearing habitat: Section 2.4, Chapter 5
  - Case studies: Section 4.3.6

1.4.3 Subsequent ISRP Reviews

As discussed in Section 1.3, the mid-Columbia coho program has been the subject of numerous ISRP reviews. All have resulted in substantial changes to the program. The 2006 ISRP review of the draft Master Plan for the project that was prepared as feasibility studies were ending[14] led to the program being funded outside the NPCC Fish and Wildlife Program. The Master Plan was substantially revised in response to the 2006 review and re-submitted for a Step One review in March 2009, followed with another review in November 2009. The main issues raised in the last review are summarized below, followed by the sections of this plan where those issues are addressed.

Issue 1. The performance metrics at each stage of the project are insufficient.

See Tables 4-1 and 4-2 and detailed discussion in Chapter 5.

Issue 2. The reporting of the feasibility studies does not provide explicit status of the appropriate metrics at this time.

See updated Chapter 3.

Issue 3. The rationale for the design of Broodstock Development Phase 2, Natural Production Implementation Phase, and Natural Production Support Phase I and II are not scientifically supported by the results from the feasibility studies or modeling.

ISRP suggested a modeling exercise and program design that would have answered scientific questions about the mechanisms of local adaptation. BPA and the YN evaluated the suggested approach as part of the EIS. The conclusion in Section 2.4.3 of the EIS was that it was not necessary to consider the proposed design in detail for several reasons, including the following:

> *The hydrographic challenge of Tumwater Canyon is also a reason not to try to breed separate upper and lower Wenatchee basin coho populations. Biologists do not know which characteristics, visible or not, contribute to coho successfully navigating Tumwater Canyon, so they do not want to unintentionally select out the genetic diversity that would allow these fish to survive the highly variable conditions of that reach of the Wenatchee River.*

2017 update: *Due to the low numbers of coho that have been returning to tributaries above Tumwater Dam and our inability to meet BDP2 goals, we implemented a study to evaluate which phenotypic characteristics are correlated with successful migration through Tumwater Canyon (Contingency 2a as described in Chapter 4, Section 4.3.5, which we developed based on suggestions from the ISRP). We are actively using the information from this study (detailed in*

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[14] ISRP 2006-5: www.nwcouncil.org/library/isrp/isrp2006-5.htm

Appendix 1) to implement Contingency 2b. We are not implementing the ISRP's recommendations exactly as they described because we do not wish to breed two separate stocks of coho within the Wenatchee basin and because the number of fish currently encountered at Tumwater Dam would not result in a meaningful release upstream of Tumwater Dam, although in time we expect the numbers will be adequate.

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

1.5.1 Treaty of 1855 and *U.S. v. Oregon*

In the Treaty of 1855, bands and tribes of the Yakama Nation reserved "[t]he exclusive right of taking fish in all the streams running through or bordering [their] reservation...and…taking fish at all usual and accustomed places…" "The treaty right to take fish in usual and accustomed places requires that fish runs pass such usual and accustomed places" (S. Jim and P. Rigdon, YN, letter to M. Eden, NPCC, August 25, 2005).

In the westward expansion of the United States during the 19th century, Congress required that federal representatives treat with and compensate native peoples who were then occupying the lands that were desired for inclusion in the Union. In the Treaty of 1855, 14 independent tribes and bands occupying roughly the central third of Washington State were confederated into the Yakama Nation. In exchange for ceding their ancestral lands to the United States so that they could lawfully be opened to settlement, tribal leaders secured in perpetuity certain rights and privileges that were considered necessary to preserve tribal culture and traditions. Among these reserved rights was the exclusive right to fish in rivers running through and bordering the new Yakama Reservation, and "in common with" residents of the territory at all "usual and accustomed" fishing areas. The Treaty of 1855 was ratified by Congress in 1859 and became recognized as "the supreme law of the land."

As increasing numbers of non-Indians began to develop agricultural, industrial, and fishery resources of the Columbia Basin, tribal fishers saw their Treaty-reserved fisheries steadily decline over the ensuing century. In 1968, several members of the Yakama Nation filed suit against the United States for failing to preserve and protect their access to fisheries reserved in the Treaty of 1855. The United States, on behalf of the Columbia River Treaty Tribes, filed suit against the State of Oregon for allowing non-treaty fisheries to harvest virtually all harvestable portions of Columbia River runs while restricting Treaty fisheries in order to meet escapement goals. The *United States versus Oregon* treaty fishing rights case affirmed that the 1855 treaty reserved for the tribes a fair share of the harvest, which was subsequently determined to be 50% of the harvestable portion of runs destined to pass the tribes' usual and accustomed fishing areas.

The *U.S. v. Oregon* decision also established guidelines and procedures by which the tribes could function as self-regulating fishery co-managers together with the state and federal fishery agencies. Under continuing Court oversight, a co-management process was created that provides for joint technical and policy review of management proposals by tribal, state, and federal parties to the lawsuit. This process is intended to ensure that Treaty and non-Treaty fishery regulations are consistent with harvest sharing principles and with rebuilding the upriver runs. The Yakama Nation views the *U.S. v. Oregon* process as the expression of its co-management authority and, therefore, the primary forum through which the tribe's management goals and priorities should be advanced.

The *U.S. v. Oregon* process is implemented through harvest and hatchery management plans that are jointly developed by the parties and become binding on them when adopted as Court orders. Harvest management plans are negotiated within the *U.S. v. Oregon* process and describe the management goals and guidelines that shape in-season harvest management. Hatchery management plans may be negotiated within the *U.S. v. Oregon* process or they may be brought into the process as plans jointly prepared by the relevant co-managers in a separate forum, such as a FERC hydro project licensing process. Once adopted into the *U.S. v. Oregon* management plan, these production plans become binding on the co-managers and cannot be unilaterally altered.

1.5.2 Columbia River Fish Management Plan *(U.S. v. Oregon)*

As stated in Section 1.5.1, *U.S. v. Oregon*, which remains under Court jurisdiction, upheld the treaty fishing rights of the Columbia River treaty tribes in a 1969 decision. In 1983, the court ordered the tribes, states and the federal government to develop a management plan, named the Columbia River Fish Management Plan (CRFMP). The purpose of the CRFMP is to protect, rebuild, and enhance upper Columbia fish runs while providing harvest for both Treaty Indian and non-Indian fisheries. Consistent with III.D.4 of the CRFMP, the All Species Review of the CRFMP (TAC 1997) states that the Parties continue to provide for coho production opportunity in natural areas of the upper Columbia compatible with natural production. "Possible sites include: Grande Ronde, Walla Walla, upper Yakima, Naches, and tributaries of the Clearwater, Wenatchee, Methow, and Entiat rivers."

> "Perhaps most significantly, the *US v. Oregon* framework provides the backdrop for the development and implementation of the Council's FWP [Fish and Wildlife Program]. Indeed, because the *US v. Oregon* process promotes exercise of the Yakama Nation's treaty rights, the Northwest Power Act ("the Act") requires that [the] FWP and implementing activities be consistent with *US v. Oregon* requirements. *See, 16 U.S.C. Sec. 839b(h)(6)."* (S. Jim and P. Rigdon, YN, letter to M. Eden, NPCC, August 25, 2005).

This proposed Master Plan would assist in meeting the Parties' (Yakama, Nez Perce, Umatilla and Warm Springs tribes; USFWS, NOAA, BIA, ODFW, WDFW, and IDFG) intent under the auspices of *U.S. v. Oregon*.

1.5.3 Mitchell Act

The Mitchell Act authorized the Secretary of Commerce to implement the construction of salmon hatcheries in Oregon, Washington, and Idaho as a means to mitigate for salmon production lost as a result of the construction of the federal Columbia River hydro-power system. Most of the Mitchell Act hatcheries were constructed in the lower Columbia River in the 1950s and 1960s. Only since 1988, under the jurisdiction of *U.S. v. Oregon*, have lower Columbia River Mitchell Act hatcheries been reprogrammed[15] to provide coho salmon smolts for release in upriver areas, including the Wenatchee and Methow basins. Smolts grown at these hatcheries,

[15] The word "reprogrammed" results from the fact that fish produced at a hatchery have a specific release program as part of their facility's management plan. Historically, most hatcheries, especially in the lower Columbia River, released their juveniles on-station. The Tribes took the operating agencies to court (*U.S. v. Oregon*) to get the production "reprogrammed" and released above Zone 6 (Tribal fishing zone) so that the fish would be imprinted to locations above their fishery.

which are offspring of coho that returned to the mid-Columbia, provide the basis for reintroduction efforts in these two Columbia River basins. Up to 90% of the coho salmon proposed for release in this Master Plan will be reared in Mitchell Act facilities.

1.5.4 *Wy-Kan-Ush-Mi Wa-Kish-Wit*: Spirit of the Salmon Tribal Recovery Plan

This plan (CRITFC 1995) was developed by the four Columbia River Treaty Tribes (Nez Perce, Umatilla, Warm Springs, and Yakama). It is a comprehensive plan put forward by the Tribes to restore anadromous fishes to rivers and streams that support the historical cultural and economic practices of the tribes. *Wy-Kan-Ush-Mi Wa-Kish-Wit* provides the basic goal to restore the Columbia River salmon, which is, simply: **put the fish back into the rivers**. The Master Plan meets the goals and objectives of the tribal restoration plan for coho restoration in the Wenatchee and Methow rivers.

1.5.5 Wenatchee and Methow Subbasin Plans

The Mid-Columbia Coho Restoration Program is consistent with and supports the vision and goals of both the Wenatchee and Methow subbasin plans. The vision for the Wenatchee subbasin includes restoring extirpated fish and wildlife and natural habitats that perpetuate native wildlife and fish populations into the foreseeable future. The vision for the Methow subbasin is to support self-sustaining, harvestable, and diverse populations of fish and wildlife.

Restoring extirpated fish and wildlife is a specific goal and priority to advance the vision of the Wenatchee Subbasin Plan, and is also a specific goal of the Methow Subbasin Plan: "The goal for coho salmon includes re-establishment of run sizes that provide for species recovery, mitigation of hydro-system losses, and harvestable surpluses." (NPCC 2004b) The proposed master plan represents a strategy to re-establish coho runs in five generations of supplementation by emphasizing increased fitness through local adaptation and increased productivity through coordinated habitat improvement.

In both the Wenatchee and Methow subbasin plans, coho salmon are listed as a focal species. Many of the prioritized habitat restoration actions in the subbasin plans are aimed at supporting continued restoration of coho populations. Coho salmon prefer and occupy different habitat types than the other focal species, selecting slower velocities and greater depths. Habitat complexity and off-channel habitats such as backwater pools, beaver ponds, and side channels are important for juvenile rearing, making coho salmon a good biological indicator for habitat recovery prioritized in the subbasin plans.

The following excerpts from the two subbasin plans are a sample of how coho have been incorporated into the plans. To highlight the issues, we have added emphasis within the quotations.

- ***Methow Subbasin Plan excerpts:***

  Page xxi, Section 1 Fisheries Management: This section provides the Methow Subbasin Plan goals for focal species. "**The goal for coho salmon includes re-establishment of run sizes that provide for species recovery, mitigation of hydro-system losses, and harvestable surpluses."**

  Page 33, Section 3.3.1 Fish Focal Species: Population Characterization and Status: "A focal species has special ecological, cultural, or legal status and represents a management priority in the Methow subbasins and, by extension, in the Columbia Cascade Eco-province.

Focal species are used to evaluate the health of the ecosystem and effectiveness of management actions." The inclusion of coho salmon as a "focal species" in the Methow Subbasin Plan clearly indicates that continued coho restoration is consistent with the Plan, and that coho can be used as an indicator species for select habitat types.

Page 79 Section 3.4.6 Fish Focal Species, Rationale for Selection – Coho: "Historically the Methow River produced more coho than Chinook or steelhead (Craig and Suomela 1941). Mullan (1984) estimated that 23,000-31,000 coho annually returned to the Methow River. Upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat (Mullan 1984). Today coho reintroduction is identified as a priority in the *Wy-Kan-Ush-Mi Wa-Kish-Wit* document (Tribal Restoration Plan) and has been affirmed as a priority by the Northwest Power and Conservation Council."

"Coho salmon prefer and occupy different habitat types, selecting slower velocities and greater depths than other focal species: Habitat complexity and off-channel habitats such as backwater pools, beaver ponds, and side channels are important for juvenile rearing making coho good biological indicators of these areas."

"While the historic stock of coho salmon are considered extirpated in the Upper Columbia River, … [i]n cooperation with the WDFW and the USFWS, the Yakama Nation is currently leading coho salmon recovery efforts in the basin."

Page 79 Section 3.4.6 Fish Focal Species, Coho – Representative Habitat: "Currently, coho salmon returning to the Methow Basin are spawning in the mainstem Methow River and small tributaries such as Gold Creek. **As the recovery program continues, reintroduction of coho to tributaries within the Methow Basin will aid in species dispersal."** This statement indicates that continued coho reintroduction is expected in the Methow Subbasin Plan to ensure adequate species dispersal within the Methow subbasin.

Pages 79-80 Section 3.4.6 Fish Focal Species, Coho – Key Life History Strategies, Relationship to Habitat: This section provides detailed information from both the literature and YN's coho reintroduction program regarding Upper Columbia River coho life history strategies and relationship to the habitat.

Page 81 Section 3.4.6 Fish Focal Species, Coho – Population Status: "Coho salmon returning to the Methow Basin are primarily hatchery-origin, but include an increasing naturally produced component as a result of ongoing reintroduction efforts."

Page 81 Section 3.4.6 Fish Focal Species, Coho – Population Management Regimes and Activities: "**The ideal result would be to restore coho populations in these basins [Methow and Wenatchee] to their historic levels. Because of varying degrees of habitat degradation in each of these basins, historical numbers are unlikely ever to be achieved but remain a goal towards which to strive."**

Pages 81-83 Section 3.4.6 Fish Focal Species, Coho: These pages contain detailed descriptions of coho hatchery effects (history of coho programs and current programs), hydro-electric effects (GCFMP programs and Chelan and Douglas PUD HCP obligations to coho salmon), and harvest effects.

Pages 301-353 Section 5.5 Assessment Unit Summaries: Within section 5.5 coho salmon are specifically listed as a focal species for the following Assessment Units: Lower Methow, Middle Methow, Upper-Middle Methow, Upper Methow/Early Winters/Lost River, Black Canyon/Squaw Creek, Gold/Libby Creeks, Beaver/Bear Creeks, Lower Twisp River, Upper Twisp River, Upper Chewuch River, Lower Chewuch River, Goat/Little Boulder Creeks. As a focal species in these Assessment Units, much of the recommended restoration strategies should improve habitat for coho. The geographic distribution of coho as a focal species within the Subbasin Plan is consistent with the proposed coho master plan.

- ***Wenatchee Subbasin Plan excerpts:***

Page xxi, Section 2.5.2 Key Findings: Aquatic: "Limiting factors are defined as a habitat element that limits the biological productivity and/or life history diversity of a focal species. **The focal species selected for this assessment include spring chinook salmon, late-run chinook salmon, sockeye salmon, coho salmon,** steelhead trout, bull trout, westslope cutthroat trout, and pacific lamprey." As defined in the plan, "focal species will be used to evaluate the health of the ecosystem and the effectiveness of management actions." The inclusion of coho salmon as a focal species in the Wenatchee Subbasin Plan clearly indicates that continued coho restoration is consistent with the Plan, and that coho can be used as an indicator species for select habitat types.

Page 26, Section 3.3.3 Guiding Principle-8: "Species diversity and the biotic community are a reflection of the ecosystem attributes. The co-evolved assemblage of species share requirements for similar ecosystem attributes and those attributes can be estimated by intensive study of **focal** or indicators species." Coho salmon are a focal species in the Wenatchee Subbasin Plan. They are part of the co-evolved assemblage of species. The only way to increase species diversity with co-evolved species is to restore those species which have become extirpated or limited on a geographic scale. The Subbasin Plan states that coho are a good indicator species for off-channel habitats.

Page 27, Section 3.3.3 Guiding Principle 10: "**Restoration of individual populations may not be possible without restoration of other fish and wildlife populations with which they co-evolved."** We interpret this statement from the 10th guiding principle to directly apply to the reintroduction of coho salmon (extirpated species) which co-evolved with all the other focal species in the basin. The plan acknowledges that restoration of ESA species may not be possible unless the ecosystem and co-evolved fish assemblage is restored.

Page 27, Section 3.3.3 Guiding Principle 11: "Reintroduction [coho] or supplementation [Chinook and steelhead] programs for fish and wildlife should concentrate on specific environments within the basin, **selection of an appropriate stock for reintroduction to that environment or locally adapting a donor stock [coho] where a local stock no longer exists.**" This statement from the 11th guiding principle describes the strategies of the coho reintroduction program. YN's coho reintroduction program is the only program in the basin where a local stock is not available and is "developing a locally adapting donor stock." This guiding principle supports YN's reintroduction approach.

Page 28, Section 3.3.3 Guiding Principle 12: "At some point along the scale from intact population to former populations that have had entire metapopulations extirpated from the basin and adjacent basins, emphasis on recovery actions is better focused on rebuilding population structure than on habitat restoration**.** If the goal of cost-effective restoration is to be achieved, subbasin planners need to assess the optimal mix of habitat restoration and population structure restoration to achieve biological goals."

Page 29, Section 4.1 Focal Species – Aquatic/Fish: "Fish focal species were defined that a) have special cultural significance, b) fulfill a critical ecological function, c) serve as an indicator of environmental health, d) are locally significant or rare as determined by applicable state or federal resource management agencies and/or are federally listed. Eight anadromous and resident fish species were chosen as focal species. Each of these species is considered to be culturally important, three of the species are listed under ESA and each species uniquely represent different and important habitat characteristics." Coho salmon are a focal species in the Wenatchee Subbasin Plan.

Page 29 Section 4.1 Focal Species – Table 12: Within table 12, coho are shown as a focal species with a representative habitat of "lower mid-elevation mainstem and tributaries, side channel and backwater environments." Lower and mid-elevation mainstem includes the Wenatchee River from the mouth to the Lake. Tributaries include Nason Creek, Chiwawa River, White River, and Little Wenatchee.

Page 70 - Figure 11: The figure on page 70 shows the **current** distribution of coho in the Wenatchee subbasin. At the bottom of the figure the following note is found – "**Note: Coho presence and spawning information is dynamic and is expected to change significantly each year as reintroduction efforts continue."** The Wenatchee Subbasin Plan expects coho reintroduction to continue.

Page 71 Section 4.8.5 Coho (Oncorhynchus kisutch) – Rationale for Selection: "Coho salmon were once considered extinct in the mid-Columbia region, but have since been reintroduced. Recent reintroduction efforts have resulted in natural reproduction occurring in the basin. Mullan (1984) estimated the historical run size at 38,000 to 51,000 adults to the Wenatchee, Entiat, and Methow Rivers (Peven 2003). Recently the Yakama Nation has begun a substantial and concerted effort to reintroduce coho into the upper Columbia, using the Wenatchee and Methow subbasins during the feasibility phase of this work. **Coho salmon prefer and occupy different habitat types, selecting slower velocities and greater depths than the other focal species. Habitat complexity and off-channel habitats such as backwater pools, beaver ponds, and side channels are important for juvenile rearing making coho good biological indicators for these areas."**

Page 178 Section 6.3.2 Aquatic/Fish Summary of Environmental/ Population Relationships of the Focal Species – Coho: Pages 178-179 describe the relationships of coho salmon (focal species) to the current status of the environment. Selection highlights are reported below:

> "Spawning areas for coho salmon in Nason Creek have been compromised by loss of riparian area and subsequent large wood recruitment, off-channel habitats, channel stability, and general diversity…**Coho spawning habitat in the Little Wenatchee River remains in good condition.** Coho spawning also occurs in the Wenatchee River and Icicle Creek where increases in sediment deposition, channel confinement and higher flow rates have most likely reduced incubation success**. Largely unaltered coho spawning habitat exists in the Chiwawa and White Rivers."**
>
> "Natural coho production in the Wenatchee subbasin could increase if habitat problems within Nason, Icicle, Peshastin, Mission, and Chumstick creeks were improved. Preservation of quality habitat areas in Chiwakum, Little Wenatchee, White, and Chiwawa basins would ensure high quality areas remain intact."

These conclusions within the subbasin plan indicate that YN's long-term plan is consistent with the findings in the Subbasin Plan in regards to tributaries containing coho habitat within the Wenatchee basin.

Page 305 Section 7.8.16 Summary of Near-term Opportunities by Focal Species – Coho Salmon: "**Continued development of a locally adapted broodstock is essential to ensure future populations of naturally spawning coho salmon in the Wenatchee River.** Increased habitat diversity (e.g., off-channel habitat, increased structural diversity, etc) primarily in Nason Creek, Peshastin Creek, Mission Creek, and the lower Wenatchee River would increase the success of naturally spawning coho and increase productivity. Evaluation of migrational delays in Tumwater Canyon could improve extreme flow passage conditions for adults migrating to the upper Wenatchee subbasin."

This section clearly states that the continued coho broodstock development is not only consistent with the subbasin plan but "essential" for the restoration of coho salmon in the Wenatchee subbasin.

1.5.6 Yakima River Coho Restoration

The Yakima Coho restoration project is a component of the Yakima/Klickitat Fisheries Project (YKFP). The Yakama Nation is the lead agency in both Mid-Columbia and Yakima restoration projects. Both are high-priority NPCC projects, are in the Tribal Recovery Plan, are legally binding under *U.S. v. Oregon*, and have similar overall goals. Several studies in both projects have inter-basin application. For example, the predation studies of coho on sensitive species completed in both projects confirmed minimal interactions between coho and other salmonids. Both projects adaptively manage in response to results and peer review.

1.5.7 Clearwater Basin Coho Restoration

This coho reintroduction project for the Clearwater Basin in Idaho is being implemented by the Nez Perce Tribe and is funded by Pacific Coastal Salmon Recovery Fund (PCSRF) (see Section 1.5.12).

The Nez Perce Tribe's overall goal is to reintroduce and restore coho salmon to the Clearwater River subbasin at levels of abundance and productivity sufficient to support sustainable runs and annual harvest. Consistent with the Clearwater Subbasin Plan (EcoVista 2003), the Nez Perce Tribe envisions an annual escapement of 14,000 coho to the Clearwater River subbasin.

Uncertainties exist about whether an extirpated salmon species can be reintroduced and restored to healthy abundances 500 miles from the ocean, upstream of eight mainstem hydroelectric dams, using donor stock from the Lower Columbia River. Therefore, the Nez Perce Tribe decided to develop the reintroduction program in two distinct phases, similar to the Mid-Columbia coho program.

- Phase I: Focus on establishing a localized Clearwater River coho salmon broodstock and meeting broodstock needs.
- Phase II: Focus on establishing naturally spawning populations of coho salmon in the Clearwater River subbasin.

The number of adult coho passing Lower Granite Dam has been increasing steadily since 1997 (http://www.cbr.washington.edu/dart/dart.html), suggesting that preliminary reintroduction efforts have been successful at stimulating adult returns.

1.5.8 Mid-Columbia HCP Hatchery Compensation Plans

The proposed coho program is consistent with the mid-Columbia Habitat Conservation Plan's Hatchery Compensation Plan (HCP HC) for Rock Island, Rocky Reach and Wells Dams.[16] The Rock Island/Rocky Reach HCP (Chelan PUD) provides mitigation in the form of coho project funding ($306,000 annually) for 10 years (2007-2016). Actual dollars will be adjusted annually according to the Consumer Pricing Index (CPI). Douglas PUD under the Wells HCP provided $600,000 in one lump sum to the coho project for their 10-year mitigation responsibility.

The Mid-Columbia Coho Reintroduction Feasibility Study (BPA project #1996-040-000) was closely coordinated with ongoing activities of HCP hatchery programs within the Wenatchee and Methow river basins. The proposed coho reintroduction plan will continue to build on this close coordination:

- The current and proposed coho programs share trapping facilities with HCP steelhead hatchery programs, including trapping at Dryden Dam, Tumwater Dam, and Wells Dam. At each of these facilities, YN and WDFW personnel operate the collection facilities together, reducing the personnel trapping needs for both programs.
- YN personnel have helped staff WDFW's smolt trap in the Wenatchee River near Monitor, to collect data during the spring smolt emigration.
- WDFW provides the YN with an annual population estimate for naturally produced coho.
- Hatchery coho are commonly used to evaluate the trap efficiency at the WDFW Monitor smolt trap and the WDFW/Douglas County PUD smolt trap in the Methow River.
- The YN operates a smolt trap in Nason Creek, designed to collect data from emigrating naturally produced and hatchery produced coho. This trap also collects data on other migrating species that are under the umbrella of Chelan County PUD's HCP monitoring programs and Grant County PUD. The YN also operates a spring Chinook monitoring rotary trap on the White River funded by Grant PUD. This trap could be used for coho monitoring beginning in the natural production phase of the coho reintroduction project.
- The proposed monitoring and evaluation plan is coordinated with the Chelan and Douglas County PUD HCP monitoring and evaluation plans through the sharing of resources and data collection.

1.5.9 Mid-Columbia HCP Tributary Conservation Plans

Under the Rock Island, Rocky Reach, and Wells Dam Habitat Conservation Plans' (HCPs) Tributary Conservation Plans (TC), Chelan and Douglas County PUDs will fund habitat improvement projects for the protection and restoration of "Plan Species"[17] habitat within the Columbia River watershed, and in the Okanogan, Methow, Entiat, and Wenatchee river watersheds. Coho salmon are designated as an HCP Plan Species. Habitat improvements in

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[16] "Habitat Conservation Plan" is a federal term used in Federal Energy Regulatory Commission (FERC) settlements. Under an HCP, there are several sections: passage survival, habitat and water quality, tributary conservation (tributary fund is here), and hatchery compensation, among other sections. Chelan County and Douglas County PUDs have an HCP as a condition of issuing an Incidental Take Permit under the ESA.

[17] "Plan Species" are the salmonids receiving mitigation under the HCPs. They are spring, summer and fall Chinook salmon; sockeye salmon; coho salmon; and steelhead.

tributaries identified for coho restoration should result in increased productivity for coho salmon and all Plan Species.

1.5.10 Grant County PUD Settlement Agreement

Grant County PUD finalized a Settlement Agreement (SA) with the fisheries management agencies and tribes related to fish mitigation that would become a FERC license article associated with the re-licensing of Priest Rapids and Wanapum dams. Coho are a "Covered Species" (similar to HCP "Plan Species") in the SA. The SA associated with operation of Wanapum and Priest Rapids dams has Grant PUD contributing approximately $738,00 annually (2008-2017) to fulfill their coho hatchery mitigation responsibility, thus providing another funding partner for the coho reintroduction project.

1.5.11 Grand Coulee Fish Maintenance Project (GCFMP)

The USFWS operates the Leavenworth National Fish Hatchery Complex (Leavenworth NFH, Entiat NFH, Winthrop NFH). The complex was constructed by the U.S. Bureau of Reclamation (BOR) to replace fish losses that resulted from construction of Grand Coulee Dam. These programs were authorized as part of the Grand Coulee Fish Maintenance Project (GCFMP) on April 3, 1937, and re-authorized by the Mitchell Act (52 Stat. 345) on May 11, 1938. The Leavenworth NFH complex works closely in support of the current coho reintroduction feasibility study (BPA project #1996-040-00). The MCCRP continues to share facilities and resources with Leavenworth and Winthrop National Fish Hatcheries.

1.5.12 Pacific Coastal Salmon Recovery Fund

This fund was established by Congress in FY2000 to provide grants to the States and Tribes to assist state, local, and tribal salmon recovery efforts; it is administered by National Marine Fisheries Service (NMFS) through Columbia River Inter-Tribal Fish Commission (CRITFC). Projects funded under the PCSRF must be consistent with the Tribes' salmon restoration plan *Wy-Kan-Ush-Mi Wa-Kish-Wit*, and Congressional authorization. PCSRF funds salmon-related habitat restoration and conservation projects; salmon watershed restoration and coordination projects; salmon stock enhancement and supplementation projects; salmon–related research and data collection; and the maintenance and monitoring of projects completed with assistance from this fund, consistent with the overall goal for the PCSRF. Through this program, habitat improvement and protection projects have been funded in the Wenatchee and Methow basins. Past and future PCSRF projects will help improve and protect coho spawning and rearing habitat. Specific projects in the Wenatchee and Methow basins are as follows:

- *Wenatchee Basin Riparian Enhancement* – This purchase of riparian habitat adjacent to Peshastin Creek will add to habitat protection for coho and other species in this Wenatchee River tributary.
- *Nason Creek Wetlands Acquisition* – YN purchased this land to protect and enhance 26 acres of beaver dam wetlands complex and to manage the site for salmon passage to spawning areas and over-winter rearing habitat. These wetlands are located in an important reach of Nason Creek, at RM 7, that provides spawning and rearing habitat for ESA-listed spring Chinook and steelhead along with coho and bull trout. Nason creek has been largely channelized and cut off from the floodplain by the transportation and power transmission corridor. The purchase of this property protects the largest off-channel habitat area in the drainage. The site also has potential to provide for acclimation

of hatchery coho, steelhead, or spring Chinook. The MCCRP currently releases smolts in an adjoining pond upstream of this property and may increase the number of coho acclimated and released from Nason Creek with the acquisition of this land.

- *Hancock Springs Restoration* – This YN habitat restoration project of a spring-fed tributary of the Methow River will provide off-channel rearing for naturalized coho that are part of the reintroduction project.

1.5.13 Salmon Recovery Funding Board

The goal of the state Salmon Recovery Funding Board (SRFB) is to fund the best salmon habitat projects in Washington State. "Best projects" are those that include local priorities and use the best available science. Eligible projects include restoration, acquisition, and assessment projects that will benefit salmon and the habitat and ecosystem functions on which they depend. Funding for the Board comes from state and federal sources. The SRFB relies on groups in individual watersheds to evaluate and rank proposed projects on an annual basis before it evaluates the proposals and makes funding decisions.

1.5.14 Yakama Nation Habitat Improvement Projects

While habitat improvement projects are not a specific part of the proposed Mid-Columbia Coho Restoration Program described in this master plan, the Yakama Nation is working closely with other tribal, state, federal and local governments to coordinate habitat improvement projects in the Upper Columbia Province. The Yakama Nation's Memorandum of Agreement (MOA) with BPA, Bureau of Reclamation and Corps of Engineers signed on May 2, 2008 includes $54 million to fund specific habitat recovery actions in the Wenatchee, Methow, and Entiat basins (2008 Columbia Basin Fish Accords Memorandum of Agreement between the Three Treaty Tribes and FCRPS Action Agencies—see Section 1.5.15). These actions will result in habitat improvements that would benefit multiple species before the start of the Natural Production phases of the proposed program and will continue throughout the Natural Production phases. Other funding sources, such as Salmon Recovery Funding Board, HCP Tributary Funds, Priest Rapids Settlement Agreement Habitat Funds, and Pacific Coastal Salmon Recovery Funds are currently being used to improve salmonid habitat conditions in the region, and these sources will also benefit the reestablishment of coho salmon (see various subsections in Section 1.5 above).

1.5.15 Columbia Basin Fish Accords

On May 2, 2008, BPA, Bureau of Reclamation, and U.S. Army Corps of Engineers signed the 2008 Columbia Basin Fish Accords Memorandum of Agreement between the Three Treaty Tribes and FCRPS Action Agencies. The three tribes are the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of Warm Springs Reservation, and the Confederated Tribes of the Umatilla Indian Reservation. The agreement includes funding for the YN's Mid-Columbia Coho Restoration Program through 2018. BPA conditioned its funding commitment beyond that date on securing a favorable recommendation from the Council and on compliance with all its other mandates, including NEPA.

1.6 Remaining Processes and Decisions

2017 Update: *Although BPA has published the Final EIS and Record of Decision on the Mid-Columbia Coho Restoration Program, and has decided to fund the program, a few processes still need to be completed.*

- *Because several acclimation sites and the preferred hatchery site evaluated in the EIS became unavailable after publication of the EIS, BPA must undertake NEPA reviews of any new replacement sites or modifications to sites already evaluated. Some reviews have been completed; others are in process (see Chapter 10).*
- *The Biological Opinion from NMFS on amendments to the program must be signed and provided to BPA; USFWS provided its BiOp on the amendments in July 2016.*
- *ISRP will review this revised master plan in light of issues as presented in their November 2009 review.*
- *Final facility designs will be subject to the Council's Step 3 review.*
- *Any required federal, state, and/or local permitting for sites must be completed.*

1.7 Master Plan Development Team

The master plan was developed and written by:

- Tom Scribner – Yakama Nation, project manager.
- Keely Murdoch – Yakama Nation, lead project biologist.
- Cory Kamphaus – Yakama Nation, project biologist.
- Scott Prevatte – Yakama Nation, project biologist.
- Judy Woodward – Crossing Borders Communications, technical writer/editor.
- Greg Ferguson – Sea Springs Co, engineer/fish culturist.
- Nancy Weintraub and Bruce Hollen – BPA, environmental specialists.

Subcontractors who have been important in the drafting of the plan include:

- Harry Senn – Fish Management Consultants, fish culturist.
- Dave Smith – C.P. Cramer, salmonid habitat ecologist.
- Jim Miller – GeoEngineers, geotechnical engineer.
- Doug Neeley – International Statistical Training and Technical Institute, statistician.

Members of the Mid-Columbia Technical Work Group contributed substantially to the master plan, as well as to reviews of the program throughout the years. They include:

- Laurie Weitkamp, Bill Waknitz, Kristine Peterson, Michelle McClure (NMFS)
- Jeff Haymes (WDFW)
- Cameron Thomas (USFS)
- David Carie, Julie Collins (USFWS)
- Chris Fisher (Colville Tribe)
- Scott Everett (Nez Perce Tribe)
- Chuck Peven (CCPUD)
- Tom Kahler (DCPUD)
- Linda Hermeston (BPA)

In addition, the team listed below reviewed the 2006 draft of the master plan, with significant suggestions for improvements to the proposal.

Name	Affiliation	Area of Expertise
Dan Warren	D.J. Warren & Associates, Inc.	Project Management, Budgeting, Cost Analysis, Compliance
Lars Mobrand	Mobrand-Jones & Stokes	Fisheries Science
Kevin Malone	Mobrand-Jones & Stokes	Fisheries Science
Bruce Watson	Mobrand-Jones & Stokes	Fisheries Science
John McGlenn	TetraTech/KCM, Inc.	Engineering
Mark Reiser	TetraTech/KCM, Inc.	Engineering
Nancy Bond Hemming	Nancy Bond Hemming	Technical Writing
Alison Squier	Ziji Creative Resources Inc.	Writing/editing, Compliance

CHAPTER 2.
EXISTING ENVIRONMENT

Photo from U.S. Digital Map Library

Chapter 2. Existing Environment

2.1 Description of the Subbasins

The Wenatchee and Methow subbasins are part of the Columbia Cascade Ecological Province, which extends over an area of 14,333 square miles. The province, in north central Washington, encompasses the Columbia River from Wanapum Dam to the limit of anadromous fish passage at Chief Joseph Dam. Tributary subbasins are, for the most part, high-gradient streams that begin in the North Cascade Mountains and drain directly to the Columbia River. The province also includes a few smaller streams that drain smaller watersheds adjacent to the Columbia as well as a number of gulches that arise from the channeled scablands to the east (NPCC 2004a). Besides the Wenatchee and Methow subbasins, the province includes the Entiat, Lake Chelan, Okanogan, and Upper Middle Mainstem Columbia River subbasins (Figure 2-1).

Construction of Grand Coulee Dam in 1934 blocked over 1,000 miles of habitat upstream of the Columbia Cascade Province in the upper Columbia River basin. Another 52 miles of habitat was blocked in 1961 by the completion of the Chief Joseph Dam. Within the Columbia Cascade Province, the Columbia River has three major dams: Wells, Rocky Reach, and Rock Island. Six hydroelectric projects are downstream of the province: Wanapum Dam and Priest Rapids Dam, and four federally owned projects—McNary Dam, John Day Dam, The Dalles Dam and Bonneville Dam (NPCC 2004a). (See Figure 2-1.)

To offset the loss of anadromous salmonid production by the federally built projects, the federal government built and continues to operate the Leavenworth NFH in the Wenatchee subbasin, and the Entiat and Winthrop NFHs (ENFH, WNFH) in the Entiat and Methow subbasins. No federal mitigation facility was constructed in the Okanogan subbasin (NPCC 2004a).

With the construction of each of the non-federal mid-Columbia hydroelectric projects, additional production/hatchery facilities were developed in the Columbia Cascade Province. The Habitat Conservation Plan (HCP), initiated by Chelan and Douglas PUDs for ESA Section 10 consultation, identified the mitigation obligation of the PUDs (see Sections 1.5.8 and 1.5.9). The HCP also provides the groundwork for future changes in facility production goals and operations. Details of changes in hatchery production will be resolved over the next several years (NPCC 2004a).

In spite of past mitigation efforts, declining salmonid populations in the Columbia Cascade Province have resulted in ESA listings of spring Chinook (Endangered, March 1999) and summer steelhead (Endangered, August 1997). Upper Columbia late-run Chinook and Lake Wenatchee sockeye were also petitioned (March 1998) but were determined not warranted for listing. Recent years have shown improved salmonid runs to the province, consistent with findings throughout the Columbia basin (NPCC 2004a).

Native people traditionally lived, hunted, gathered and fished within the Columbia Cascade Province. The province includes land ceded by the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) under the Treaty of 1855 to the United States. Members of the Yakama Nation and the Confederated Tribes of the Colville Reservation continue to exercise their hunting, gathering, and fishing rights within the province (NPCC 2004a).

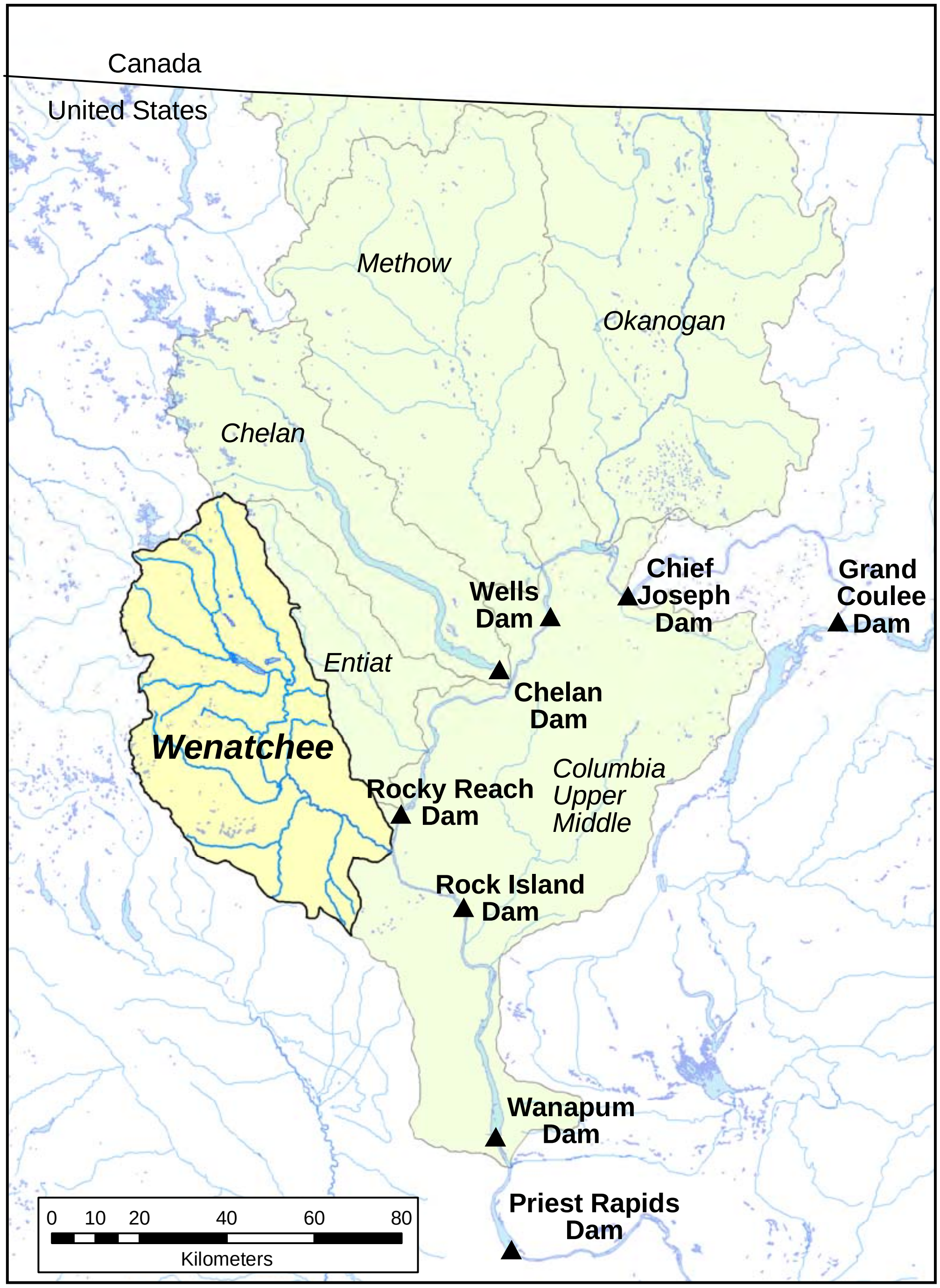

Figure 2-1. Wenatchee Subbasin in Relation to Upper Columbia River Dams and Subbasins

2.1.1 Wenatchee Subbasin

The Wenatchee subbasin lies entirely within Chelan County (Figure 2-1). The subbasin comprises 9.3% of the Columbia Cascade Province and consists of approximately 854,000 acres (1,300 square miles). Approximately 81% of the subbasin is in federal (primarily US Forest Service [USFS]) and state ownership. The remaining 19% of the land is privately owned (NPCC 2004a).

The watershed originates in the Cascade Mountains, and includes the Alpine Lakes and Glacier Peak wilderness areas. The Wenatchee River enters the Columbia River at river mile (RM) 470. Five major tributaries—the Chiwawa, White, and Little Wenatchee rivers, and Nason and Icicle creeks—are the source of over 94% of the surface waters within the subbasin even though their drainage area represents only 58% of the total subbasin area (CCCD 1998 *in* NPCC 2004a).

Four major irrigation districts in the Wenatchee subbasin and two smaller irrigation groups have about 68% of the total issued water rights; other users are domestic (10%), commercial and industrial (8%), municipal (6%), fish hatcheries (3%) and all others (4%). Combined, these users have 420 cfs in water rights permits and certificates (357 cfs surface water, 63 cfs ground water). The largest user is the Wenatchee Reclamation District, which serves over 9,000 users by diverting up to 200 cfs at Dryden Dam (NPCC 2004a).

Among subbasins in the upper Columbia region, the Wenatchee supports the greatest diversity of populations and overall abundance of salmonids. There are core populations of sockeye salmon, steelhead, bull trout and both spring and later-run Chinook salmon in the upper Wenatchee subbasin that are relatively strong when compared to other populations in the Columbia basin (NPCC 2004a).

2.1.2 Methow Subbasin

The Methow subbasin lies entirely within Okanogan County (Figure 2-2). The subbasin comprises 12.7% of the Columbia Cascade Province and consists of 1,167,764 acres (1,825 square miles) (NPCC 2004b).

The Methow River's confluence with the Columbia is at river mile 524 near Pateros, Washington. The Methow subbasin is characterized by large tracts of relatively pristine habitat contrasted with a growing human population. Less than 2% of the subbasin's land is irrigated. Six fish species and fourteen wildlife species are listed as Endangered, Threatened, or as Species of Concern (NPCC 2004b).

Logging, mining, orchards, farming, and grazing have played a substantial role in the Methow Valley for nearly a hundred years. Timber operations in the Methow watershed played an important role in the subbasin's economy through the 1800s. Activities related to timber harvest take place in the middle and upper reaches of the watershed (NPCC 2004b).

Unlined irrigation agricultural canals were introduced to the Methow subbasin in the 1800s as ranchers and farmers discovered that an irrigation system was required to supply consistent water for crops and livestock. The height of farming and ranching occurred in the Methow subbasin between 1940 and 1968 when 20,240 acres of land were irrigated from unlined surface diversions. Today, about 17,000 acres are under irrigation, and many of the subbasin farmers raise fresh fruit and vegetables (Methow Basin Watershed Plan, March 2004).

Farming and grazing are confined primarily to the lower and mid reaches of the subbasin. Fruit orchards and small farms growing alfalfa and other irrigated crops constitute the majority of the subbasin's agricultural activities (NPCC 2004b).

Recreation, tourism, and related development play an increasing role in the area's economy. The Methow Valley offers an extensive range of tourism- and recreational-related opportunities (NPCC 2004b).

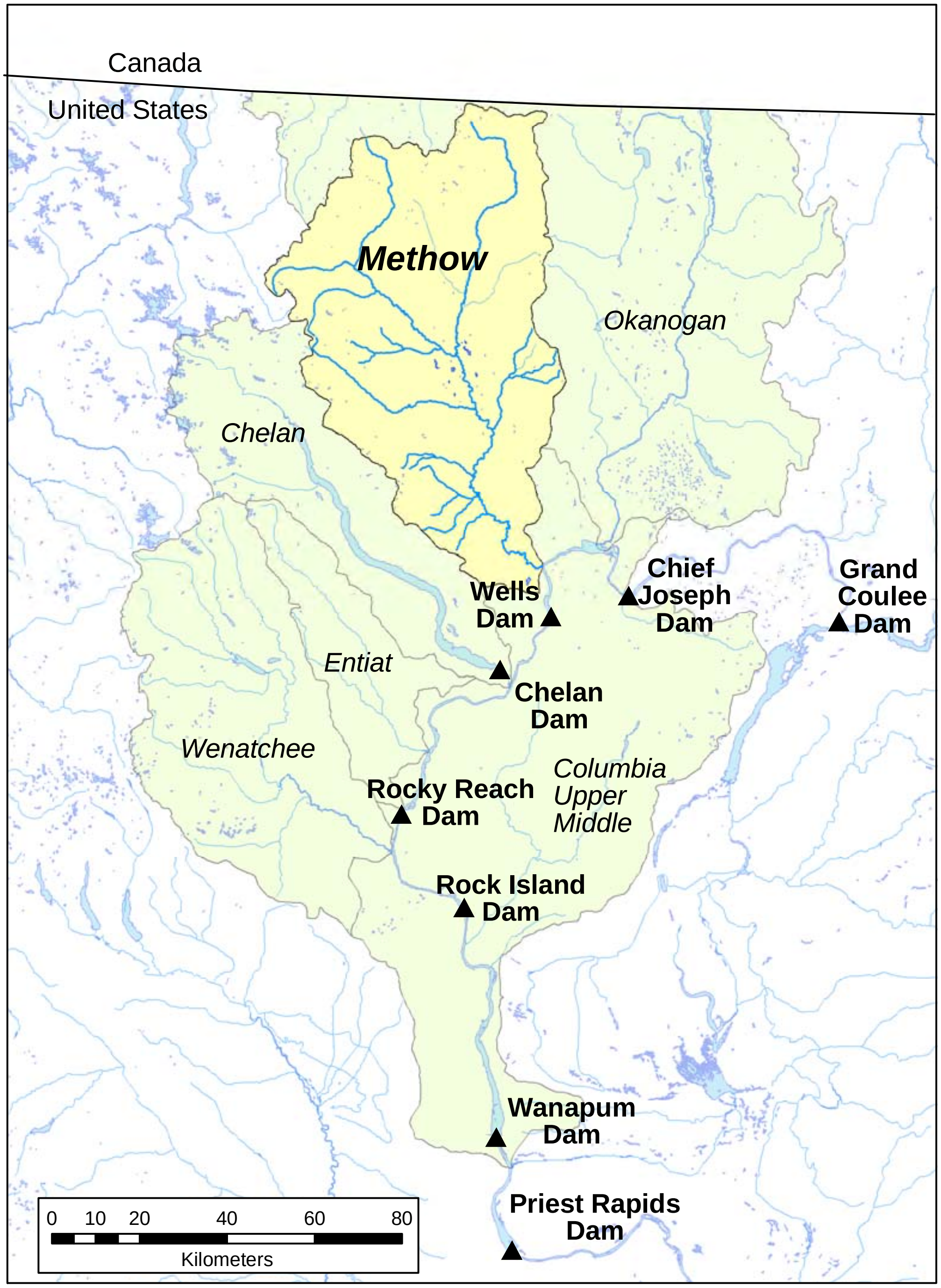

Figure 2-2. Methow Subbasin in Relation to Upper Columbia River Dams and Subbasins

2.2 Status of Coho (*Oncorhynchus kisutch*) in the Subbasins

Chapman (1986) estimated that the peak run of coho entering the Columbia River in the 1880s was about 560,000 fish (NPCC 2004b). Mullan (1984) pointed out that most coho spawned in the lower Columbia River tributaries. Mullan (1984) estimated the historical coho run size at 6,000 – 7,000 adults to the Wenatchee basin and 23,000 – 31,000 to the Methow basin. Coho salmon were once considered extirpated in the mid-Columbia region. Recent reintroduction efforts have resulted in natural reproduction occurring in some parts of the basins.

Population Characterization

Distribution

Historic. Coho salmon were once considered extirpated in the upper Columbia River (Fish and Hanavan 1948; Mullan 1984). Mullan (1984) estimated that upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat. There are conflicting reports of whether the Okanogan subbasin historically produced coho (Craig and Suomela 1941; Vedan 2002).

Information regarding the historic distribution of coho salmon within the Wenatchee River basin is limited. Based on affidavits from long-time residents, Nason Creek was likely an important spawning area, and nearly all the smaller creeks had a run of coho salmon (Mullan 1984). The fall run of salmon in the Wenatchee River basin continued until about 1914-1915, after which it rapidly declined (Mullan 1984).

Washington Water Power blocked the Methow River at Pateros between 1915 and 1929, preventing all fish passage during those years; by the time the project was removed, the Methow River run of coho was extinct. By the 1930s, the coho run into the mid- upper Columbia was virtually extirpated. Tributary dams on the Wenatchee, Entiat, and Methow rivers appeared to be more destructive to coho than either steelhead or Chinook (NPCC 2004b, p. 623).

Because the indigenous stock of coho salmon were extirpated in the upper Columbia River system, the Wenatchee and Methow subbasin coho are not addressed under the ESA or by WDFW's 1994 Washington State Salmonid Stock Inventory (SASSI) (Peven 2003).

Current. Coho salmon rear in their natal tributaries. A portion of juvenile coho migrate downstream during the fall, presumably seeking over-winter habitat (Sandercock 1991). Some juvenile coho may also migrate upstream to overwinter in small tributaries (Tripp and McCart 1983).

Since the YN's program of coho reintroduction feasibility studies began, coho have been found to spawn throughout the Wenatchee River; in Nason, Beaver, Icicle, Peshastin, Chumstick and Mission creeks; and in the lower quarter mile of the Chiwawa River. In 2004, coho also returned to the Little Wenatchee River to spawn. Coho salmon returning to the Methow basin are spawning in the mainstem Methow, Chewuch and Twisp rivers and in small tributaries such as Gold, Libby, and Beaver creeks.

Abundance

Historic. Historically 120,000-166,500 coho were attributed to the mid-and upper Columbia tributaries (Yakima, Wenatchee, Entiat, Methow, and Spokane Rivers) (Mullan 1984). Mullan (1984) estimated that the Wenatchee River supported adult returns of approximately 6,000 – 7,000 coho and the Methow River supported 23,000 – 31,000.

There were two previous attempts in the twentieth century to rebuild coho populations, although these two programs were not designed or intended to rebuild sustainable upriver runs—they were for harvest augmentation. Fish were not released in the natural production habitat areas in the watershed. Between the early 1940s and the mid-1970s, the USFWS raised and released coho as part of their mitigation responsibilities for the construction of Grand Coulee Dam (Mullan 1984). Chelan PUD also had a coho hatchery program until the early 1990s. While some natural production may have occurred from these releases, the programs overall were not designed to reestablish naturally spawning populations. All coho releases under the CCPUD program (1971-1993) were made from the Turtle Rock Fish Hatchery, located in the middle of the Columbia River above Rocky Reach Dam. The release location likely contributed to the inability to produce a naturally spawning coho run. This reach of the Columbia River does not provide suitable coho spawning and rearing habitat.

Current. The Yakama Nation, as the lead agency, began a feasibility study in 1996 to evaluate coho reintroduction in mid-Columbia tributaries. Since the reintroduction of coho to the Wenatchee River in 1999, the abundance of adult returns has ranged between an estimated 350 to 5,031 (C. Kamphaus, YN, personal communication, Feb. 28, 2011). A proportion of these fish are taken into the hatchery for broodstock development; the remainder have spawned naturally. The first generation of naturally produced coho smolts emigrated from the Wenatchee River basin in 2002 with an estimated population size of 17,000 (Murdoch et al. 2004). Detailed data on natural coho production in the Wenatchee basin is presented in Chapter 3, Section 3.3.3.

Spawning ground surveys are used to enumerate the numbers and distribution of naturally spawning coho in the Methow subbasin. Since 1999, adult returns to the Methow River have ranged from 140 to 1,601 (C. Kamphaus, YN, personal communication, Feb. 28, 2011). Similar to the Wenatchee, a proportion of the coho returning to the Methow River are either trapped for broodstock at Wells Dam or volunteer into Winthrop NFH, ultimately contributing to the next Mid-Columbia River (MCR) brood. See Chapter 3, Section 3.3.3 for data on natural production in the Methow basin.

Habitat Productivity

Historic. Historic production of coho salmon is difficult to determine, although the Methow River most likely produced more coho than Chinook or steelhead (Craig and Suomela 1941 *in* NPCC 2004b). Historically, coho production was most likely not as high as sockeye or late-run Chinook in the Wenatchee (NPCC 2004a). Mullan (1984) estimated the historical coho run size to be 6,000 – 7,000 in the Wenatchee River and 23,000 – 31,000 in the Methow River. .

Current. Current productivity is affected by loss or degradation of habitat in spawning and rearing areas, downstream mortality through the mainstem Columbia River, ocean conditions, harvest, and other abiotic factors (drought, etc.).

As described in the Wenatchee Subbasin Plan (NPCC 2004a), habitats in need of restoration within the Wenatchee basin include Nason, Icicle, Peshastin, Chumstick, and Mission Creeks. These areas lack habitat diversity, may have some passage obstructions, or have poor water quality (NPCC 2004a). Other areas within the Wenatchee subbasin proposed for coho reintroduction have good aquatic habitat and should be protected. The aquatic habitat in the Chiwawa River is in good condition with minimal development (NPCC 2004a). Development is confined to the lower reach of the Chiwawa River. The White and Little Wenatchee rivers are among the healthiest watersheds in the Columbia Basin (NPCC 2004a).

In the Methow subbasin, habitat losses and associated loss of productivity have chiefly resulted from artificial and natural fish passage barriers, alteration and reduction of riparian habitat, loss of habitat connectivity, in-stream and floodplain habitat degradation, low flows and dewatering, and extreme water temperatures (NPCC 2004b). By improving habitat in known areas in need of restoration in both subbasins, it is reasonable to assume that production of coho would increase.

2017 Update: *A report on projects completed annually in Upper Columbia subbasins can be found on the UCSRB web site. A habitat report that summarizes all work done between 1999 and 2014 as well as productivity can be found at: http://www.ucsrb.org/Assets/Documents/Library/Reports/20150112%20-IntegratedRecoveryReport_Habitat_FINAL%20DRAFT.pdf. Annual implementation reports which are simpler and list projects completed that year can be found at http://www.ucsrb.org/Assets/Documents/Library/Reports/Tab%203%2020140919_Implementation%20Report_FINAL.pdf.*

Diversity

Because hatchery stocks were used to reintroduce coho salmon (and to develop a local broodstock), spatial and life history diversity within the basin is likely lower than the historic populations of coho salmon. For restoration programs, where the population will be perpetuated from the original founders, collecting a minimum of 50 individuals for broodstock is commonly recommended in the conservation literature to prevent detrimental effects of inbreeding depression. As increased natural production occurs, incorporating naturally produced coho into the broodstock will maintain the effective population size and will encourage genetic diversity (Miller and Kapuscinski 2003). More habitat would most likely increase spatial and life history diversity for coho salmon in mid-Columbia tributaries.

Historical pictures of the native Methow coho indicate the fish were equal in size to the spring Chinook (Mullan et al. 1992b).

Key Life History Strategies: Relationship to Habitat

Time of entry and spawning

Coho salmon enter the Wenatchee and Methow subbasins in early September through late November. Adults ascend the tributaries in the fall and spawn between mid-October and late December, although there is historical evidence of an earlier run of coho salmon (Mullan 1984).

Pre-spawning

Coho entering in September and October hold in larger pools prior to spawning; fish entering later may migrate quickly upstream to suitable spawning locations. The availability and number of deep pools and cover is important to offset potential pre-spawning mortality. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Clean gravel at the appropriate size and proper water depth and velocity are needed for redd building. Burner (1951) reported the range of depths for coho spawning to be between 8 and 51 cm. Coho spawn in velocities ranging from 0.30 to 0.75 m/s and may seek sites with groundwater seepage (Sandercock 1991).

Incubation and emergence

The length of time required for eggs to incubate in the gravel largely depends on temperature. Sandercock (1991) reported that the total heat requirement for coho incubation in the gravel (spawning to emergence) was 1,036 degree days over zero degrees C (±138 days). The percentage of eggs and alevins that survive to emergence depends on stream and streambed conditions. Fall and winter flooding, low flows, freezing of gravel, and heavy silt loads can significantly reduce survival. In both the Methow and Wenatchee basins, fall flooding is frequent. This may negatively affect incubation and emergence success, especially in years of extreme flow. Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the basins, and the conditions have improved in most watersheds. Coho fry emerge from the gravel in April or May, but can emerge as early as March in some tributaries (K. Murdoch, C. Kamphaus, personal communication).

Fry

Juvenile coho salmon generally distribute themselves downstream shortly after emergence and seek out suitable low-gradient tributary and off-channel habitats. They congregate in quiet backwaters, side channels, and shady small creeks with overhanging vegetation (Sandercock 1991).

Parr

Coho salmon prefer slower velocity rearing areas than Chinook salmon or steelhead (Lister and Genoe 1970; Allee 1981; Taylor 1991a). Recent work completed by the Yakama Nation supports these findings (Murdoch et al. 2004). Juvenile coho tend to overwinter in riverine ponds and other off-channel habitats. Over-winter survival is strongly correlated to the quantity of woody debris and habitat complexity (Quinn and Peterson 1996). Conservation and restoration of high functioning habitat in natal tributaries and restoration of riparian and geofluvial processes in or near known and potential parr rearing areas will have the highest likelihood of increasing parr survival.

Smolt

Naturally produced coho smolts in the Wenatchee and Methow subbasins emigrate between March and May (Murdoch et al. 2004).

2.3 Status of Other Anadromous and Resident Fish in the Subbasins

2.3.1 Steelhead

Background

Upper Columbia River tributaries were once productive wild summer steelhead systems, but the populations have declined significantly since the early 1900s. The intensive commercial fisheries in the late 1800s and industrial development of the Columbia River were largely responsible for the decline of the wild steelhead run (Mullan et al. 1992; Chapman et al. 1994b). Unlike Chinook and sockeye salmon catches, steelhead harvest remained fairly constant from the early 1900s through 1940 at about 300,000 fish. Between 1938 and 1942, lower river commercial fisheries, including tribal fisheries within Zone 6, took about 70% of the run. Curtailing the commercial fisheries resulted in a resurgence of wild steelhead productivity in the upper Columbia River region, where the run size tripled (5,000 fish to 15,000 fish) between 1941 and 1954 (Mullan et al. 1992). Sale of steelhead by non-Indians was prohibited beginning in 1975. Subsequent to the dramatic increase, escapement has fluctuated widely. When the wild productivity declined again with completion of the Columbia River hydropower system, hatchery steelhead had replaced natural production in the run counts, masking the gravity of the change in wild fish production. Wild fish were subjected to, and suffered as a result of, mixed stock fisheries in the lower Columbia River directed at their abundant hatchery cohort. And, while the hatchery steelhead could sustain the relatively high harvest rates, their wild counterparts could not.

Hatchery fish made up an increasing fraction of the steelhead run after the 1960s, as wild runs were already depleted (Chapman et al. 1994b). Spawner-recruit analysis by Mullan et al. (1992) calculated the maximum sustainable yield (MSY) run size and escapement for steelhead at Rock Island Dam to be 16,000 – 19,000 and 4,000 – 7,000, respectively. When hatchery produced steelhead are combined with the naturally produced steelhead, no long-term declining trend is evident. However, naturally produced steelhead currently exist only at threshold levels.

ESA listing status

Upper Columbia River summer steelhead were listed as Endangered in August 1997 because the naturally spawning population was not replacing itself. Hatchery fish in the region, derived from local populations, were included in the listing because they are necessary to achieve recovery.

Current management strategy

Artificial production programs using locally adapted summer steelhead were fully implemented by the late 1960s. External marking of all hatchery steelhead was implemented in 1987, allowing non-tribal fisheries to increase harvest rates on the component of the run that could sustain it, while providing more protection to the beleaguered wild component. Current artificial production programs focus releases into the Wenatchee, Methow and Okanogan systems, although the Entiat River received a portion of the hatchery steelhead up through 1998. Since the success of supplementation through artificial propagation remains equivocal, NMFS requested at least one stream in the region be treated as a reference stream, essentially eliminating all hatchery released steelhead. The Entiat River was chosen as the reference stream for the region because of the relatively small number of steelhead released annually (<50,000 fish), the limited public access in comparison to the other rivers, and the greater potential to account for changes in productivity based upon a more refined natural production area in the other systems.

Wild steelhead returning to the upper Columbia River region sustain themselves only at threshold population size today. The high hatchery return rate, genetic homogeneity of hatchery and wild steelhead (Chapman et al. 1994b), and maintenance of near MSY levels in most years suggest a truly wild fish does not exist. Rather, natural production sustains them, and without hatchery supplementation, the steelhead would suffer dire consequences.

All the artificial production programs operating in the region are intended to contribute to recovery of the naturally produced component as well as provide selective harvest opportunities.

Sport harvest is used as a management tool to remove hatchery-origin steelhead in excess of full habitat seeding levels in order to increase the proportion for natural-origin steelhead in the spawning population.

Escapement objectives

The run size needed at Priest Rapids Dam to meet minimum escapement objectives for the tributary streams of the region totals 9,550 adults. The 9,550 fish run size is intended to provide a minimum of 2,500 natural spawners in the Wenatchee River, 2,500 natural spawners for the Methow River, and 600 natural spawners for the Okanogan River. Although the total run size is managed as a composite of hatchery and wild fish, because conservation and recovery of the Evolutionarily Significant Unit (ESU) is critical, embedded within the total run size is the requirement to achieve at least 1,300 wild (naturally produced) summer steelhead.

When the natural-origin UCR steelhead run is predicted to exceed 1,300 fish at Priest Rapids Dam and the total UCR steelhead run is predicted to exceed 9,550 steelhead, then a harvest fishery may be considered as an option to remove excess adipose-fin-clipped hatchery-reared steelhead.

2.3.2 Spring Chinook

Background

The numbers of spring Chinook that entered the Columbia River in the years immediately following the construction of Bonneville Dam (1938) averaged less than 102,000 (Chapman et al. 1995a). Numbers of spring Chinook passing Rock Island Dam in the late 1930s and 1940s were likely depressed from years of over fishing. Runs increased in the 1950s, partly in response to reduced harvest rates. However, reduced harvest rates occurred concomitant with the hydropower development era, essentially reducing production of spring Chinook from the upper Columbia. Spring Chinook counting at Rock Island Dam (1933) began in 1935, and the numbers for the period 1935 – 1938 were less than 3,000 fish per year. Adult counts of spring Chinook passing dams upstream of Priest Rapids Dam fluctuated extensively in the years following, but reached a peak of about 27,000 fish in the mid-1980s, a period of high ocean productivity. Escapements dropped precipitously in the six years following the peak, rose again in 1992 and 1993, but dropped to less than a few hundred in 1995 when ocean productivity dropped.

PUD-funded programs began comprehensive operation in the late 1980s and early 1990s. The focus of these programs was to increase the number of adult spring Chinook spawning naturally by using locally adapted spring Chinook, i.e., supplementation.

ESA listing status

Spring Chinook from the upper Columbia River region was listed as Endangered under the ESA in March 1999. Three populations of spring Chinook are recognized within the ESA listing; Methow, Entiat and Wenatchee. All three have established recovery levels, and collectively will need to meet or exceed these levels for the ESU to achieve recovery. In addition to the ESA listing of the natural-origin spring Chinook, hatchery-origin spring Chinook derived from local populations were included within the listing since they were deemed necessary to achieve recovery. Carson NFH-origin spring Chinook continue to be reared at the Leavenworth NFH. These fish are not included in the listing, and are therefore not subject to ESA management constraints.

Current management strategy

The WDFW operates several hatcheries and/or their satellite facilities above Priest Rapids Dam to produce spring Chinook smolts for release into the Chiwawa, Chewuch, Methow and Twisp rivers. Commensurate with hydropower dam relicense requirements through the Federal Energy Regulatory Commission (FERC), the Wenatchee basin spring Chinook smolt release number total is expected to increase, as well as expand to other tributaries, namely Nason Creek and the White River.

Current programs, as well as anticipated programs, reflect the origin of adults used for brood fish to produce the subsequent progeny. A supplementation strategy, using wild fish in the broodstock, is used with the goal of increasing the number of adults successful at spawning naturally.

Escapement objective

Recovery criteria for spring Chinook natural spawning escapement in the principle tributaries of the upper Columbia River region include a minimum 12-year geometric mean number of naturally produced spawners: 2000 for the Wenatchee, 500 for the Entiat, and 2,000 for the Methow.

2.3.3 Upper Columbia Sockeye

Background

Sockeye in the Columbia River upstream from the confluence of the Snake River historically inhabited the lakes of the Yakima basin, Lake Wenatchee, lakes upstream and including Lake Osoyoos in the Okanogan basin, and the Arrow Lakes in British Columbia (upstream of Hugh Keenleyside Dam on the Columbia River near Castlegar, B.C.). Construction of impassable dams, removal of water for irrigation, hydropower operations, and overfishing significantly altered the historic distribution of sockeye upstream of the Snake River, such that Lake Wenatchee and Lake Osoyoos retain the only current populations.

Since 1938, the percentage of sockeye destined for waters upstream of Rock Island Dam has been reported to vary from less than 1% (1941) to greater than 95% (1979) of the total that entered the Columbia River (Chapman et al. 1995b). Although in some years the escapement has been significantly altered by harvest in the lower Columbia River, i.e., in the mid-1980s, the percentage as a total of the run to the mouth of the Columbia River has grown steadily to generally exceed 90%. The percentage of adults returning to Lake Wenatchee and Lake Osoyoos has varied considerably from the total at Rock Island Dam. Historically, the Lake Wenatchee population outnumbered the Lake Osoyoos population. However, since the early 1960s and with the exception of 2002, the percentage of sockeye destined for Lake Osoyoos has been greater than the percentage destined for Lake Wenatchee. More recent counts have shown the Lake Osoyoos population to generally represent 60 – 75% of the count at Rock Island Dam. However, the percentage of adults observed on the spawning grounds has not comported well with the number of fish counted at different dams. Spawning ground surveys in both basins have often been able to account for only 50 – 70% of the dam counts. A variety of reasons could contribute to this disparity, including: 1) inflated dam counts due to a high rate of fallback, 2) inefficiencies of the spawning ground surveys as they relate to the ability to accurately account for total escapement, and 3) high pre-spawning mortality (conceivably a factor for the Lake Osoyoos population).

Historical artificial production programs were supported by the USFWS, but sockeye were not a dominant species cultured; by the 1960s, no artificial production of sockeye was occurring within the region. In 1990, the WDFW began operation of a small artificial production program

(200,000 smolts) for sockeye from Lake Wenatchee as part of the Rock Island Settlement Agreement and now the new Mid-Columbia River Habitat Conservation Plan (HCP).

ESA listing status

Upper Columbia River sockeye are not currently listed under the federal ESA. The stock status for the Wenatchee population was rated as depressed by WDFW in 2002 because of short-term severe declines escapements in 1998 and 1999. The spawning escapement goal for this stock is 23,000 fish. Despite a significant improvement in the 2000 and 2001 returns, the stock was at less than half the goal from 1994 to 1999.

Management strategy and escapement objectives

The natural and hatchery populations of sockeye originating from the Wenatchee and Okanogan basins are managed for natural spawning escapement goals of 23,000 fish over Tumwater Dam in the Wenatchee basin.

Recreational fisheries will be implemented when the run size exceeds (or is expected to exceed) 25,000 sockeye at Tumwater Dam. The Lake Wenatchee population is the only one that has an artificial production program associated with it. The current artificial production program of 200,000 smolts annually is supported by CCPUD as part of the Mid-Columbia River HCP (formerly part of the Rock Island Settlement Agreement). This program is slated to change, and likely increase, consistent with the recently signed Mid-Columbia River HCP, which replaces the Rock Island Settlement Agreement.

2.3.4 Upper Columbia Summer/Fall Chinook

Summer/fall Chinook are not considered NTTOC in the context of coho restoration. The Upper Columbia River summer Chinook aggregate population is healthy and not ESA listed. The population(s) was proposed for listing in the early 1990s, but a final determination by NMFS concluded a listing was not warranted. Total spawner abundance has continued to increase from the low levels experienced in the early 1990s to the currently strong returns.

2.3.5 Bull Trout

Background

Bull trout (*Salvelinus confluentus*) are members of the char subgroup of the family Salmonidae. Bull trout range throughout the Columbia River and Snake River basins, extending east to headwater streams in Montana and Idaho, into Canada and in the Klamath River basin of south-central Oregon. Distribution of the population is scattered and patchy (USFWS 2005). Bull trout exhibit a number of life-history strategies. Stream resident bull trout complete their entire life cycle in the tributary streams where they spawn and rear. Most bull trout are migratory, spawning in tributary streams where juvenile fish typically rear for one to four years prior to migrating to either a larger river (fluvial) or lake (adfluvial), where they spend their adult life, returning to the tributary stream to spawn (Fraley and Shepard 1989).

For the purposes of recovery, the Upper Columbia Recovery Unit Team has identified three core areas, including the Wenatchee, Entiat, and Methow rivers. Within each core area many local populations may exist.

Within the Wenatchee Core Area, bull trout are dispersed throughout the basin, with the strongest populations centered around Lake Wenatchee and the Chiwawa River (WDFW 1998).

The Draft Recovery Plan (Chapter 22 - Upper Columbia Recovery Unit) identifies 6 migratory local populations within the Wenatchee River; these local populations include the Chiwawa River (including tributaries), White River, Little Wenatchee River (below the falls), Nason Creek (including Mill Creek), Chiwaukum Creek, and Peshastin Creek (including Ingalls Creek). Resident, fluvial, and adfluvial bull trout currently exist in the Wenatchee River Core Area (WDFW 1998). Resident bull trout occur in Icicle Creek above the barrier falls, and migratory bull trout are known to frequent the area below the falls. The Chiwawa River local population complex is the stronghold for bull trout in the upper Wenatchee (WDFW 1998). Adult bull trout 46 to 61 centimeters in length have been found throughout the river. Whether these migratory fish are fluvial (from the mainstem Chiwawa River, Wenatchee River, or Columbia River), adfluvial fish from Lake Wenatchee, or a combination is not known.

Within the Methow Core Area, bull trout are known to occur in Gold Creek, Twisp River, Chewuch River, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, and Goat Creek. The WDFW classifies the status of bull trout in the Lost River as “healthy,” but the remaining bull trout in the Methow River are classified as “unknown” (WDFW 1998). Adfluvial, fluvial and resident life history forms are present in the Methow River. The largest populations of migratory bull trout are in the Twisp River, Wolf Creek, West Fork Methow River, and Lost River. The overall status and distribution of resident bull trout in the Methow River are unknown (Draft Bull Trout Recovery Plan).

Overall, bull trout in the Wenatchee, Entiat, and Methow core areas persist at low abundance, with the population in the Chiwawa River considered among the strongest (NPCC 2004a). Since 1999, estimates of spawning adults in the Chiwawa River have ranged between 246 and 462 (from the Draft Bull Trout Recovery Plan). Results from the 2001 redd surveys in the Wenatchee Core Area indicate that the annual spawning population is probably less than 1,000 individuals and should be considered at risk of genetic drift. Seven of the local populations in the Methow Core Area are mostly under 100 adults annually and are at risk of inbreeding depression. Based on available information, adult spawning abundance in the Methow Core Area is probably less than 1,000 adults.

Reasons for decline of bull trout include historic and current land use activities. Some of the activities in core areas, especially water diversions, hydro power development, forestry and agriculture, may have significantly reduced important fluvial populations (Draft Recovery Plan).

Declines in salmon species (including the extirpation of coho salmon) have decreased the forage base for bull trout. In addition to decreasing prey availability, the decline of salmon and steelhead reduced a historic energy source coming into the basin through the dying and recycling of nutrients from adult carcasses, eggs, and juveniles.

ESA listing status

The USFWS issued a final rule listing the Columbia River and Klamath River populations of bull trout as a threatened species under the ESA on June 10, 1998 (63 FR 31647). The Upper Columbia Recovery Unit encompasses the geographic area from the Yakima River upstream to Chief Joseph Dam. The recovery unit includes the Entiat, Wenatchee, Methow, Chelan, and Okanogan basins, and the mainstem Columbia River.

The Wenatchee, Entiat, and Methow Rivers have been identified as core bull trout habitats for the Upper Columbia Recovery Unit, and were designated as Critical Habitat October 18, 2010 (75 FR 63898).

Current management strategy

The goal of the bull trout recovery plan is to ensure the long-term persistence of self-sustaining, complex, interacting populations of bull trout distributed across the native range of the species so that they can be de-listed. To achieve this goal, the following objectives have been identified for bull trout in the Upper Columbia Recovery Unit (from the Draft Recovery Plan): 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas within the Upper Columbia Recovery Unit, 2) maintain increasing trends in abundance of bull trout, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

Recovered abundance levels in the Upper Columbia Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information and professional judgment of the recovery team.

Recovery criteria for bull trout in the upper Columbia Recovery Unit are as follows:

1) Distribution criteria will be met when bull trout are distributed among at least 16 local populations in the Upper Columbia Recovery Unit.
2) Abundance criteria will be met when the estimated abundance of adult bull trout among all local populations in the Upper Columbia Recovery Unit is between 6,322 to 10,426 fish.
3) Trend criteria will be met when adult bull trout exhibit a stable or increasing trend for at least two generations at or above the recovered abundance levels within the Wenatchee, Entiat and Methow core areas.
4) Connectivity criteria will be met when specific barriers to bull trout migration in the Upper Columbia Recovery Unit have been addressed.

2.4 Status of Habitat

Habitat in these basins has been evaluated and described using several methods. Section 2.4.1 summarizes habitat descriptions from the Wenatchee and Methow subbasin plans. Using these descriptions, Section 2.4.2 evaluates habitat using the NPCC habitat condition criteria (NPCC 2000). Section 2.4.3 presents the EDT analysis of the Wenatchee and Methow subbasins.

2017 Update: *In the Wenatchee basin, the lower section of the Wenatchee River below the city of Leavenworth, Chumstick Creek, portions of Icicle Creek, Mission Creek, and Brender Creek are on the State of Washington's 303(d) list of impaired water bodies for several parameters, including dissolved oxygen (DO), acidity/alkalinity (pH), and temperature. Subsequent to the evaluations reported below, Washington's Department of Ecology established load allocations for total phosphorus originating from sources that affect the water quality of the lower Wenatchee River and its tributaries, including Mission, Brender, and Chumstick creeks (Carroll et al. 2006, Carroll and Anderson 2009). The WDOE TMDL (Total Maximum Daily Load) for phosphorus in these areas has affected the siting of the proposed hatchery and certain acclimation facilities originally proposed in the Master Plan.*

2.4.1 Habitat Descriptions from Subbasin Plans

Subbasin plans for the Wenatchee and Methow basins were prepared for the Council in 2004. Many of the habitat conditions described have changed since then.

2.4.1.1 Wenatchee Subbasin Habitat Description

The Wenatchee subbasin contains some of the most pristine habitat in the Columbia River Basin (NPCC 2004), while also experiencing considerable habitat degradation in some drainages. The subbasin is very diverse in elevation and environmental conditions. Quality Habitat Assessment (QHA) was used during the subbasin planning process to provide a structured qualitative approach to analyzing the relationship between the focal species and habitat conditions. For the assessment, the Wenatchee subbasin was divided into 11 Assessment Units that included the lower (mouth to Tumwater Canyon) and middle Wenatchee River (Tumwater Canyon to Lake Wenatchee) and tributaries: Mission Creek, Peshastin Creek, Chumstick Creek, Icicle Creek, Nason Creek, Chiwawa River, White River, Little Wenatchee River, and Lake Wenatchee. The status of the habitat described below was summarized from the Wenatchee Subbasin Plan (NPCC 2004a).

Lower Wenatchee River

The lower portion of the Wenatchee River begins at RM 25.6 (below Tumwater Canyon) and flows southeasterly from the town of Leavenworth to the Columbia River. Settlement along the Wenatchee River began in 1890 with the construction of the Great Northern Railroad along the Wenatchee River. This was followed by floodplain development, irrigation diversion structures, and bank armoring. Over a century of development has reduced in-stream large woody debris (LWD) and LWD recruitment, and reduced side-channel/wetland habitat as well as the opportunity for development of side-channel/wetland habitat. To varying degrees the altered riparian and channel conditions have also reduced pool frequency, increased bank erosion, possibly increased channel entrenchment, and altered stream flows. Stream diversions and well withdrawals from shallow aquifers in the floodplain probably have the greatest influence on low stream flows. Channel confinement, channelization, and riparian and upland land use impacts probably have the greatest influence on peak flow timing and duration. Chumstick Creek,

Middle Wenatchee Assessment Unit

The middle Wenatchee assessment unit includes the mainstem Wenatchee River from Tumwater Canyon (RM 25.6) to Lake Wenatchee (RM 54). Within Tumwater Canyon, the river character has been modified over time by log drives and by construction of the railroad, dam, and highway. During railroad construction in the 1800s, the canyon bottom was narrowed and large boulders were removed, possibly resulting in channel degradation (Andonaegui 2001). Tumwater Dam at RM 31, built in the early 1900s, has altered channel bed grade and substrate content above and below the structure, creating Lake Jolanda. Log drives in the early 20th century removed LWD in the channel and blasted boulders from the channel to facilitate log drives. Within the Wenatchee River upstream of Tumwater Canyon, channel complexity and riparian condition has been altered over time from historic log drives and floodplain and streamside development. Results of these activities include reduced riparian and wetland connectivity, a loss of aquatic species connectivity through wetlands, reduced high flow refuge, reduced sinuosity and side-channel development, increased bank erosion, reduced single pieces and complexes of LWD, reduced pool frequency, and a reduction in channel roughness.

Anthropogenic factors affecting the upper Wenatchee subbasin include private home building and associated private land development; timber harvest on both private and federally owned lands; farming and associated land conversion; and the construction of state highways, county roads and logging roads.

Mission Creek

Mission Creek drains a 59,712-acre watershed located approximately 10 miles west of Wenatchee. Mission Creek flows 9.4 miles before emptying into the Wenatchee River (RM 10.4) at the town of Cashmere. Mission Creek is considered the most polluted water body in the Wenatchee River subbasin. Cumulative disruption of both stream channel and upland habitat throughout the watershed, except in the Devils Gulch reach of Mission Creek, has resulted in a declining population of salmonids since the mid-1880s (Rife 1999). Conditions that limit rearing habitat in the watershed include dewatering, low flows, and high in-stream temperatures (Andonaegui 2001). Diversion dams and culverts also create fish passage barriers that reduce access to spawning and rearing habitat. Floodplains have been separated from the stream channels and channels have been altered by forest roads and by urban, agricultural and residential development. Channelized streams have eliminated or reduced woody riparian vegetation to a narrow band of mostly shrubs with some mature trees. Water quality in Mission Creek is poor. Mission Creek is on the WDOE 1998 303(d) list for temperature, low dissolved oxygen, high fecal coliform and pesticide counts. Water quantity in Mission Creek is also poor; the watershed is on the 303(d) list for low in-stream flows.

Peshastin Creek

Peshastin Creek originates near Swauk Pass and flows north, entering the Wenatchee River downstream of the town of Peshastin at RM 20. Ingalls Creek is the largest tributary to Peshastin Creek. The loss of channel sinuosity, floodplain function, and riparian habitat (including off-channel habitat) within the channel migration zone of Peshastin Creek has had the greatest effect on salmon production. Channel confinement resulting from the improvement of State Route 97 has reduced spawning habitat for salmon and steelhead and has also reduced juvenile rearing habitat for all salmonid species, especially over-wintering habitat. Floodplain and riparian habitat function have been reduced by residential and agricultural development and by timber harvest, and mining, which have been active in various forms for over 100 years. Low LWD counts further reduce habitat quality. Peshastin Creek has been added to the current 303(d) list for exceeding temperature requirements and is considered “poor” by Forest Plan standards. Peshastin Creek is also included on the WDOE 1998 303(d) list for low in-stream flows.

Chumstick Creek

The Chumstick watershed is oriented in a north-south direction, with tributaries entering from the north and east. Chumstick Creek flows south into the Wenatchee River at RM 23.5, at the east end of the town of Leavenworth. Chumstick Creek once supported a population of summer steelhead, coho and possibly spring Chinook salmon. Land development and use on both public and private land have created poor habitat conditions for most stream attributes. Railroad logging began in Chumstick valley in 1910 when the Lamb-Davis Timber company finished laying 26 miles of track from Leavenworth to Plain. In later years the track was removed and used as the base for Highway 207. Many degraded habitat attributes can be linked to channel confinement resulting from road density and construction, loss of floodplain connectivity and alteration of disturbance regimens. Additionally, in-stream flows are very low, upstream access is blocked by multiple stream crossing and impoundments, water quality is degraded, and high-fine sediments may limit spawning success and food production by macro-invertebrate communities. The Chumstick Creek drainage has been identified as one of the more problematic watersheds in the Wenatchee subbasin relative to land-use impact and management issues. However, with replacement of several culverts with bridges, as of 2009, fish passage has been restored to the lower 6 miles of Chumstick Creek. Chumstick Creek is on the WDOE 303(d) list for dissolved oxygen, fecal coliform, pH, and low in-stream flow.

Icicle Creek

Icicle Creek originates high in the Cascade Mountains and is a 5th order stream. Icicle Creek drains 214 square miles in north central Washington. Icicle Creek flows east 31.8 RM before emptying into the Wenatchee River at RM 25.6 in the city of Leavenworth. From the USFS wilderness boundary to the headwaters, aquatic habitat closely resembles historic conditions. Floodplain connectivity and riparian habitat below the wilderness boundary have been altered by road construction, campground development, timber harvests and private development. Habitat alteration increases dramatically below RM 2.8, primarily from streamside development and channel confinement. Bank stabilization, flood control, and loss of riparian habitat limits the stream's ability to adjust to sediment, debris, and high flows. This loss of function exacerbates bank destabilization in a naturally mobile stream section, which in turn contributes additional sediment to the stream channel. Decreased in-channel complexity from the loss of LWD degrades channel conditions in the lower 2.8 miles (Andonaegui 2001).

Leavenworth NFH structures partially block anadromous migration beginning at RM 2.8. The hatchery's intake diversion dam is a fish passage barrier at low flows. The Icicle-Peshastin Irrigation District diversion dam at RM 5.7 may also hinder upstream fish passage at low flows (Mullan et al. 1992). Fish screens at the District and at the hatchery diversion do not meet current NMFS criteria and require updating. Changes in the historic channel's flow regime have caused sediment accumulation and vegetation encroachment. It is likely that both the head-gate, which is a migration barrier at high flows, and the intake and fish screens will be replaced at some point in the future. Once completed, the hatchery and the irrigation withdrawal will be in compliance with NMFS and USFWS requirements under Section 7 of the ESA.

Nason Creek

The headwaters of Nason Creek lie in the eastern slopes of the Cascade Mountains. Nason Creek flows east out of Lake Valhalla (4,830 feet elevation) for approximately 21 miles and empties into the Wenatchee River at RM 53.6 just below Lake Wenatchee. Habitat in Nason Creek has been altered by human activities including railroad development, road building, channel straightening, timber harvest, and private development; the lower 15 miles of Nason Creek contain the most habitat features in poor condition. Due to a natural fish barrier, Gaynor Falls, this reach also contains all the anadromous salmonid spawning habitat and is a key corridor for connectivity of sub-watersheds. Low in-stream flows are common in August and September, a natural condition related to snow accumulation and snow melt patterns (Andonaegui 2001). Nason Creek has been the focus of many habitat projects in recent years. The Upper Columbia Biological Strategy (UCRTT 2007) recognizes that Category 2 watersheds such as Nason Creek have the highest potential to increase abundance and productivity through restoration efforts.

Little Wenatchee River

The Little Wenatchee River is a 4th order stream draining a 64,794-acre watershed. The Little Wenatchee River flows southwest for 25 miles and empties into Lake Wenatchee. The Little Wenatchee River is among the healthiest watersheds in the Columbia basin (NPCC 2004). Several moderate habitat concerns exist, however. Most of the concerns occur in and below areas of extensive timber harvest (Andonaegui 2001; USFS 1998). Most timber harvest in the Little Wenatchee River corridor has occurred from the mouth upstream to Cady Creek (RM 0.0-16.9) and in the Rainy Creek drainage. In these areas, the potential for LWD input has decreased. Harvest activities and moderate road densities of 2.4 miles per square mile may also contribute to high stream temperatures by increasing runoff and decreasing water storage potential (Andonaegui 2001). During the 1970s, biologists were concerned that LWD complexes created fish passage barriers in the lower few miles of the river. They made several attempts to remove the complexes, although wood kept accumulating in the same locations (Andonaegui 2001; Mullan et al 1992; USFS 1998). A stream survey conducted in 2000 concluded that LWD levels below RM 7.8 had good quantities of LWD present in the channel (Andonaegui 2001). Pool frequency, depth and quality are considered good (Andonaegui 2001).

White River

The White River is a 5th order stream. The drainage encompasses 99,956 acres and originates in alpine glaciers and perennial snow fields. The White River flows south-southeast for the majority of its length (26.7 RM). Two large tributaries, Napeequa (RM 11.0) and Panther (RM 13.1) creeks, support anadromous salmonids. The White River drainage is among the healthiest in the Columbia Basin (NPCC 2004). Several habitat concerns, however, exist (USFS 1998; Andonaegui 2001). The mainstem below the wilderness boundary has had some alteration; consequently, many habitat indicators are in only fair condition. The most altered are in the lower watershed below Panther Creek. Changes have resulted from floodplain development and impacts on riparian areas from historic cedar logging and roading. On private lands, homes and vacation retreats are being built (USFS 2004). The mainstem below White River Falls is a key spawning and migration corridor for anadromous salmon. The White River still maintains high quality, complex habitat with refuge and rearing habitat for multiple life stages and life histories. The watershed is well connected to adjacent high quality habitat in Lake Wenatchee and the Chiwawa River that provide refuge during disturbance events. The floodplain is in good condition.

Chiwawa River

The Chiwawa River originates from 5 glaciers on the southwestern slopes of the Entiat Mountains and flows southeasterly for 37 miles to its confluence with the Wenatchee River near the town of Plain. The Chiwawa River is a 5th order stream. Overall the Chiwawa watershed is in good condition. Development is minimal compared to most other watersheds in the Wenatchee subbasin and is confined to the lower areas of the watershed. Several factors can potentially influence conditions in the lower Chiwawa River watershed, including high road density, road location, private land development, forest practices, and a water diversion. Road concerns occur mainly in the lower mainstem and Meadow Creek. In the upper watershed, there is no indication that frequency, size or intensity of natural disturbance events has changed other than alteration of the fire cycle through fire suppression. Channel conditions for much of the upper Chiwawa are presumed to be near historic conditions since floodplain connectivity remains intact and channel condition has had only minor alteration. In the lower Chiwawa River, log drives occurred until the mid-1930s. Although channel conditions have repaired considerably since that time, some evidence of in-channel degradation remains. Chiwawa wetlands and off-channel habitat in the watershed are in good condition (USFS 2003). The valley floor has an extensive network of ponds, beaver canals, side channels, abandoned oxbows and other wetlands. Abundance, diversity, connectivity and quality of these wetlands are high.

2.4.1.2 Methow Subbasin Habitat Description

The Methow River subbasin is comprised mostly of large tracts of relatively pristine habitat. Topography varies from mountainous alpine terrain at elevations of 8,500 feet to gently sloping wide valleys down to an elevation of 800 feet. This diverse habitat supports well over 300 species of fish and wildlife (NPCC 2004b). The Methow Subbasin Plan (NPCC 2004b) reports that Methow basin habitat losses have resulted chiefly from artificial and natural fish passage barriers, alteration and reduction of riparian habitat, loss of habitat connectivity, in-stream and floodplain habitat degradation, low flows, and dewatering.

Lower Methow River

The lower Methow River includes the Methow mainstem and its tributaries from the town of Carlton to the mouth of the Methow River. Agriculture uses in this sub-watershed are primarily field crops and cattle at the upper end, with orchards along the lower end. This reach provides rearing habitat and acts as a migration corridor for all anadromous salmonids. Timber harvest, livestock grazing and high road densities characterize much of the Libby Creek drainage, with roads running parallel to every major stream. The lower 2.9 miles of Libby Creek have been channelized. Culverts and irrigation diversion structures impede salmonid passage on a number of tributaries. Upstream passage for salmonids is also limited by heavy beaver activity in some tributaries. Timber harvest, livestock grazing and elevated road densities also characterize Gold Creek. The lower 3.5 miles of Gold Creek have had riprap placed along the banks. Gold and Libby Creeks are characterized by low in-stream flows, and Gold Creek dewaters in a lower reach between RM 3 and RM 2 during some low-water years.

Middle Methow River

The middle Methow drainage includes the mainstem Methow from its confluence with the Chewuch River to the town of Carlton. County roads and state highways parallel both sides of the Methow River throughout this reach. Diking, conversion of riparian area to agriculture and residential uses, and LWD removal along the mainstem Methow River have resulted in loss of side-channel access, riparian vegetation, and overall habitat complexity. Much of the habitat within this area has not been adequately inventoried or assessed, and data gaps exist regarding the extent of habitat alterations. The Methow Valley Irrigation District diverts water to its east canal, about five miles north of the town of Twisp at RM 44.8.

Upper Methow River

The upper Methow River drainage includes the mainstem Methow from its headwaters to the Chewuch River (RM 50.1). Major tributaries in the drainage include Goat Creek, Wolf Creek, Hancock Creek, Little Boulder Creek, Dawn Creek, Gate Creek, Robinson Creek, Rattlesnake Creek, and Trout Creek. Methow mainstem habitat between the Lost River confluence and Winthrop has been greatly affected by human activity. The river has a low gradient throughout this reach, and a number of dikes block access to valuable side-channel spawning and rearing habitat. The floodplain is constrained by those dikes as well as by rip-rapping and bank stabilization measures. Riparian habitat has been converted to agricultural use, and more recently and increasingly, to residential use along the mainstem between the Early Winters confluence and the Mazama bridge, which in some areas has resulted in bank erosion. Historic timber harvest activities, fire, livestock grazing, and construction of logging roads throughout the lower reaches of the Goat Creek and Wolf Creek drainages have also resulted in large sediment loads in the Methow River. Improvement in grazing practices in this sub-watershed and in other areas of the basin has helped reduce the current impact of livestock grazing. The amount of sediment delivered to creeks and streams from natural occurrences has not been quantified relative to the amount of sediment contributed through human use.

Twisp River

The Twisp River flows into the Methow at the town of Twisp. A substantial portion of the Twisp river sub-watershed lies within designated wilderness and is in nearly pristine condition. Most human activity and related habitat changes within the drainage have taken place in the lower 15 miles of the Twisp River. Reduced levels of LWD, road placement, diking, bank hardening, and conversion of riparian areas to agriculture and residential uses have altered habitat conditions in this area, resulting in the loss of channel complexity and floodplain function. There are seven irrigation diversions on the Twisp River. The Twisp River from Buttermilk Creek to the mouth has been diked and rip-rapped in places, resulting in a highly simplified channel and disconnected side channels and associated wetlands. Levels of LWD recruitment potential in the lower Twisp River are below normal.

Beaver Creek

Beaver Creek drains into the Methow River five miles downstream from the town of Twisp. Previously, anadromous salmonids have had limited access to Beaver Creek due to its many obstructions. Most of these diversions have been removed or are in the process of being modified for passage. Road density in the Beaver Creek drainage is the highest in the Methow subbasin. Extensive timber harvest has occurred in the Beaver Creek drainage since the 1960s, resulting in heavy sediment loading, slope destabilization, and reduction in recruitment potential for LWD (USFS 2000a). Limited grazing activity has also contributed to stream sediment delivery in Beaver Creek. In low-water years, Beaver Creek goes dry in the fall, except in the uppermost reaches and in the lowest 0.3 mile, which maintain flows via irrigation return.

Chewuch River

The Chewuch River enters the Methow at the town of Winthrop. The majority of the human impact has occurred in the lower half of the drainage, with the upper 50% remaining generally undisturbed. Five ditches divert water within the Chewuch sub-watershed, and two roads parallel segments of the Chewuch. Low flows in late summer through winter reduce quantity of rearing habitat in the lower Chewuch River. High water temperatures in the lower river may at times cause a migration barrier. Extensive riprap for flood control associated with residential development has also occurred in the lower eight miles of the Chewuch as well as along several tributaries. The drainage’s upper reaches are characterized by harsh winters and icing.

Early Winters Creek

Early Winters Creek enters the Methow about 3.5 miles upstream from the town of Mazama. The majority of the watershed is in relatively pristine condition. Human impacts are primarily restricted to the lower two miles of Early Winters Creek, including its alluvial fan. The lower half-mile has been rip-rapped and diked to keep the channel in a stable location in order to accommodate Highway 20 and to protect private property. The lowest two miles have low levels of LWD, and pool quality and quantity is poor. Severe low flows persist in the lower 1.4 miles of the creek. Low base flows are naturally occurring during the winter months; however, low flows during the late summer and early fall may be exacerbated by two irrigation diversion (USFS 1998b). In 2000 and 2001 the USFS completed a restoration project on this reach of the creek. The restoration included an increase of LWD, pools and quality habitat. The Early Winters Ditch on Early Winters Creek is currently meeting NMFS and USFWS target flow of 35 cfs for spring Chinook and bull trout, and the irrigation district is using wells that are not in continuity with groundwater and surface water to meet the remainder of its irrigation needs. Fine sediment and chemical runoff from state Route 20 may negatively affect water quality.

Wolf Creek

Wolf Creek, a Methow River tributary, drains the Methow about 3 miles above the town of Winthrop. Approximately 80% of the drainage is designated wilderness with very good habitat conditions. The Forest Service manages the remainder of the drainage for multiple uses with exception of the last 1.5 miles, which is privately owned. Impacts from timber harvest and roads are limited primarily to the Little Wolf Creek drainage. Introduction of woody debris and pool formation projects were completed in 2000 along the lower 0.5 mile of the creek.

Goat Creek

Goat Creek drains into the Methow from the north about a mile downstream from the town of Mazama. Portions of the upper third of the Goat Creek drainage have been heavily grazed. The lower two-thirds of the drainage have been logged, roaded and grazed (USFS 1995). The Goat Creek drainage has over 150 miles of roads—more than 4 miles of road per square mile—with almost all of those located in the lower half of the drainage. Sediment from roads and slope failures is carried by Goat Creek to salmon spawning areas in the Methow River. Livestock have also damaged or suppressed re-growth of riparian vegetation in some tributaries. Goat Creek exhibits elevated water temperatures, low flows, and/or dewatering in August and September (USFWS 1998).

Lost River

The Lost River empties into the Methow River from the north at RM 73.0, roughly six miles above Early Winters confluence. About 95% of the drainage lies within the Pasayten Wilderness. Human impact in the drainage is largely restricted to the river's lower mile. Within the channel migration zone of the first mile, the construction of roads and dikes associated with home development has constrained the channel and floodplain function, potentially reducing pool quality and quantity as well as side-channel habitat. Some riparian habitat in the lower mile has been converted to residential development and pasture land. Residential construction on the alluvial fan may lead to a constrained channel in the future. LWD has been removed from the lower mile of the river for flood control and firewood gathering; however, the potential for LWD recruitment is thought to be at natural levels. Lower stream flows are a natural condition throughout the Lost River drainage, but water temperatures remain cold.

2.4.2 Description of Wenatchee and Methow Subbasin Habitats Based on NPCC Habitat Condition Criteria

Based on the habitat descriptions provided by the Wenatchee and Methow River Subbasin Plans (NPCC 2004a and NPCC 2004b), we rated each assessment unit, or watershed within the subbasins, using the criteria for conditions described by the NPCC (NPPC 2000).

The NPCC presents restoration strategies, including artificial production strategies, based on the current condition and the restoration potential of habitat for the species and life stages of interest (NPPC 2000). Generally, for intact habitat where a target population is largely intact, “the biological objective for that habitat will be to preserve the habitat and restore the population of the target species up to the sustainable capacity of the habitat.” The NPCC recommends artificial production under the proper conditions, including 1) complementing habitat improvements by supplementing with native fish populations up to the sustainable carrying capacity and 2) replacing lost salmon or steelhead populations (NPPC 2000). Restoration of salmon populations is recommended when a species is experiencing low to no natural production, or, as is the case for mid-and upper Columbia River coho, where the natural population has been eliminated. Artificial production for the purpose of restoration is recommended only when the habitat is in good condition or in the process of being restored (NPPC 2000). Within the Wenatchee and Methow basins, the tributaries proposed for coho reintroduction include both “intact” and “restorable” habitat conditions and meet the criteria for implementing an artificial production program for the purpose of restoration. Table 2-1 shows habitat condition for the two subbasins using the NPCC criteria.

Table 2-1. Wenatchee and Methow subbasin habitat conditions

Subbasin	Assessment Unit	Habitat Condition	Description
Wenatchee	Lower Wenatchee River	Compromised	Ecological function or habitat structure substantially diminished
	Mission Creek	Compromised	Ecological function or habitat structure substantially diminished
	Peshastin Creek	Compromised	Ecological function or habitat structure substantially diminished
	Chumstick Creek	Compromised	Ecological function or habitat structure substantially diminished
	Middle Wenatchee River	Restorable	Potentially restorable to intact status through conventional techniques and approaches
	Icicle Creek	Restorable	Potentially restorable to intact status through conventional techniques and approaches
	Nason Creek	Restorable	Potentially restorable to intact status through conventional techniques and approaches
	Little Wenatchee River	Intact	Ecological functions and habitat structure largely intact
	White River	Intact	Ecological function and habitat structure largely intact
	Chiwawa River	Intact	Ecological function and habitat structure largely intact
Methow	Lower Methow River	Compromised	Ecological function or habitat structure substantially diminished
	Middle Methow River	Compromised	Ecological function or habitat structure substantially diminished
	Upper Methow River	Restorable	Potentially restorable to intact status through conventional techniques and approaches
	Twisp River	Intact	Ecological function and habitat structure largely intact
	Beaver Creek	Compromised	Ecological function or habitat structure substantially diminished
	Chewuch River	Restorable/ Intact	Potentially restorable to intact status through conventional techniques and approaches
	Early Winters Creek	Intact	Ecological function and habitat structure largely intact
	Wolf Creek	Intact	Ecological function and habitat structure largely intact
	Goat Creek	Restorable	Potentially restorable to intact status through conventional techniques and approaches
	Lost River	Intact	Ecological function and habitat structure largely intact

2.4.3 Description of Wenatchee and Methow Subbasin Habitats Based on Ecosystem Diagnosis and Treatment Method

Coho habitat within the Wenatchee and Methow subbasins was assessed using the Ecosystem Diagnosis and Treatment (EDT) method. EDT is an analytical model which relates habitat features and biological performance to support conservation and recovery planning for salmonids (Lichatowich et al. 1995; Lestelle et al. 2004). EDT incorporates information from empirical observation, local experts, and other models and analyses.

The Information Structure and associated data categories are defined at three levels of organization. Together, these can be thought of as an information pyramid in which each level builds on information from the lower level (Figure 2-3). As we move up through the three levels, we take an increasingly organism-centered view of the ecosystem. Levels 1 and 2 together characterize the environment, or ecosystem, providing the characterization of the environment needed to analyze biological performance for a species. The Level 3 category characterizes the same environment from the perspective of "the focal species" (Mobrand et al. 1997)—in this case, coho salmon. This category describes the biological performance in relation to the state of the ecosystem described by the Level 2 ecological attributes.

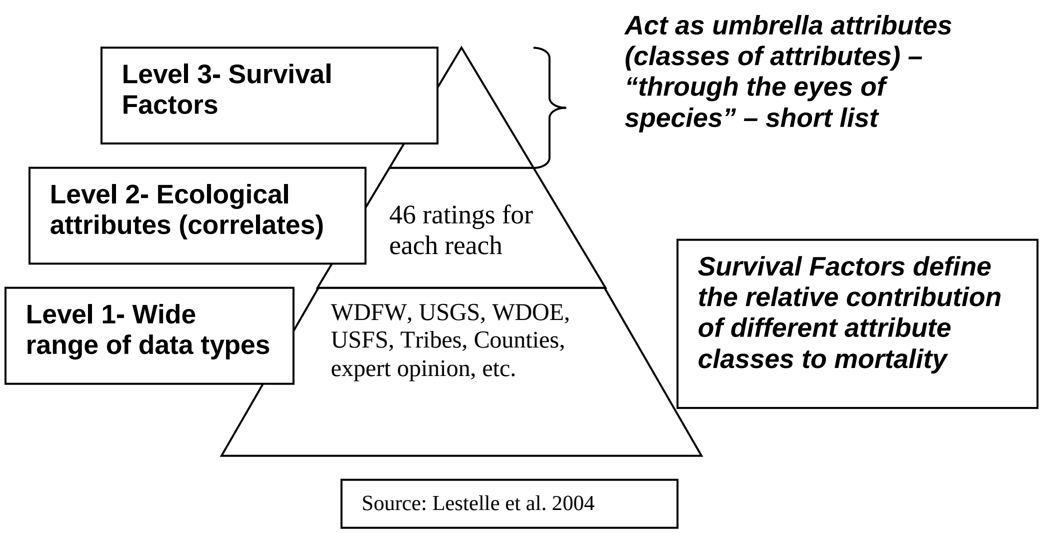

Figure 2-3. Data and Information Pyramid

2.4.3.1 Wenatchee Subbasin EDT Diagnosis for Coho Salmon

The Wenatchee subbasin was divided into 119 stream reaches and 23 obstructions. A stream reach was a segment of river in which environmental, anthropogenic, and biological attributes were relatively constant. The stream reaches were grouped into 19 larger geographic areas or assessment units (AU). A habitat work group consisting of biologists from WDFW, USFWS, USFS, Yakama Nation, Chelan County, and several environmental consulting firms, rated the habitat attributes for the stream reaches within the Wenatchee basin. The work group drew upon published and unpublished data and information. More detail on the processes and habitat ratings can be found in the Draft Upper Columbia Salmon Recovery Plan (UCSRB 2005).

Priority Assessment Units

Based on the average rank and the sum of the **protection benefits** across three performance measures—diversity index, productivity, and abundance—the top assessment units for habitat protection benefits to coho salmon are predicted to be the Chiwawa River, White River, and Upper Wenatchee River (Chiwaukum Creek to Lake Wenatchee). This means that coho in the basin will benefit most from protecting the existing attributes of these three assessment units. Other highly ranking assessment units for coho in the protection category include Tumwater Canyon, Lower Nason Creek (mouth to Gaynor Falls), and the Little Wenatchee River.

Based on the average rank sum of **restoration benefits** across the three performance measures—diversity index, productivity, and abundance—the assessment units which ranked highest in restoration benefits for coho salmon are Lower Nason Creek, Upper Wenatchee River, and the White River. This means that the model predicts that the greatest increases in coho abundance, productivity, and life history diversity would occur if the degraded habitat in these streams was restored. The inclusion of the upper Wenatchee River as a top restoration priority was somewhat unexpected but consistent with the EDT results for spring Chinook in the Wenatchee basin. The Chiwawa and White rivers ranked relatively high in restoration benefits to coho productivity, even though they are thought to be in relatively pristine conditions. It appears that, in this pristine habitat, there are still a few small problems which, if fixed, would substantially increase productivity (C. Baldwin, WDFW, pers. comm.). The Chiwawa and White rivers also ranked highest in protection benefits to coho productivity.

Figure 2-4 and Table 2-2 summarize model predictions of the relative importance of geographic areas for protection and restoration measures.

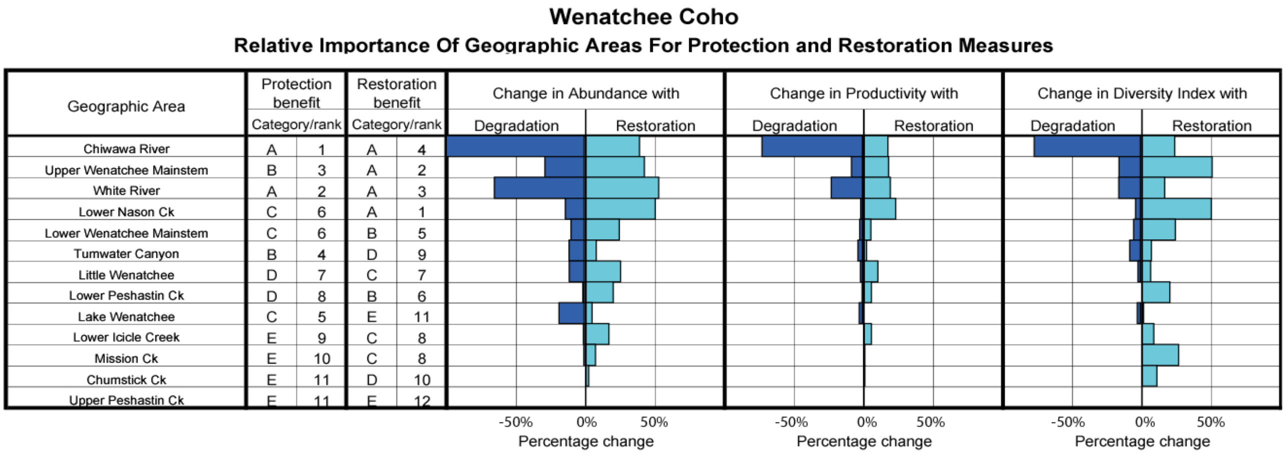

Figure 2-4. EDT Model Output for the Assessment Unit Summary for Wenatchee Coho Salmon

Note: The restoration and degradation potential is the percent change in each of the performance measures (abundance, productivity, diversity) that would take place if all environmental attributes in that assessment unit were either restored or degraded.

Figure 2-4 illustrates model predictions of which assessment units will be the most important to re-establishing a naturally reproducing coho population. For example, the figure shows that the White River ranks high for coho for protection: its existing habitat qualities make the White the second most valuable river for coho of those evaluated in the Wenatchee subbasin. The figure also shows that, if the attributes of that river are degraded, then coho abundance would be reduced by over 60% (assuming coho occupied that river); and if all the attributes currently at risk were restored, that coho abundance could be increased by 50%. The reaches that ranked highest in protection and restoration values also provided the highest predicted coho productivity (Table 2-2).

Table 2-2. Wenatchee basin coho adult productivity values predicted by EDT

Location	White R	Chi-wawa R	Little Wenat-chee R	Wenat-chee R	Nason Ck	Icicle Ck	Pesh-astin Ck	Beaver Ck	Chum-stick Ck	Mission Ck
EDT Predicted Productivity Values	1.6	1.5	1.5	1.3	1.1	<1	<1	<1	<1	<1

Note: Productivity values less than 1 are unlikely to establish naturally reproducing populations.

Stream Reach Analysis

Reach and life stage-specific limiting factors are shown in Figure 2-5. Habitat diversity, obstructions, sediment load, and key habitat quality were primary limiting factors in one or more assessment units (Figure 2-5). Other limiting attributes of lesser importance included channel stability, competition with hatchery fish, flow, and food. The Chiwawa River, White River, Upper Wenatchee River and Lower Nason Creek have no primary limiting factors for coho (Figure 2-5). Primary limiting factors are those attributes ranking “high” in restoration priority. Primary limiting factors were found in Chumstick Creek (obstructions and key habitat quality), Little Wenatchee River (sediment load), Lower Icicle Creek (habitat diversity, obstructions, and sediment load), Lower Peshastin Creek (obstructions), Lower Mainstem Wenatchee (habitat diversity), Mission Creek (obstructions, sediment load, and key habitat quality), Tumwater Canyon (habitat diversity), and Upper Peshastin Creek (habitat diversity). Assessment units with the fewest limiting attributes are predicted to be important reaches for coho reintroduction.

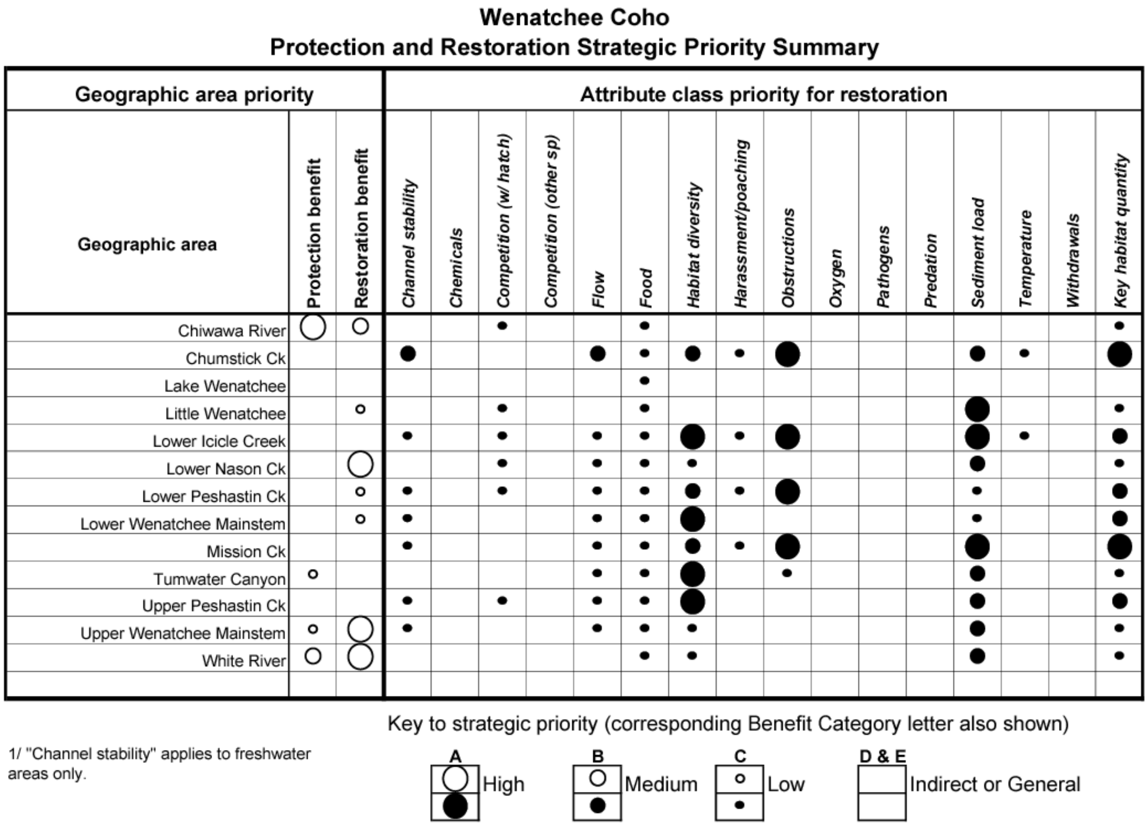

Figure 2-5. EDT Strategic Priority Summary for Wenatchee Basin Coho Salmon

Note: Prioritized attributes in need of restoration are shown for each assessment unit.

2.4.3.2. *Methow Subbasin EDT Diagnosis*

Coho habitat within the Methow subbasin was also assessed using the EDT method. The Methow subbasin was divided into 148 stream reaches; the reaches were grouped into 13 assessment units (AUs). A stream reach was a segment of river in which environmental, anthropogenic, and biological attributes were relatively constant. A technical workgroup rated habitat attributes for the stream reaches within the Methow subbasin. The work group drew upon published and unpublished data and information. More detail on the processes and habitat ratings can be found in the Methow Subbasin Plan (NPCC 2004b).

Priority Assessment Units

Based on the average rank and the sum of the protection benefit across three performance measures (as identified in the Wenatchee Diagnosis), the assessment units that ranked highest for habitat protection benefits to coho are the Upper Methow River (Rkm 119.8 – 134.6, including the Lost River and Early Winters Creek), the Upper Twisp River (Rkm 27.8 – 49.9), and the Middle Methow River (Rkm 53.1 – 94.3). The highest ranking assessment units in terms of protection benefits are predicted to be essential to coho restoration in the Methow basin. Other high ranking assessment units include Upper Middle Methow (Rkm 94.3 – 119.8), Lower Twisp River (Rkm 0.0 – 27.8), and Upper Chewuch River (Rkm 18.1 – 56.0). Assessment units that ranked highest for restoration benefits to coho salmon are Middle Methow River, Upper Chewuch River, and Lower Chewuch River (Rkm 0.0 – 18.1). A summary of relative importance to coho of geographic areas for protection and restoration measures is shown in Figure 2-6.

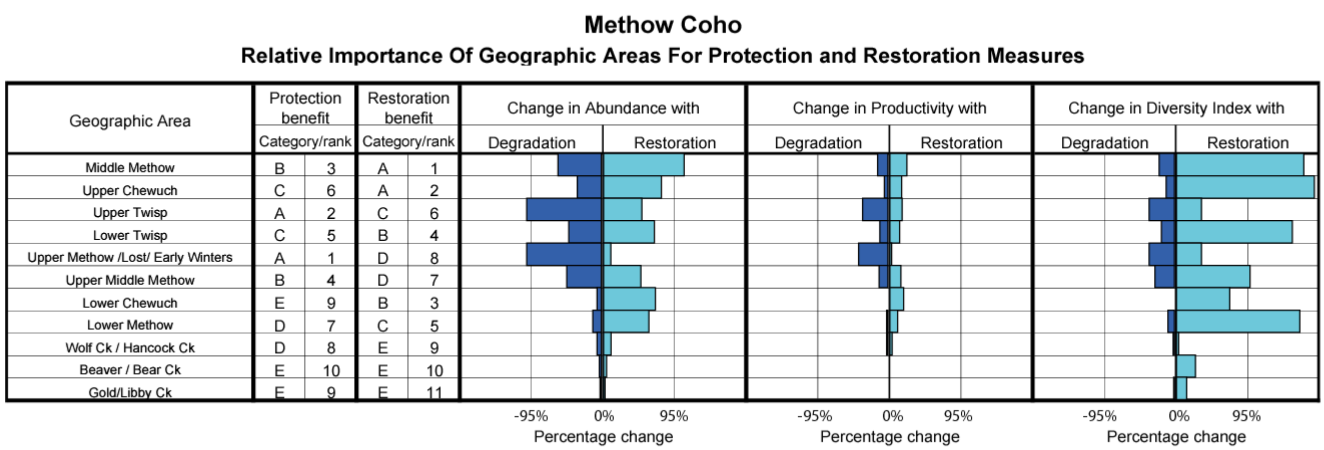

Figure 2-6. EDT Model Output for the Assessment Unit Summary for Methow Coho Salmon

Note: The restoration and degradation potential is the percent change in each of the performance measures (abundance, productivity, diversity) that would take place if all environmental attributes in that assessment unit were either restored or degraded.

As described in the Wenatchee Diagnosis, the reaches that ranked highest in protection and restoration values also provided the highest predicted coho productivity (Table 2-3).

Table 2-3. Methow basin coho adult productivity values predicted by EDT

Location	Lost River	Twisp River	Methow River	Early Winters Creek	Chewuch Creek	Wolf Creek	Beaver Creek	Gold Creek
EDT Predicted Productivity Values	1.4	1.3	1.2	1.2	1.1	<1	<1	<1

Note: Productivity values less than 1 are unlikely to establish naturally reproducing populations.

Stream Reach Analysis

Reach and life stage specific limiting factors are shown in Figure 2-7. Habitat diversity was a primary limiting factors in five assessment units (Figure 2-7). Other limiting attributes of lesser importance included channel stability, competition with hatchery fish, flow, food, harassment and poaching, predation, sediment load, and key habitat quality. The Lower and Upper Chewuch River, Lower and Upper Twisp River, Upper-Middle Methow River, and Upper Methow/Lost/Early Winters Assessment Units have no primary limiting factors for coho (Figure 2-7). Primary limiting factors are those attributes ranking "high" in restoration priority. Primary limiting factors were found in Beaver, Gold, and Libby creeks; in Lower Methow River and Middle Methow River; and in Wolf Creek and Hancock Creek. Assessment units with the fewest limiting attributes are predicted to be important reaches for coho reintroduction.

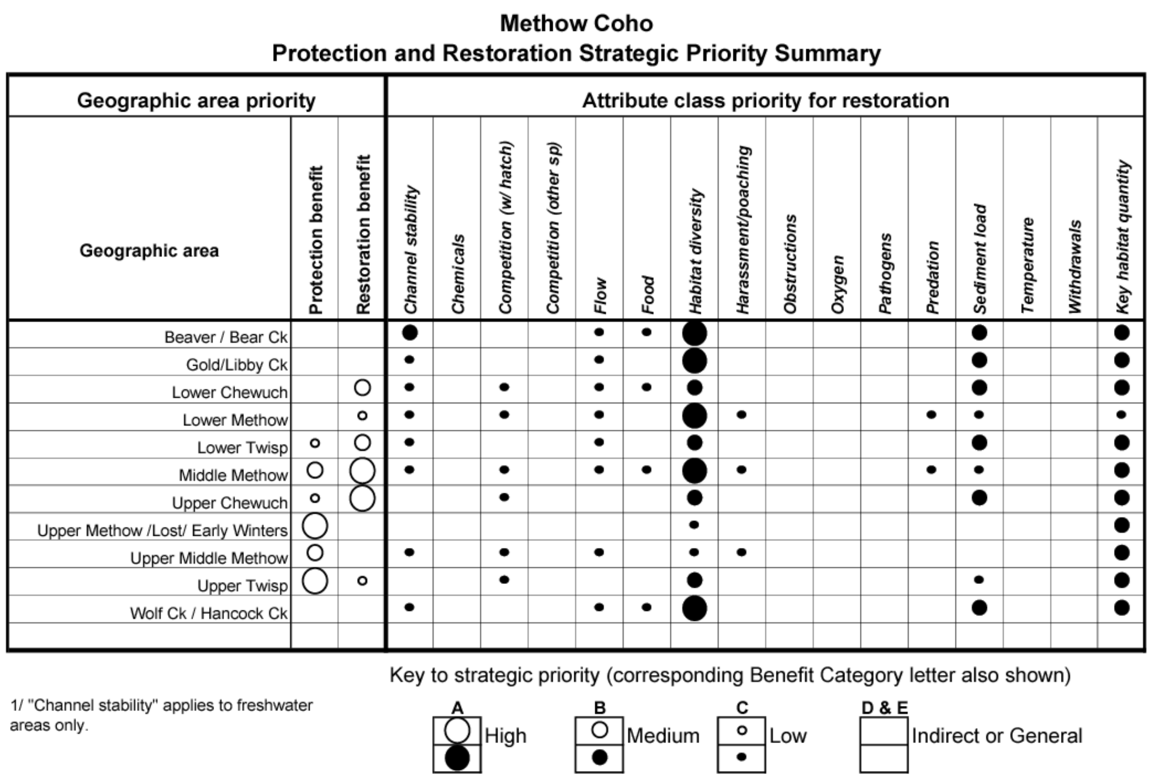

Figure 2-7. EDT Strategic Priority Summary for Methow Basin Coho Salmon

Note: Prioritized attributes in need of restoration are shown for each assessment unit.

Chapter 3.
Summary of Feasibility Study Results and Resolution of Critical Uncertainties

Chapter 3. Summary of Feasibility Study Results, Resolution of Critical Uncertainties, and Program Monitoring Results to Date

***2017 update**: This chapter summarizes the results of feasibility studies (sections 3.1 and 3.2), which were provided in the 2010 version of the Master Plan; and the results of performance indicator monitoring that has continued since completion of the feasibility studies (section 3.3). Although the program proposed in the Master Plan was not approved for funding until BPA's Record of Decision in July 2012, activities begun during the feasibility studies continued with alternative funding. Those activities included continuing broodstock development, monitoring of survival rates, and collection of other data to help determine the program's progress and effects.*

Studies to determine the feasibility of reintroducing coho into mid-Columbia basins began in 1996. In response to a National Marine Fisheries Service Biological Opinion (NMFS 1999), a Hatchery and Genetics Management Plan (HGMP) was prepared in 1999 which outlined goals, objectives, and study plans. As studies progressed, project participants and the Mid-Columbia TWG[18] refined the study objectives, which were outlined in a revised version of the HGMP (YN et al. 2002). Feasibility studies, considered complete in 2004/2005, were designed to achieve two primary goals:

1) ***Determine whether a broodstock can be developed from lower Columbia River coho stocks whose progeny can survive in increasing numbers to return as adults to the mid-Columbia region.***
2) ***Initiate natural reproduction in areas of low risk to sensitive species and in other select areas to study the risks and interactions with sensitive species.***

Project performance indicators were developed to measure success at achieving the feasibility study goals (Section 1.10 of the 2002 HGMP); numeric targets were not established. Feasibility study goals and results are summarized in Table 3-1; Tables 3-2 and 3-3 summarize measurements of performance indicators. Section 3.1 of the Master Plan more fully describes study results in terms of benefits to coho, while Section 3.2 details the results of interaction risk studies.

Feasibility Study Performance Indicators

Benefits to coho

- Trends in survival of hatchery coho as measured by PIT tags (smolt-to-smolt), and by counts at dams/facilities and CWTs (smolt-to-adult).
- Coho natural production using redd counts and smolt production estimates.

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[18] TWG members included Bonneville Power Administration, Confederated Tribes of the Colville Indian Reservation, Nez Perce Tribe, NOAA Fisheries, U.S. Fish and Wildlife Service, Northwest Power and Conservation Council, U.S. Forest Service, Chelan and Douglas County Public Utility Districts.

- Adaptive changes from the original out-of-basin stock, using genetic monitoring of neutral allelic frequencies; and physical and behavioral traits such as fecundity, body morphometry, maturation timing, and straying and homing to acclimation sites.

Risks to other listed species

- Predation on other species by program fish as indicated by stomach content analyses.
- Superimposition of spring chinook redds by spawning coho as measured by superimposition studies.
- Competition for food and habitat during freshwater rearing of naturally produced coho juveniles as measured through micro-habitat use and growth evaluations.
- Other potential ecological interactions as indicated by residualism studies or by F2 evaluations.

Table 3-1. Summary of feasibility study goals and results

Feasibility Study Goals	Results	Goal Achieved
1) Determine whether a broodstock can be developed from Lower Columbia River stocks.	Lower Columbia River (LCR) coho were transferred to the Wenatchee basin in 1999, 2000, and 2001. A limited number of LCR transfers were used to supplement local broodstocking efforts in 2002. Since 2004, no LCR broodstock have been released in the Wenatchee basin (Table 3-2). Releases of LCR coho smolts were discontinued in the Methow River basin in 2006. By no longer relying on the transfer of coho from Lower Columbia River hatcheries, we have demonstrated that a local broodstock can be developed from Lower Columbia River stocks. SARs have trended upwards with each generation of broodstock development (Figure 3-1).	Yes
2) Initiate natural reproduction in areas of low risk to sensitive species and in other select areas to study the risks and interactions with sensitive species.	We have documented spawning escapement in the Wenatchee and Methow basins (Figures 3-3 & 3-4). In the Wenatchee basin, redd counts ranged from a low of 28 in 2002 to a high of 1,666 in 2007 (mean = 627; Figure 3-3). From these redds, juvenile production has been well documented. Annual population estimates of naturally produced coho emigrating from the Wenatchee River range from a low of 5,826 in 2002 to a high of 48,708 in 2007 (Table 3-7). The naturally produced coho smolts have survived to return as adults. SARs for naturally produced coho range from 0.15% to 1.64% (Table 3-7). Studies of interactions with sensitive species (spring Chinook, steelhead, and sockeye) were developed under the direction, guidance, review and approval of the Mid-Columbia Coho Technical Workgroup. Critical uncertainties answered include rates of residualism, redd superimposition, predation by hatchery coho on naturally produced spring Chinook fry, and competition for space and food during freshwater rearing. Summaries of the studies are in Section 3.2. No significant impacts on listed fish were detected throughout the evaluations (Section 3.2).	Yes

3.1 Benefits to Coho

Feasibility Goal 1) Determine whether a broodstock can be developed from lower Columbia River coho stocks whose progeny can survive in increasing numbers to return as adults to the mid-Columbia region.

In achieving this goal, the program quickly eliminated the use of Lower Columbia River stocks and transitioned exclusively to a local broodstock, demonstrating that a local broodstock could be developed. Performance indicators such as coho survival at various stages demonstrated increasing survival rates during the feasibility phase.

3.1.1 Coho Survival

The Mid-Columbia Coho Reintroduction Feasibility Study began in 1996 with releases of acclimated reprogrammed lower Columbia River stocks in the Methow River. In 1999 the focus of the feasibility study shifted to the Wenatchee River basin due to low smolt-to-adult survival rates (SARs) and a lack of suitable broodstock collection facilities in the Methow River. Releases of acclimated coho in the Wenatchee basin began with coho pre-smolts reprogrammed from lower Columbia River facilities; since then, the program has transitioned to 100% local brood collected in both basins (Table 3-2).

Table 3-2. Broodstock collected and smolts produced

Brood Year	Release Year	Basin	Brood Source	Adult Return Year	Broodstock Collected	Mid-Columbia Smolts Produced
1996	1998	Methow	LCR	1999	150*	143,000
1997	1999	Wenatchee	LCR	2000	928	585,000
1998	2000	Wenatchee	LCR	2001	1,219	738,900
		Methow	LCR	2001	334	162,800
1999	2001	Wenatchee	LCR & MCR	2002	213	133,000
		Methow	LCR	2002	52	22,000
2000	2002	Wenatchee	MCR & LCR	2003	1,706	1,064,000
		Methow	LCR	2003	208	65,000
2001	2003	Wenatchee	MCR	2004	1,450	1,468,000
		Methow	LCR	2004	118	45,000
2002	2004	Wenatchee	MCR & LCR	2005	1,406	1,382,900
		Methow	LCR	2005	354	246,958
2003	2005	Wenatchee	MCR	2006	1,329	989,509
		Methow	MCR & LCR	2006	331	519,585
2004	2006**	Wenatchee	MCR**	2007	1,015	974,378
		Methow	MCR**	2007	738	469,102
2005	2007**	Wenatchee	MCR**	2008	927	1,036,292
		Methow	MCR**	2008	507	521,538
2006	2008**	Wenatchee	MCR**	2009	1,056	872,006
		Methow	MCR**	2009	393	425,968

* Indicates number spawned and not total number of broodstock collected.
** 100% mid-Columbia-brood-origin smolts were released in both basins.

Figure 3-1 shows SARs for coho returns to the Wenatchee and Methow rivers. During brood years 1998 and 1999, only lower Columbia River transfers were released, and SARS in the Wenatchee and Methow basins were similar. During brood years 2000 through 2002, first-generation mid-Columbia brood were released in the Wenatchee while only lower Columbia River transfers were released in the Methow basin; during this time SARS were higher for the

Wenatchee than for the Methow. Brood years 2003 and 2004 represent mid-Columbia brood released in both basins, and SARS in both basins are similar.

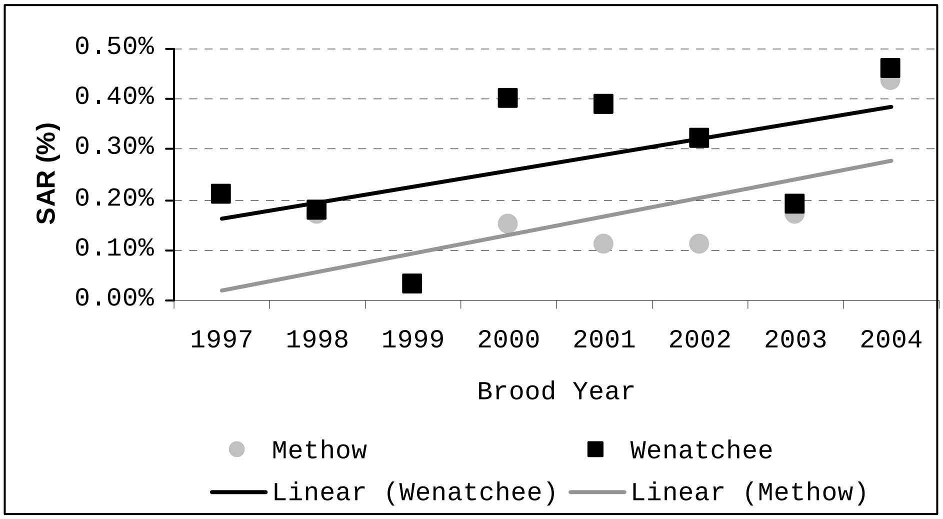

Figure 3-1. Smolt-to-Adult Survival Rates for Hatchery Coho in the Methow and Wenatchee Rivers During Feasibility Studies

In 2002 (BY 2000) and 2003 (BY 2001), we released differentially coded-wire-tagged lower Columbia brood (LCR) and first generation mid-Columbia brood (MCR) from Dam 5 on Icicle Creek, to determine if a survival advantage can be observed with one generation of broodstock development. Both groups were reared at lower Columbia facilities and were acclimated in the same pond, for the same duration of time. Figure 3-2 shows that SARs for BY 2000 and BY 2001 were higher for mid-Columbia brood (0.53% and 0.56%) than for lower Columbia brood (0.31% and 0.45%). In both years, results of a z-test for differences in proportions indicated that mid-Columbia brood survive at statistically higher rates than reprogrammed lower Columbia brood coho.

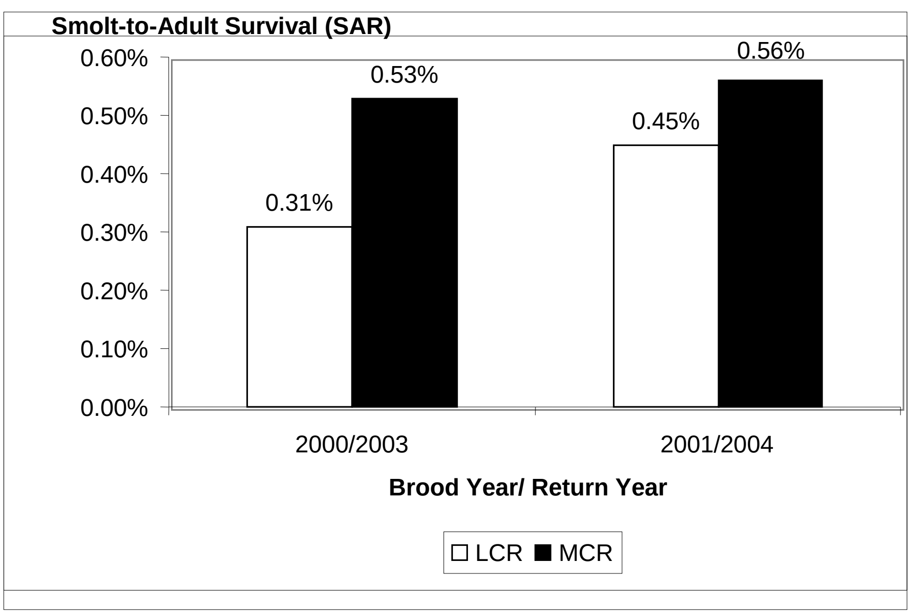

Figure 3-2. SARs for Reprogrammed LCR Brood and First-generation MCR Brood Reared at Lower Columbia Facilities during Feasibility Studies

The feasibility phase demonstrated that a local broodstock can be developed from lower river stocks. It appears that a survival advantage can be achieved with one generation of selection. Our proposal uses methods that are expected to encourage a continuation of the selection process, eventually resulting in a locally adapted population (Chapters 4 and 5). We expect to continue to see increases in survival as local adaptation progresses.

3.1.2 Spatial Distribution of Returning Adults

During the feasibility phase, extensive spawning ground surveys and radio-telemetry studies documented spawning escapement and distribution. In 2000, 2001, and 2002, spawning ground surveys focused on the Wenatchee River basin; they expanded to include the Methow basin in 2003 and 2004. Figures 3-3 and 3-4 show the number and distribution of redds in the Wenatchee and Methow basins. Both figures show an increasing trend in redd counts, demonstrating that reintroduced coho salmon are spawning in the natural environment.

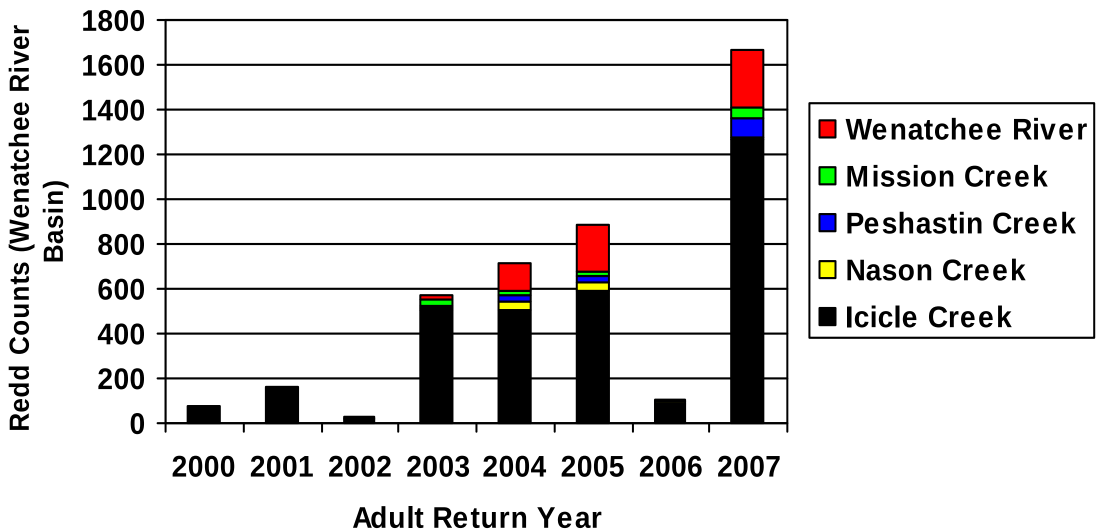

Figure 3-3. Number and Distribution of Coho Redds in Wenatchee Basin, 2000 – 2007

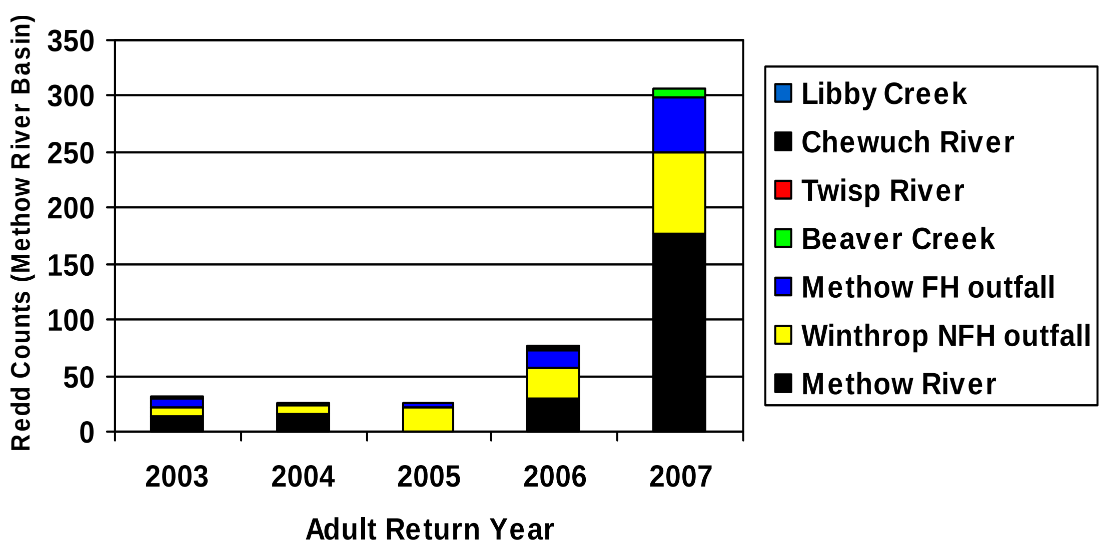

Figure 3-4. Number and Distribution of Coho Redds in Methow Basin, 2003 – 2007

3.1.3 Natural Production

With data collected from a WDFW-operated rotary smolt trap on both the Wenatchee and Methow rivers, we estimated the population size of naturally produced coho emigrant smolts and calculated an egg-to-emigrant survival rate (Tables 3-3 and 3-4). This egg-to-emigrant survival rate can be viewed as a maximum rate, because unidentified coho redds cannot be accounted for in this estimate. The egg-to-emigrant survival rates observed for naturally produced coho are within the range of those observed for natural-origin spring Chinook in the basin. The egg-to-emigrant survival rate for spring Chinook in the Chiwawa River ranged from 4.7% to 18.1% over ten years (Miller 2003). Table 3-3 demonstrates that during feasibility studies in the Wenatchee, observed redds produced smolts, and smolts returned as adults.

Table 3-3. Natural coho production in the Wenatchee River, Brood Years 2000 - 2004

Brood Year	Redds	Natural Smolt Estimate[1]	Egg-to-Emigrant Survival[2]	Smolt-to-Adult Survival	Return Year
2000	77	17,054	8.20%	0.38%	2003
2001	165	36,678	8.65%	0.44%	2004
2002	28	5,826	7.71%	0.90%	2005
2003	625	41,208	2.44%	0.15%	2006
2004	714	14,106	0.73%	1.64%	2007

[1] Natural coho smolt production estimate provided by T. Miller (WDFW unpublished data).
[2] Egg-to-emigrant survival should be viewed as a maximum due to the possibility of unidentified and uncounted coho redds.

Table 3-4. Natural coho production in the Methow River, Brood Years 2003 - 2004

Brood Year	Redds	Natural Smolt Estimate[1]	Egg-to-Emigrant Survival[2]	Smolt-to-Adult Survival	Return Year
2003	28	990	1.59%	0.0%	2006
2004	34	194	0.22%	0.0%	2007

[1] Natural coho smolt production estimate provided by T. Miller (WDFW unpublished data).
[2] Egg-to-emigrant survival should be viewed as a maximum due to the possibility of unidentified and uncounted coho redds.

3.2 Risks to Other Species

Feasibility Goal 2) Initiate natural reproduction in areas of low risk to sensitive species and in other select areas to study the risks and interactions with sensitive species.

As planned in the HGMP (YN et al. 2002), critical uncertainties regarding species interactions were investigated. The issues identified in the HGMP are as follows:

1) rate of predation by hatchery coho on spring Chinook fry,
2) rate of predation by hatchery coho on sockeye fry,
3) superimposition of spring Chinook redds by spawning coho,
4) rates of residualism, and
5) competition for space and food during freshwater rearing of naturally produced coho juveniles as measured through micro-habitat use and growth evaluations.

The HGMP also identified the need for additional studies of interactions between naturally produced coho and listed and sensitive species, if sufficient numbers of naturally produced coho allowed a meaningful study to be conducted.

The studies summarized below answered a number of the critical uncertainties identified in the feasibility phase. However the question of predation rates by *naturally* produced coho on spring Chinook fry remains. We will answer this question during the NPIP as part of the proposed M&E plan (see Chapter 7).

With the completion of many species interaction evaluations and most critical uncertainties answered, the monitoring and evaluation plan (Chapter 7) is designed to coordinate the coho reintroduction effort with other ongoing programs, such as the Chelan and Douglas PUD HCP Hatchery Compensation M&E Plan and the Integrated Status and Effectiveness Monitoring Program (BPA Project # 2003-017-00), to monitor the status of listed and endangered species. Much of the data previously or currently being collected by this program, or that is currently proposed by other programs, can be used to help detect negative effects, if any, of coho reintroduction.

3.2.1 Predation by Hatchery Coho on Other Species

Predation by hatchery coho on spring Chinook fry

During the feasibility phase, the YN completed three predation evaluations in the Wenatchee basin and two predation evaluations in the Yakima River. Methods for all five studies were similar and are detailed in Dunnigan (1999), Murdoch and Dunnigan (2002), Murdoch and LaRue (2002), Murdoch et al. (2005). Hatchery coho smolts released from acclimation sites were recaptured at a smolt trap downstream. The distance downstream varied in each tributary and depended upon the location of the acclimation site and distribution of Chinook redds and fry. The protocols specified that all fish be removed from the live box hourly. The frequent removal of coho from the trap was intended to minimize predation within the live box. The target sample size of coho in each study (approximately 1,000) was collected from throughout the run and retained for stomach content analysis. We estimated the incidence of predation, gastric evacuation rate, and residence time; these factors allowed us to estimate the total number of prey items consumed. We estimated the incidence of predation on spring Chinook by hatchery coho smolts using the following formula:

$$I = n/N$$

Where I = the incidence of predation, n = the number of coho samples containing Chinook remains, and N = the total number of coho samples collected.

Murdoch and Dunnigan 2000. In 2000 we completed a study to measure predation on summer Chinook fry by hatchery coho smolts volitionally released into the Icicle River and recaptured at a rotary smolt trap operated by WDFW on the Wenatchee River (RM 7.1) (Murdoch and Dunnigan 2002). The total migration distance from release to recapture was 21.3 miles and included some of the highest densities of Chinook redds and subsequent fry emergence in the Wenatchee River. We observed an incidence of predation of 0.006 (95%CI 0.0016-0.0154). We estimated the total number of summer Chinook fry consumed based on the gastric evacuation rate of 30.2 hours and a residence time of 16.5 days. Because the release was volitional, we had no way of accurately calculating residence time in the Wenatchee River. We used the day the volitional release began to the date of mean catch at the trap. Because it took approximately three weeks for all the fish to leave the pond, we believe the model over-estimates the total number of fish consumed due to the known overestimate in residence time. We estimated the total number of summer Chinook fry consumed to be 134,125 or 1.31% (95% CI 0.36% to 3.35%) of the total summer Chinook fry population. This rate of predation is higher than studies of predation by hatchery coho on spring Chinook fry, presumably because of the greater abundance and availability of summer Chinook fry. Similar studies have shown that the rate of predation is higher with greater abundance and densities of prey (Hawkins and Tipping 1999; Hawkins 2002).

Murdoch and LaRue 2002. In 2001, YN completed a study to measure predation on spring Chinook fry in Nason Creek (Murdoch and LaRue 2002). We volitionally released coho smolts from the Butcher Creek acclimation pond (RM 8.1 on Nason Creek) and recaptured the smolts in a rotary smolt trap located at RM 0.8 on Nason Creek. We observed an incidence of predation of 0.0018 (95%CI 0.0002-0.0066). We estimated the total number of summer Chinook fry consumed based on the gastric evacuation rate of 40.5 hours and a residence time of 15.8 days. As during the 2000 evaluation, we used the date the volitional release began and mean catch at the trap to estimate residence time. This method likely resulted in an over-estimate of residence time, because it typically takes approximately three weeks for most of the fish to leave the pond. We estimated the total number of spring Chinook fry consumed to be 2,436 or 0.96% (95% CI 0.12% to 3.5%) of the total spring Chinook fry population in Nason Creek.

Murdoch et al. 2005. In 2003, YN repeated the 2001 predation evaluation in Nason Creek. We added PIT tag detectors to the outlet of the Butcher Creek pond and scanned all recaptures at the trap for the presence of PIT tags. This allowed us to calculate the actual residence time for hatchery coho in Nason Creek and to produce an accurate estimate of the total number of fish consumed. We observed an incidence of predation of 0.0028 (95%CI 0.0006-0.0082). We estimated the total number of spring Chinook fry consumed based on the gastric evacuation rate of 40.5 hours and a residence time of 1.7 days. The estimated number of spring Chinook fry consumed was 1009 or 0.14% (95% CI 0.03% to 0.4%) of the total spring Chinook fry population in Nason Creek. The 2003 predation evaluation probably produced the most accurate results due to our ability to measure residence time with PIT tags. Predation evaluations in the Yakima River have produced similar results (Dunnigan 1999).

Predation/Interactions: hatchery coho and sockeye fry

During 2001, 2002, and 2003 we investigated the distribution of sockeye fry in Lake Wenatchee and the migration timing and patterns of coho smolts migrating through the lake to determine if hatchery coho have the opportunity to encounter and prey upon sockeye smolts (Murdoch and LaRue 2002; Murdoch et al. 2004; Murdoch et al. 2005). We used radio-telemetry to track the migration of coho smolts through the lake and hydroacoustics, tow netting, and snorkeling to determine the distributions and diel movements of sockeye fry within the lake.

We found that upon entering Lake Wenatchee, sockeye fry rapidly assume a pelagic existence. The results of the hydroacoustics and tow netting indicated that during the day sockeye fry were primarily found below 45 meters. At night the fry moved towards the surface and shoreward. Coho appeared to migrate primarily through littoral areas. The sockeye fry entered the pelagic zone of the lake shortly after emergence and assumed daily vertical migrations typical in other sockeye rearing lakes. Based on the results of the 2002 and 2003 evaluations (Murdoch et. al. 2004; Murdoch et. al. 2005) we believe that the predation risk for sockeye salmon fry by hatchery coho smolts is low. Because of the diel vertical movements of the fry, the greatest opportunity for hatchery coho to encounter a sockeye fry is at night when coho feeding ceases (Sandercock 1998). Crepuscular periods may present limited opportunity for predation.

To verify our conclusion, we initiated a predation evaluation in 2003. Hatchery coho smolts were released from the Two Rivers Acclimation Site on the Little Wenatchee River (RM 1.5), migrated through Lake Wenatchee and were recaptured and retained for stomach analysis in a smolt trap located approximately 0.5 RM downstream from Lake Wenatchee. No coho collected for stomach content analysis contained fish remains (Incidence of Predation = 0.0), although sample sizes were much lower than desired (72 samples collected) due to low trap efficiency (<0.5%), rendering the results inconclusive.

3.2.2 Superimposition by Coho on Spring Chinook Redds

In 2001 we initiated a study to evaluate superimposition of spring Chinook redds by spawning coho. For this study, we triangulated the precise location of spring Chinook redds in Nason Creek, to ensure that Chinook redds could be located a month or more later while coho were spawning. We triangulated the locations of 50 spring Chinook redds in two study reaches. For each identified coho redd, any Chinook redds nearby were relocated, and the percentage of superimposition, if any, was visually estimated. In 2001 three coho redds were counted in Nason Creek and none had superimposed on spring Chinook redds. Since 2001, to determine Chinook redd locations, we have relied on CCPUD or WDFW to flag Chinook redds with a location description on the flagging; we then followed our previous procedure to identify coho superimposition. We have observed no redd superimposition in Nason Creek. While it is possible that superimposition could occur with increased spawner densities of both Chinook and coho, in general, coho appear to select smaller gravels and different habitat types (edges vs. pool tail outs) for spawning.

3.2.3 Rates of Residualism

In 2000 and 2001, we completed comprehensive and systematic snorkel surveys to determine rates of residualism in hatchery coho. In 2000 we completed three surveys of Icicle Creek; each survey sampled approximately 20% of the available habitat. During the first survey (July 5), we observed 4 residual coho (expands to 20 when the sample rate is accounted for). During the second survey (July 24), we observed no residual coho. During the final survey (August 3), we observed one residual coho (expands to 5). We completed two surveys in Nason Creek. Each survey sampled approximately 20% of the available habitat. We found no residual coho during either survey. We repeated the surveys in 2001. In 2001 we sampled 20% of the available habitat in Icicle Creek and observed 2 residual coho (expands to 10). We sampled approximately 28% of the available habitat in Nason Creek and found no residual coho. Snorkel surveys were also conducted in the Methow River with similar results.

Due to the low estimates of hatchery coho residuals, it is unlikely that the residuals were ecologically capable of negatively impacting any species present unless the environment was at or exceeding the natural carrying capacity.

3.2.4 F2 Interactions

Competition for food and habitat

The YN completed two replicate studies to examine microhabitat use by juvenile coho, Chinook, and steelhead (Murdoch et al. 2004; Murdoch et al. 2005). The purpose of these studies was to investigate habitat use and growth of spring Chinook, steelhead and coho salmon in Nason Creek, with the specific objective to determine the potential for naturally produced juvenile coho salmon to negatively impact spring Chinook salmon and steelhead parr through competition for space and food. Due to the low numbers of naturally produced coho in Nason Creek during the feasibility phase of the reintroduction effort, we out-planted approximately 33,000 hatchery coho fingerlings in Nason Creek for the competition evaluations. Although the scatter-planted coho salmon were of hatchery origin, they served as a surrogate for naturally produced coho, providing valuable information regarding interactions between juvenile coho, Chinook and steelhead. Scatter-planting densities were based on the estimated carrying capacity and temporary coho escapement limits (memo from Tim Tynan, NMFS-SFD and Laurie Weitkamp-NWFSC, June 29, 2001). The estimate was provided by Tom Cooney (NMFS-UCR TRT). The study designs were reviewed and approved by the mid-Columbia coho TWG. During the course of both studies, we collected data on distribution; macrohabitat preference; microhabitat use in control and treatment reaches; and growth of age-0 spring Chinook salmon, age-0 coho salmon, and yearling steelhead. During the studies, we collected micro-habitat data on 4,968 juvenile Chinook, 729 juvenile coho, and 254 juvenile steelhead.

We found that coho, Chinook, and steelhead select different microhabitats. Coho did not appear to displace Chinook or steelhead from preferred microhabitats (there was no difference in microhabitat use by Chinook and steelhead prior to, and after, coho scatter-planting) (Murdoch et al. 2004; Murdoch et al. 2005). The presence of coho in the treatment reaches did not affect the growth or condition factor of Chinook or steelhead. The extensive data collected during both years lends convincing evidence that the reintroduction of juvenile coho, at accepted densities, is unlikely to negatively affect Chinook or steelhead through competition for space and food. The microhabitat selection results we observed are consistent with other studies and have been well supported in the literature (Hartman 1965; Lister and Genoe 1970; Allee 1981; Glova 1987; Bisson et al. 1988; Spaulding et al. 1989; Murphy et al. 1989; Bugert and Bjornn 1991; Taylor 1991a; Mullan et al. 1992; Nickelson et al. 1992; Beecher et al. 2002; Hicks and Hall 2003; Riley et al. 2004).

Predation by naturally reared coho on spring Chinook fry

During July 2002, approximately 33,000 coho parr were scatter-planted in Nason Creek between RK 3.0 and 13.0. Details on scatter-plant location and numbers can be found in Murdoch et al. 2004. The scatter-planted coho over-wintering in Nason Creek were recaptured in the rotary smolt trap described in Section 3.2.1. Trap operation began the second week of March and continued until mid-June. The scatter-planted coho were identified by an adipose clip and verified in the lab through coded wire tag (CWT) recovery. During the predation evaluation, all naturally reared coho and naturally produced coho were retained for stomach content analysis. In lieu of a measured residence time, an estimated "predation window" was used in the expansion equations described in Murdoch et al. 2005. The predation window was calculated as the time between mean Chinook fry emergence, as measured by tracking temperature units and verified by catch at the trap, and mean passage of scatter-planted coho at the trap.

During the study, 37 naturally reared coho smolts were captured in the rotary smolt trap (mean fork length = 108.9 mm; standard deviation = 13.9). All were retained for stomach content analysis. Of the 37 coho, one had consumed a fish, which was not positively identified as a spring Chinook fry (Murdoch et al. 2005). We analyzed the data as a "worst case scenario" by assuming that the prey fish collected were confirmed as spring Chinook.

Results of the stomach content analysis indicate that naturally reared coho fed primarily on insects. Of all the naturally reared coho samples collected during the study (n=37), 28 (75.7%) contained insects. Five (13.5%) of the samples were empty, five (13.5%) contained plant material, one (2.7%) contained fish, and two (5.4%) were unidentifiable (likely detritus or other digested fish food).

After expanding the incidence of predation by the "window of predation," estimated gastric evacuation rate, and the estimated number of naturally reared coho in the river during the study, we estimated the total number of spring Chinook fry consumed to be 1,265 or 0.17% of the spring Chinook fry population in Nason Creek.

The small sample size of naturally reared coho may not have resulted in an accurate estimate of the incidence of predation. Results of a z-test for differences in proportions indicate no significant difference in the incidence of predation between naturally reared and hatchery coho (p=0.31). Reasons the rate of predation could be higher for naturally produced coho than for hatchery coho include increased residence time (increased opportunity to consume spring Chinook fry), and dietary differences as a result of natural rearing. Because naturally produced coho are smaller than hatchery coho, their ability to consume a spring Chinook fry may be size-limited. An accurate measure of predation by naturally produced coho smolts on newly emerged spring Chinook fry may not be possible until more natural coho are produced in tributaries containing spring Chinook.

3.3 Post-Feasibility Studies Monitoring Results

2017 Update: *This section, which is new in the 2017 version of the Master Plan, continues the reporting of performance indicator monitoring described in Section 3.1.*

A monitoring and evaluation plan for the proposed phased program was included in the 2010 version of the Master Plan (see updated version in Chapter 7). Those activities were designed to monitor the success of the proposed "full implementation" coho restoration program. Many activities continued from the feasibility studies and are reported in this section; other studies were designed to provide data to address remaining uncertainties, such as the ability of returning adults to navigate Tumwater Canyon and the risks associated with potential effects of supplemented species (including coho salmon) on non-target taxa.

Metrics were established in the 2010 Master Plan to determine when each phase of the proposed program would be considered successful, including broodstock collection numbers (see the summary in Chapter 4 and the details in Chapter 5); and contingency plans were identified in Chapter 4, Section 4.3.5 that provide guidance should those metrics not be met.

Monitoring data for the completed Broodstock Development Phase 1 and the ongoing Broodstock Development Phase 2 are reported in Chapter 5, Sections 5.1 and 5.2. Monitoring of adult returns to Tumwater Canyon has resulted in implementation of one of the contingency plans for BDP2 in the Wenatchee basin (see Section 5.2.1 for a summary, and Appendix 1 for the *full study results report). The risk assessment is now complete, with a summary of results in Section 7.2.1.1 and the full report in Appendix 2).*

3.3.1 Coho Survival

Smolt-to-adult survival rates (SARs) capture the survival of coho smolts after release from the acclimation pond through the remainder of their lifecycle to return as adults. SARs capture mortality that occurs during the migratory corridor, estuary, and in the ocean. Due to fluctuations in migratory and ocean conditions, SARs are highly variable for all species; however as coho become locally adapted to the Upper Columbia, including the longer migration as both juveniles and adults, we expect SARs to increase over time. We measure SARs-to-basin based on known spawning escapement (i.e., redd counts; Figure 3-5) and SARs to the upper Columbia based upon dam counts (Figure 3-6).

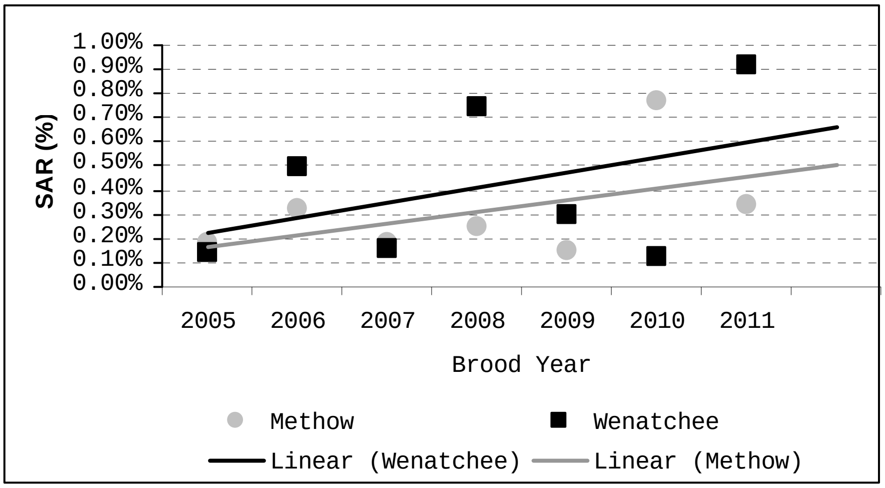

Figure 3-5. Smolt-to-Adult Survival Rates for Hatchery Coho in the Methow and Wenatchee Rivers, BY 2005-2011 (in-basin escapement)

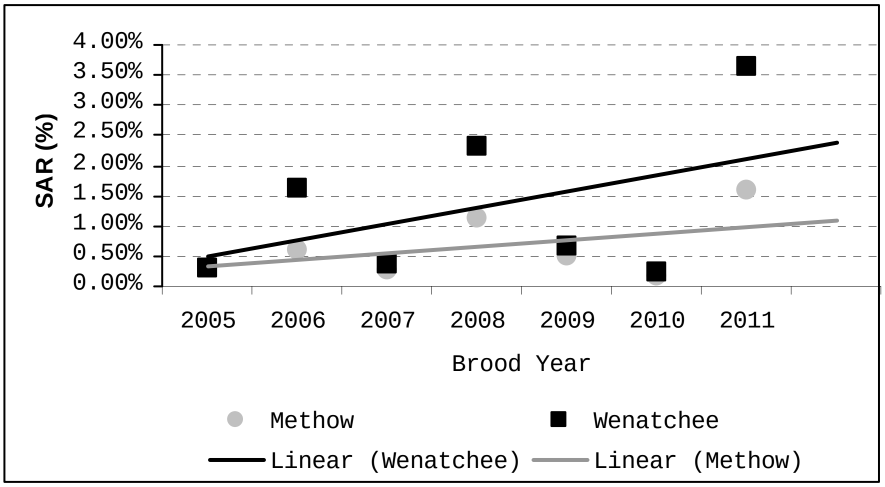

Figure 3-6. Smolt-to-Adult Survival Rates for Hatchery Coho in the Methow and Wenatchee Rivers, BY 2005-2011 (dam counts) [19]

[19] SARs for the Wenatchee are calculated as the difference between the number of coho counted at Rock Island Dam and Rocky Reach Dam; SARs for the Methow are based on the number of coho counted at Wells Dam.

3.3.2 Spatial Distribution of Returning Adults

Redd counts provide an estimate of spawning escapement along with the distribution of reintroduced coho salmon. During the BDP1 and BDP2 phases, as expected, the spawner distribution in the Wenatchee has been largely concentrated in Icicle Creek and areas downstream of Icicle Creek. Icicle Creek provides only limited rearing and spawning habitat for coho; therefore, spawner success in Icicle Creek is limited by both lack of suitable habitat and by density dependent factors. We expect spawning distribution to shift to higher quality habitats following the implementation of the Natural Production phases.

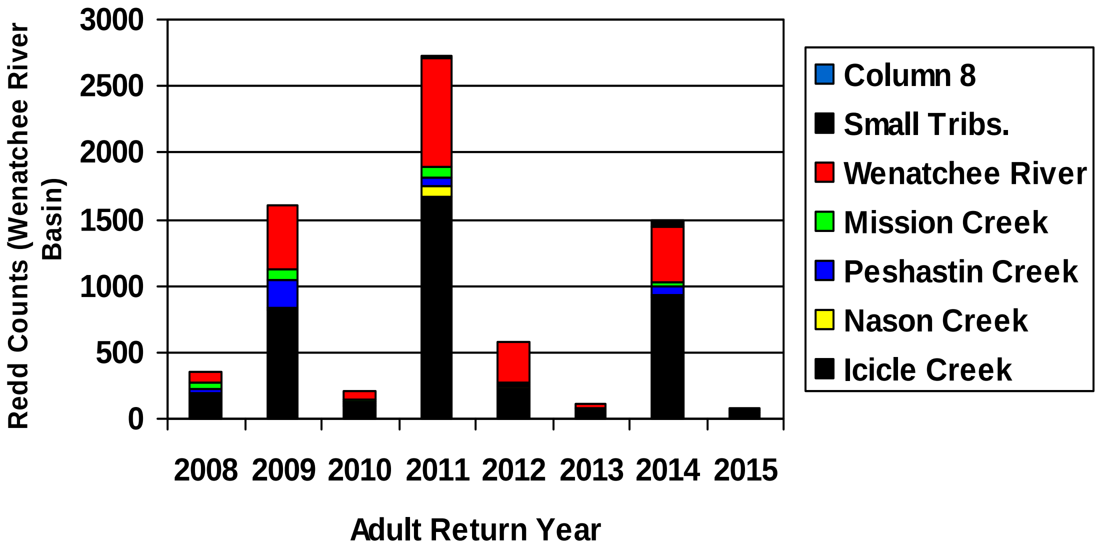

Figure 3-7. Number and Distribution of Coho Redds in Wenatchee Basin, 2008 – 2015

Similar to the Wenatchee basin, the coho spawner distribution during BDP1 and BDP2 in the Methow basin is largely the result of releasing most coho from Winthrop NFH (Figure 3-8). Returning coho are homing back to the hatchery, spawning in the outfall areas and in the Methow River downstream from the hatchery. Following the implementation of the Natural Production Phases we would expect to see a shift in redd distribution to the Chewuch, Twisp, and upper Methow rivers, reducing densities in the area surrounding the fish hatcheries.

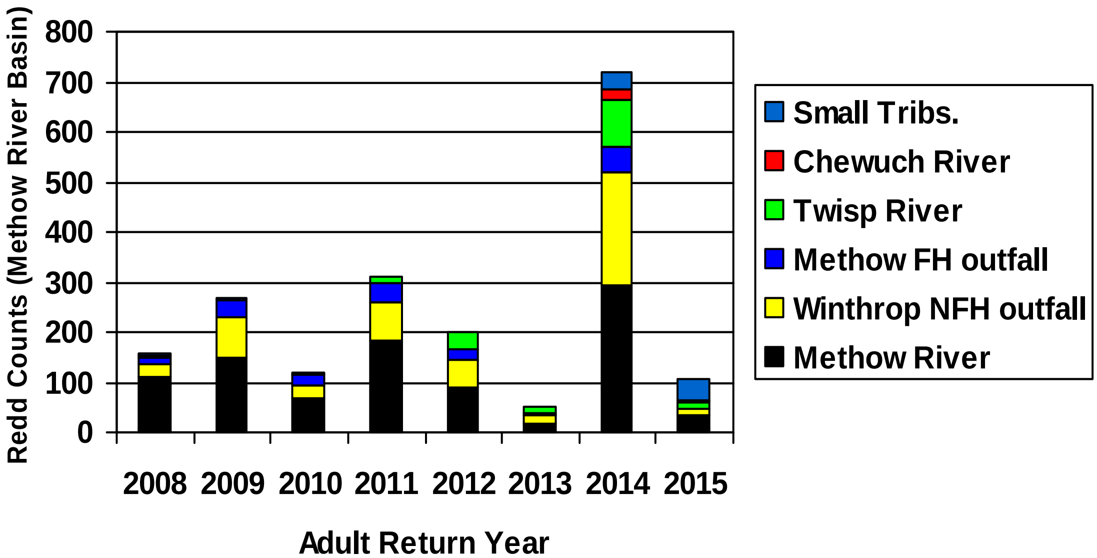

Figure 3-8. Number and Distribution of Coho Redds in Methow Basin, 2008 – 2015

3.3.3 Natural Production

Spawning escapement in the natural environment is not an objective of the broodstock development phases (which is where the phased program is now), so performance standards for NRR or NOR escapement were not established. To meet broodstock development goals, most coho smolts are released in Icicle Creek, which provides very limited spawning habitat. Nonetheless, because natural production is an ultimate goal of this program, we are monitoring natural spawning to the extent possible to provide a baseline for future phases and to determine if natural spawning is increasing.

Egg-to-emigrant survival rates are based on data from redd surveys and juvenile smolt trapping. Coho redds can be notoriously hard to find. In some years, high fall flows and associated turbidity result in an underestimate of spawning escapement. The natural smolt estimate is generated through the WDFW smolt trapping in the lower Wenatchee River.

Table 3-5. Natural coho production in the Wenatchee River, Brood Years 2005 - 2011

Brood Year	Redds	Natural Smolt Estimate[1]	Egg-to-Emigrant Survival[2]	Smolt-to-Adult Survival[3]	Smolt-to-Adult Survival[4]	Return Year
2005	940	48,708	1.81%	0.15%	0.30%	2008
2006	110	16,753	4.87%	1.36%	4.41%	2009
2007	1,671	20,335	0.51%	0.36%	0.84%	2010
2008	346	20,741	1.83%	0.81%	2.57%	2011
2009	1,601	NA[5]	NA[5]	NA[6]	NA[6]	2012
2010	216	NA[5]	NA[5]	NA[6]	NA[6]	2013
2011	2,721	30,342	0.36%	0.51%	3.58%	2014

[1] Natural coho smolt production estimate provided by (WDFW unpublished data).
[2] Egg-to-emigrant survival should be viewed as a maximum due to the possibility of unidentified and uncounted coho redds.
[3] Survival rate using in-basin escapement counts.
[4] Survival rate using dam counts of Rock Island minus Rocky Reach.
[5] Estimate not provided due to relocation of the Lower Wenatchee trap operated by WDFW.
[6] Survival rate not possible due to inability to provide a smolt estimate for the basin.

Table 3-6. Natural coho production in the Methow River, Brood Years 2005 - 2011

Brood Year	Redds	Natural Smolt Estimate[1]	Egg-to-Emigrant Survival[2]	Smolt-to-Adult Survival[3]	Smolt-to-Adult Survival[4]	Return Year
2005	25	1,999	3.07%	0.17%	0.28%	2008
2006	76	412	0.18%	*7.90%*[5]	*15.04%*[5]	2009
2007	187	1,144	0.25%	1.00	1.55%	2010
2008	92	1,009	0.35%	*0.00%*[6]	1.12%	2011
2009	269	2,330	0.32%	*0.00%*[6]	*0.00%*[6]	2012
2010	119	1,618	0.43%	0.76%	1.51%	2013
2011	312	3,147	0.35%	0.53%	2.51%	2014

[1] Natural coho smolt production estimate provided WDFW (unpublished data).
[2] Egg-to-emigrant survival should be viewed as a maximum due to the possibility of unidentified and uncounted coho redds.
[3] Survival rate using in-basin escapement counts.
[4] Survival rate using dam counts of Wells Dam counts.
[5] Likely overestimate of smolt-to-adult survival due to low smolt emigration estimate.
[6] Unlikely zero natural origin fish were produced from these brood years; likely 1) artifact of low carcass recoveries and 2) lack of broodstock collections at Wells Dam (run-at-large which would have identified NO adults) due to high proportion of swim-ins to Winthrop NFH (entirely comprised of HO returns).

Chapter 4.
Overview of Proposed Program and Alternatives

Chapter 4. Overview of Proposed Program and Alternatives

4.1 Introduction

Feasibility study results and subsequent monitoring, as summarized in Chapter 3, demonstrate that coho can be successfully reintroduced into mid-Columbia river basins.

For the following reasons, the YN proposes to continue and expand the reintroduction program over the long term.

- Coho are returning to a number of watersheds in the Wenatchee and Methow basins and reproducing naturally.
- We have demonstrated that it is possible to develop a local broodstock from Lower Columbia River (LCR) stocks. The program no longer relies on transfers of LCR coho to the Wenatchee or the Methow rivers (see Section 3.1 of this plan).
- Studies have shown little or no risk of adverse ecological interactions between hatchery-produced coho and listed and sensitive species in these basins.
- Reintroducing coho meets restoration goals as laid out in the Columbia River Anadromous Fish Tribal Fish Restoration Plan, *Wy-Kan-Ush-Mi Wa-Kish-Wit* (CRITFC 1995).
- Agreements under *U.S. v. Oregon* entitle YN to releases of 1.5 million coho in mid-Columbia basins. YN and WDFW believe that establishing self-sustaining and naturally reproducing populations of a locally adapted stock is more ecologically sound and more likely to allow the program eventually to be terminated than if fish are produced under a traditional harvest augmentation program.

The resource co-managers, YN and WDFW, have established a goal of reintroducing naturally reproducing coho in Wenatchee and Methow tributaries. While questions remain, the co-managers believe the feasibility studies and subsequent program activities demonstrate that they are questions of *how best* to achieve the goal of reintroducing a naturally reproducing, locally adapted coho population, rather than *whether* it can be done (YN/WDFW letter to NPCC, 8/16/04).

4.2 Issues/Alternatives Considered in Program Development

In this section, we present the background for how and why the proposal was developed.

4.2.1 Alternatives Considered

As the feasibility studies neared their conclusion and began showing encouraging results, program managers considered how to proceed. Initially, overall program options appeared to fall into three broad categories:

1) Take no further action to restore coho
2) Continue feasibility studies
3) Pursue approval and funding for a traditional (non-experimental) supplementation-style program.

The option to **take no further action** is not a reasonable alternative, given the successes to date. In addition, it is not a cost-effective or ecologically sound use of *U.S. v. Oregon* fish, nor does it effectively meet tribal restoration goals, goals in the subbasin plans, or a variety of policy guidance from the last several years that endorses re-establishment of coho in mid-Columbia tributaries. While some natural reproduction is taking place in the Wenatchee and Methow basins, it is too limited to ensure self-sustaining populations in those areas. Simply planting un-acclimated fish in those basins without continuing to develop a locally adapted broodstock would be spending limited funds and resources on producing fish that experience has shown survive at lower rates than locally adapted fish. Concerns about the effect of naturally reproducing coho on listed species in the basins would not be addressed without a monitoring program in place.

The option to **continue feasibility studies** is not necessary or cost-effective because feasibility questions have been answered—coho will survive to return to mid-Columbia basins, a locally adapted broodstock is being developed, and risks to other species from hatchery fish have been shown to be low.

To date, the template for a **traditional supplementation program** can best be described as establishing some production goal (rarely habitat-based), designing and constructing facilities to achieve that goal, followed with monitoring and evaluation activities to determine if the goal was achieved. The long-term facility/program footprint would be established and permanent prior to any results from monitoring and evaluation that could significantly alter or terminate part or all of a program.

Initially, YN considered proposing a traditional supplementation program in three basins—in the Wenatchee and the Methow, as well as in the Entiat (which was part of the long-term vision from the outset). However, co-managers and members of the TWG raised several concerns, including:

- the costs of a program to reintroduce a non-listed species when the regional focus seems to be on restoring listed fish; and
- the concern that effects of naturally reproducing coho on listed species had not been effectively studied because adequate numbers of such coho were not yet available to allow a statistically meaningful study.

2017 Update: *The EIS on the proposed program (part of Step 2 of the Council's 3-step process) considered the No Action Alternative as required by the National Environmental Policy Act (NEPA). This alternative was defined in Section 2.3 in the EIS and its effects on environmental resources were evaluated throughout the document.*

Alternatives to the proposed action were suggested by the public during scoping and reviews of the EIS, and by ISRP in its review of the 2010 Master Plan. These alternatives were not evaluated in detail in the EIS (see Section 2.4 of the EIS). The rationale for not considering the ISRP alternative in detail is reproduced in its entirety below.

Independent Science Review Panel Alternative

During reviews of the Master Plan prepared for the Council, its Independent Science Review Panel (ISRP) suggested modifications to the program design. In some cases, their suggestions became part of the proposal. The most recent and significant alternative suggested by the ISRP is reproduced below from the ISRP letter of November 24, 2009 (Memorandum ISRP 2009-47 to Tony Grover, Director, Fish and Wildlife Division, Northwest Power and Conservation Council from Eric Loudenslager, ISRP Chair).

Under ideal circumstances one program design would involve splitting the combined production into lower and upper releases, each with unique tags, in the first generation. These two groups would be genetically identical for all practical purposes. The proportions (or numbers) of each of these two groups that arrive at Tumwater Dam would be compared. In this first generation, this would measure the environmental effect of the different release sites on the migration distance within the subbasin. In the second generation, fish that returned to Dryden and fish that returned to Tumwater would be mated within return locations. Paired releases of the progeny of these parents would be conducted both in the upper and lower sites in the river. The contrast of return site between the two subpopulations released from the same location would serve as a measure of response to selection (adaptation). The magnitude of the response would serve to predict the number of generations required to achieve the goals for each of the program phases and facilitate establishing causation, which is needed if the contingency plan needs to be implemented. If a program like this was used it would make a significant contribution to documenting genetic and environmental sources of variation influencing an attempt to reestablish a self-sustaining extirpated population.

While this approach to program design could provide interesting data, it delays practical results in favor of a scientific exercise that develops alternative program designs in order to model their potential differing outcomes in advance. In addition, it would be difficult to evaluate the effect of migration distance on adult coho survival within the two basins. After surviving the hundreds of miles of migration from the Columbia River mouth to the mid-Columbia basins, it is unlikely that adult migration distance within the basins would be a significant survival factor. For example, in the Wenatchee basin, the distance between Dryden Dam and Tumwater Dam is only 15 miles, compared to the 486 miles and 7 dams from the mouth of the Columbia River to Dryden Dam. More likely, the in-basin key to survival would be the habitat conditions within the basins, and, for the Wenatchee, the hydrographic difficulty for adults (rather than the distance) of reaching high quality spawning and rearing habitat above Tumwater Canyon (K. Murdoch, YN Fisheries Biologist, personal communication, November 2009). The hydrographic challenge of Tumwater Canyon is also a reason not to try to breed separate upper and lower Wenatchee basin coho populations. Biologists do not know which characteristics, visible or not, contribute to coho successfully navigating Tumwater Canyon, so they do not want to unintentionally select out the genetic diversity that would allow these fish to survive the highly variable conditions of that reach of the Wenatchee River.

This ISRP alternative does not require detailed evaluation in this EIS because the effects on the environment would fall within the range of effects already being analyzed.

4.2.2 Rationale for Proposed Program

To balance the concerns raised by WDFW and the TWG with the encouraging results from the feasibility studies and the long-standing policy goals related to coho, the original plan was modified.

- The current proposal differs from the traditional approach in that it allows for potential program changes as a result of monitoring and evaluation. The basic concept is to initially minimize the impact of the facility footprint (see Sections 4.3.2 and Chapter 6), and to evaluate what does or does not work in achieving project goals by using or modifying existing facilities in the early program phases. This approach allows evaluation and adaptive management, which in turn enables new facility development to proceed in a cost-effective manner.

- The proposal calls for studies of effects of naturally reproducing coho on listed species, when numbers of naturally produced coho are sufficient to undertake such studies (Sections 4.3.3 and 7.2). They would be preceded by baseline monitoring of listed and sensitive species, to allow proponents to determine whether the status of sensitive species changes as coho numbers increase.
- The proposal includes contingency plans for considering a change in direction, focus, or specific activities of the program based on monitoring results at several key stages (Section 4.3.5).
- With limited resources for the program and the desire of regional fish managers to maintain the Entiat as a reference stream, at this point the program will focus on the basins with more habitat potential—the Wenatchee and Methow.
- The proposed program terminates when restoration goals are met.

The proposal attempts to balance political, practical, and ecological concerns. The Yakama Nation has a treaty right, under the Treaty of 1855, to take fish in usual and accustomed places. This means that fish runs must pass those usual and accustomed places; coho do not now pass such places in the mid-Columbia in harvestable numbers. Because the *U.S. v. Oregon* process promotes exercise of the Yakama Nation's treaty rights, the Northwest Power Act requires the Council's Fish and Wildlife Program and implementing activities to be consistent with *U.S. v. Oregon* requirements (16 U.S.C. Sec. 839b(h)(6). The Columbia River Fish Management Plan, which implements *U.S. v. Oregon* directives, allocates a certain number of coho to mid-Columbia basins. The Yakama Nation believes that developing these fish into naturally reproducing populations is a more ecologically sound and ultimately cost-effective method of attempting to restore treaty rights related to coho, and will, in the long-term, result in more significant opportunities for both tribal and non-tribal harvest, than simply dumping them into mid-Columbia tributaries will ever achieve. Despite the money spent on previous traditional coho hatchery programs in the basins, little or no harvest occurred in mid-Columbia tributaries that were usual and accustomed fishing places for Yakamas. The Tribal Restoration Plan has included a goal of restoring coho populations since 1995. Furthermore, the Methow and Wenatchee subbasin plans both name coho as a focal species.

At the same time, Yakama Nation and WDFW recognize the importance of ensuring other species are not adversely affected. Spring Chinook, for example, are extremely important culturally to the YN, as they are to other tribes and to non-tribal fishers. The YN has no desire to reintroduce coho at the expense of spring Chinook, steelhead, or other fish species. Yet, in practical terms, continuing feasibility studies for many more years, without making larger-scale attempts to increase numbers of coho in mid-Columbia tributaries, simply adds costs to the region's efforts to restore coho with no benefit in terms of harvest or ecological diversity. In addition, the small-scale studies of interactions done so far demonstrated that effects (either beneficial or adverse) are unlikely to be observed until a significant number of juvenile and adult coho are introduced into the regional ecosystem.

The extensive monitoring program proposed (see Section 4.3.3 for a summary and Chapter 7 for details) is necessary in order to:

1) help proponents to respond to potential species interactions;

2) determine if or when goals of each phase have been achieved;

3) guide any necessary adaptations in program management or direction;

4) provide scientific documentation of the results of this innovative program.

The expense of the monitoring program is offset by the relatively low capital costs achieved by focusing on use of existing facilities for the first two phases of the program; and by proposing primarily low-cost new facilities in later phases, if warranted.

4.3 Proposed Program

The proposed program as summarized in Section 4.3.1 below and detailed in Chapter 5 was reviewed by the NPCC's Independent Science Review Panel (ISRP) in summer and fall of 2009. The panel suggested that the proposed program take a different approach to broodstock collection, smolt releases, and monitoring, particularly in the second phase of Broodstock Development. YN modified the Contingency Plan (Section 4.3.5) in response to the comments, but for the Master Plan, has chosen to retain the phased approach as written in the 2009 draft. The Environmental Impact Statement (USDOE/BPA 2012), discussed in more detail this and other alternative approaches suggested during reviews.

4.3.1 Phased Approach

The proposed coho salmon reintroduction plan builds on the Mid-Columbia Coho Reintroduction Feasibility Study begun in 1997 (see Section 2.1).

The conceptual plan in the Wenatchee and Methow basins originally included five distinct phases. However, since the first version of the Master Plan (2006) was written, the first phase (Broodstock Development Phase 1) was completed in both basins.

The program is designed to be discontinued after a minimum of five generations of natural production supplementation, unless it can be demonstrated that continued supplementation is needed to meet program goals. The ultimate long-term goal (as defined in the plan's biological objective and metrics) is to create naturally reproducing populations which would provide harvest in most years.

- **Broodstock Development Phase 1 (BDP1)** was designed to develop a mid-Columbia broodstock from lower Columbia River coho, so that they would become increasingly adapted to the longer migration to mid-Columbia tributaries. BDP1 focused on eliminating reliance on lower Columbia stocks and transitioning to a local broodstock.
- **Broodstock Development Phase 2 (BDP2)** is designed to encourage local adaptation of the broodstock by moving broodstock capture sites further upstream. The objective is to determine if the reintroduced stock is able to exceed what might be its current limits of stamina and run timing, thus allowing coho to begin to occupy the better quality habitat in the upstream portions of the basins (Murdoch et al. 2004). This phase has been completed in the Methow basin and is currently underway in the Wenatchee basin.
- **Natural Production Phases** focus on decreasing domestication selection and increasing fitness in the natural environment. Hatchery coho will be introduced to habitat areas predicted by EDT to be the most successful for coho, with a few additional areas included in order to respond to contingencies (see Section 1.4.1/Council Requirement 5). Also, hatchery and natural broodstock compositions will be managed to increase the proportion

of natural influence (PNI)[20] in the population, with the goal of having a PNI value greater than 0.5; that is, the natural environment must have a greater influence on the population than the hatchery environment. The natural production phases are described below.

- **Natural Production Implementation Phase (NPIP)** proposes high smolt release numbers into most habitat areas for one generation (3 years). The goal is to begin the local adaptation[21] process by releasing enough hatchery fish in the natural environment to result in a spawning aggregate in each tributary of sufficient size that natural selection can act upon the population, and enough first-generation natural-origin adults will begin to return so that they can be incorporated into the broodstock as the Natural Production phases continue. YN is ready to begin this process in the Methow basin as soon as all acclimation sites are permitted.
- **Natural Production Support Phases 1 and 2** would emphasize further local adaptation and naturalization. Initially, release numbers would be reduced by 30% from the numbers released during NPIP. The goal would be to increase the proportion of natural-origin fish in the broodstock (pNOB) to 35% and to limit the proportion of hatchery-origin fish on the spawning grounds (pHOS) to 75%. As we reach this initial goal, we will continue to reduce the hatchery program size, increase the pNOB and decrease the pHOS to the point that we are able to reach a PNI value greater than 0.50 (pNOB = 80%, pHOS < 65%). A PNI > 0.5 is predicted to result in increased natural fitness and survival rates for the population (L. Mobrand, pers. comm.). The total expected duration of the Support Phases is four generations (12 years).

Key goals and management strategies for the five phases in each basin are summarized in Tables 4-1 and 4-2.

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[20] If pNOB is the percent natural-origin fish in the hatchery broodstock and pHOS is the percent hatchery-origin fish among natural spawners, then PNI= pNOB/(pNOB+pHOS).

[21] We use the term "local adaptation" to refer to the process of naturalization: addressing the loss of fitness that occurs with hatchery stocks by emphasizing selection in the natural environment so that the population becomes adapted to habitats within each subbasin and ultimately achieves PNI > 0.5. "Local adaptation" is distinguished from "broodstock development" which selects for coho that can return to the Wenatchee and Methow rivers but does not address loss of fitness and adaptation to the natural environment.

Table 4-1. Wenatchee basin program summary

	BDP1	BDP2	Natural Production Implementation	Natural Production Support	Long Term Biological Objective
Management Goal	-Eliminate transfers of Lower Columbia River Brood. -Broodstock collection = 1,312.	-"Fine tune" broodstock so that returning coho can reach key habitat in the basins. -Broodstock collection = 1,050.[a]	-Initiate natural production in key habitat areas. -NOR [b] escapement >600.	-Develop locally adapted fully integrated stock. -NOR escapement >900.	-Self-sustaining, naturally reproducing population is established. -NOR escapement >1,500. -Terminal and mainstem harvest in most years.
Management Strategy	-Primary release site in Icicle Creek. -Broodstock collected at Dryden Dam and LNFH.	-Release 50% of smolts above Tumwater Dam, 50% in Icicle Creek. -Broodstock collected at Tumwater Dam.	-Release Wenatchee juveniles in areas predicted by EDT[e] to be most productive for coho in sufficient numbers to seed habitat and begin local adaptation. -Substitute adult outplants if no suitable acclima-tion sites exist. -Implement matrix schedule for harvest and broodstock management. pNOB [c] = 10% pHOS [c] = 90%	-Further local adaptation process and reduce domestication selection. -Convert to integrated hatchery program and move towards PNI >0.5. [d] -Implement matrix schedule for harvest and broodstock management. pNOB = 80% pHOS = 65%	-Harvest according to the matrix schedule. -Implement hatchery supplementation as needed to prevent extirpation and achieve harvest goals, subject to condition that PNI >0.5.

a. BDP 2 would be considered completed when 50% of the female broodstock are available for trapping at Tumwater Dam.
b. NOR = natural-origin recruits: the number of natural-origin coho allowed to pass collection points and proceed to spawning grounds.
c. pNOB = proportion of natural-origin fish in broodstock; pHOS = proportion of hatchery-origin fish on spawning grounds.
d. PNI = proportionate natural influence (in the population).
e. EDT was the primary guide to identify coho release locations; however, additional locations lower in the basin (assumed to have supported coho historically) were also selected to support the contingency plan and to evaluate where coho would be most successful. See Section 1.4.1/Council Requirement 5.

Table 4-2. Methow basin program summary

	BDP1	BDP2	Natural Production Implementation	Natural Production Support	Long Term Biological Objective
Management Goal	-Eliminate transfers of Lower Columbia River Brood. -Broodstock collection = 656.	-"Fine tune" broodstock so that returning coho can reach key habitat in the basins. -Broodstock collection = 1,312 trappable coho: at least 656 [a] at Winthrop NFH, the remainder at Wells FH.	-Initiate natural production in key habitat areas. -NOR [b] escapement >600.	-Develop locally adapted, fully integrated stock. -NOR escapement >900.	Self-sustaining naturally reproducing population is established. -NOR Escapement >1,500. -Terminal and mainstem harvest in most years.
Management Strategy	-Primary release sites at WNFH and Wells FH. -Primary broodstock collection site is Wells Dam.	-Primary release sites at WNFH and selected tributaries (Twisp, Chewuch, etc.) -Primary collection sites at WNFH and tributary weirs.	-Release Methow juveniles in areas predicted by EDT[e] to be most productive for coho in sufficient numbers to seed habitat and begin local adaptation. -Substitute adult outplants if no suitable acclima-tion sites exist. -Implement matrix schedule for harvest and broodstock management. pNOB [c] = 10% pHOS [c] = 90%	-Further the local adaptation process and reduce domestication selection. -Convert to integrated hatchery program and move towards PNI [d] >0.5. -Implement matrix schedule for harvest and broodstock management. pNOB = 80% pHOS = 65%	-Harvest according the matrix schedule. -Implement hatchery supplementation as needed to prevent extirpation and achieve harvest goals, subject to condition that PNI >0.5.

a. A total of 1,312 broodstock would be needed to increase release numbers during the Natural Production Implementation Phase, some of which may be trapped at Wells FH.
b. NOR = natural-origin recruits.
c. pNOB = proportion of natural-origin fish in broodstock; pHOS = proportion of hatchery-origin fish on spawning grounds.
d. PNI = proportionate natural influence (in the population).
e. EDT was the primary guide to identify coho release locations; however, additional locations lower in the basin (assumed to have supported coho historically) were also selected to support the contingency plan and to evaluate where coho would be most successful. See Section 1.4.1/Council Requirement 5.

Table 4-3 shows release plan numbers for each phase in both the Wenatchee and Methow basins. It should be noted that Broodstock Development Phase 2 has lasted longer than anticipated when this phased approach was developed. See discussion in Section 5.2.

Table 4-3. Proposed smolt release numbers

WENATCHEE																				
Broodstock Dev																				
Phase 1																				
Phase 2	1.00	1.00	1.00	1.00	1.00															
Natural Production																				
Implementation						1.16	1.16	1.16												
Support Phase 1									0.81	0.81	0.81	0.81	0.81	0.81						
Support Phase 2															0.40	0.40	0.40	0.40	0.40	0.40
WEN. SUBTOTAL	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.16**	**1.16**	**1.16**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**
METHOW																				
Broodstock Dev																				
Phase 1	0.50	0.50																		
Phase 2			0.50	0.50	0.50															
Natural Production																				
Implementation						1.00	1.00	1.00												
Support Phase 1									0.70	0.70	0.70	0.70	0.70	0.70						
Support Phase 2															0.35	0.35	0.35	0.35	0.35	0.35
MET. SUBTOTAL	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**1.00**	**1.00**	**1.00**	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**
TOTAL	**1.50**	**1.50**	**1.50**	**1.50**	**1.50**	**2.16**	**2.16**	**2.16**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**

(numbers are in millions)

4.3.2 Proposed Facilities – Overview

The MCCRP's design is based on input from experienced Yakama Nation biologists, reviews of the recent scientific literature, and discussions with regional experts. Important publications include Hatchery Reform: Principles and Recommendations of the Hatchery Scientific Review Group (HSRG) (Mobrand et al. 2004). Many of the conclusions reached by the HSRG about the future of hatcheries and how they should be operated are being implemented by the MCCRP. These include using hatcheries as part of an "integrated strategy" to meet harvest and conservation goals, operating hatcheries "with consideration of the potential for genetic and ecological interactions with natural stocks," and developing plans with well-defined goals and informed feedback.

The project design and operation are also consistent with features of "landscape hatcheries" as described by Williams et al. (2003). MCCRP practices that conform to the recommended principles of ecosystem-based hatchery programs are the capture of locally returning brood that are genetically representative of the local stock; production of fish using wild characteristics as a guideline; rearing on natural water temperatures at low densities; system flexibility (responsiveness to the principles of adaptive management); decentralized, small-scale release sites; and the monitoring and evaluation of results.

A variety of facilities and operating procedures were evaluated and employed to reduce risk, minimize impacts to natural populations, speed reintroduction, and test alternative strategies. These include:

- Trapping adults at hatchery and acclimation return sites, existing dams, existing tributary weirs, and in small temporary weirs if possible.
- Rearing fish in traditional hatcheries and acclimation facilities.

- Acclimating and releasing smolts from hatcheries, existing and constructed ponds, temporary rearing tanks, and in-river seine enclosures.
- Acclimating fish over the winter at sites where cold weather operation is possible and for shorter periods where it is not.
- Planting excess adults in appropriate under-seeded habitat at locations where acclimation sites are impractical.
- Alternating releases from multiple sites in watersheds where several acclimation alternatives exist.

The program described in this Master Plan is a conceptual design. It is expected to change as more is learned about coho stocks in snow-dominated watersheds through the monitoring and evaluation plan. The application of the principles of adaptive management are expected to result in changes to brood capture, fish rearing, and acclimation methods and locations.

Broodstock Development Phases

Fish produced for the broodstock development phases are captured at existing adult traps, produced from existing hatcheries, and released from acclimation sites that for the most part did not require new rearing unit construction. However, modifications to existing facilities were necessary in order to meet project goals. The following facilities have been used during the broodstock development phases:

- Broodstock capture:

  Wenatchee basin: traps at Leavenworth NFH, Tumwater Dam and Dryden Dam.

  Methow basin: trapping facilities at Wells FH, Winthrop NFH, Methow FH, and Wells Dam east/west ladders.

- Broodstock holding and early incubation:

  Wenatchee Basin – Leavenworth NFH for both brood holding and early incubation, Peshastin Incubation Facility for early incubation only.

  Methow Basin - Winthrop NFH for both holding and early incubation.

- Rearing to pre-smolt size: Cascade FH, Willard NFH, and Winthrop NFH.
- Acclimation:

  Wenatchee: Rohlfing, Coulter, Butcher, and Beaver ponds in the upper Wenatchee and Leavenworth NFH on Icicle Creek.

  Methow: Winthrop NFH, Twisp Ponds, Gold Creek in the lower Methow basin, Wolf Creek (formerly known as “Biddle”), and Wells Fish Hatchery.

Locations of existing facilities are shown in Chapter 6, figures 6-1 and 6-2.

Natural Production Implementation Phases

The plan proposes to continue rearing most program fish at existing hatcheries during the NPIP; however, one small hatchery is proposed in the Wenatchee basin (Natapoc Hatchery). Acclimation is planned at a combination of existing and new sites. The release sites primarily target EDT-predicted coho spawning and rearing habitat (see Section 1.4.1/Council Requirement 5). Most acclimation sites are existing waterways (e.g., beaver ponds, wetlands, side channels, etc.) and small, constructed ponds. Table 4-4 lists the facilities currently operating (O) and proposed or being considered for use in the future (F) in each basin; their locations are shown in Chapter 6, figures 6-1 and 6-2.

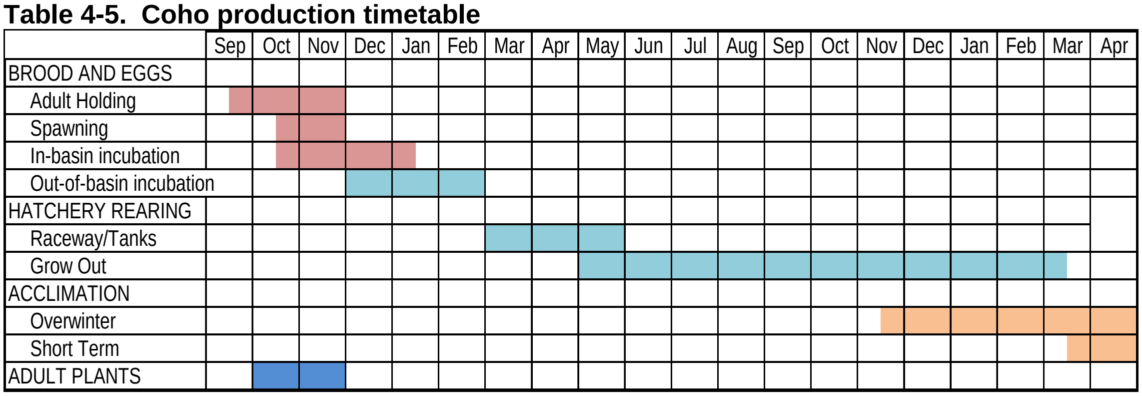
Table 4-4. Summary of facilities

ADULT CAPTURE			
O or F	**Wenatchee**	**O or F**	**Methow**
O	Dryden Dam	**O**	Wells FH
O	Leavenworth NFH	**O**	Wells Dam ladders
O	Tumwater Dam	**O**	Winthrop NFH
F	Chiwawa Weir	**O**	Methow FH
F	Other tributary weirs	**F**	Twisp Weir
		F	Other tributary weirs
INCUBATION/LONG-TERM JUVENILE REARING			
O or F	**Lower Columbia River**	**O or F**	**Methow/Wenatchee**
O	Cascade FH	O	Winthrop NFH
O	Willard NFH	O	Leavenworth NFH (Incubation)
		O	Peshastin Incubation Facility
		F	Natapoc FH
ACCLIMATION			
O or F	**Wenatchee**	**O or F**	**Methow[1]**
O	Leavenworth NFH	**O**	Winthrop NFH
O	Rohlfing	**O**	Lower Twisp Ponds
O	Coulter	**O**	Twisp Weir A.F.
O	Butcher	**O**	Gold Creek
O	Beaver	**O**	Wolf Creek
F	Tall Timber	**F**	Mid-Valley
F	White River Bridge	**F**	Blue Buck
F	White River Springs	**F**	Goat Wall
F	Trinity	**F**	Eightmile Ranch
F	Two Rivers	**F**	Early Winters
F	Merry Canyon	**F**	Newby
F	Brender	**F**	Utley
F	Clear	**F**	Chewuch A.F.
		F	Upper Twisp
ADULT PLANTS[2]			
O or F	**Wenatchee**	**O or F**	**Methow**
F	Dirty Face (confined)	**F**	Hancock (confined)
F	Grouse Creek	**F**	Early Winters Creek
F	Chikamin Creek	**F**	Weeman Bridge
F	Atkinson Flats	**F**	Newby Bridge Creek
F	Sears Creek Bridge	**F**	Buttermilk Bridge
F	Napeequa River	**F**	MSWA
F	Little Wenatchee Road	**F**	Chewuch Bridge

1. Not all these sites will be used; a few sites still are being evaluated.
2. All adult plants are unconfined except the two noted.

The schedule of fish culture activities is shown in Table 4-5. The timing of egg and fish transfer between facility components is guided by this schedule. Adults are moved from capture sites to holding facilities in the fall for ripening and spawning. Green eggs are incubated at or near these holding facilities. All eyed eggs from the Wenatchee program and a portion of the Methow production are moved to hatcheries in late fall/early winter for final incubation and rearing to the pre-smolt stage. The following fall, some of the hatchery production can be moved to target watersheds for over-winter/intermediate rearing to take advantage of a prolonged period of imprinting. Site locations may vary depending on which rearing strategy is employed. In late winter to early spring, the remaining pre-smolts are moved to final acclimation/release sites.

Table 4-5. Coho production timetable



Note: Color differences indicate different facilities.

4.3.3 Summary of Proposed Monitoring and Evaluation Plan

The success of the proposed coho reintroduction plan depends on extensive monitoring and evaluation to answer key questions such as which acclimation sites are most successfully producing returning fish; when the program in each basin can move into a new phase; whether supplementation will be appropriate; and whether naturally produced coho are adversely affecting listed and sensitive species. Table 4-6 summarizes the M&E plan; details are provided in Chapter 7. References to activities for BDP1 are left in the table to show the monitoring that was done for that phase, which is now completed in both basins.

Table 4-6. Summary of M&E activities

M&E Activity	Indicator	Strategy	Restoration Phases	Coordination with other programs
Release-to-McNary survival	Project Performance	PIT tags	BDP1, BDP2, NPIP, NPSP[1]	No
In-pond survival	Project Performance	PIT tags, predation control	BDP1, BDP2, NPIP, NPSP[1]	No
Pre-release fish condition	Project Performance	Physical examination	BDP1, BDP2, NPIP, NPSP	No
Volitional release run-timing and tributary residence	Project Performance / Species Interaction	PIT tags, smolt trapping	BDP1, BDP2, NPIP, NPSP[1]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Spawning escapement and distribution	Project Performance	Redd counts Carcass recovery Radio-telemetry CWT Parentage Based Tagging (PBT)	BDP1, BDP2, NPIP, NPSP	No
Natural smolt production	Project Performance	Smolt trapping CWT Scale analysis	BDP1, BDP2, NPIP, NPSP[2]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Egg-to-emigrant survival	Project Performance	Smolt trapping Redd counts CWT Scale analysis	BDP1, BDP2, NPIP, NPSP[2]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Adult-to-adult survival	Project Performance	Adult trapping Redd counts Carcass recovery CWT PBT	BDP1, BDP2, NPIP, NPSP	No
Adult-to-adult productivity	Project Performance	Adult trapping Carcass recovery CWT PBT Scale analysis	NPIP, NPS	No

[1] PIT tags will be used during NPSP if smolt-to-adult rates are not meeting program goals and further investigation into survival is warranted.

[2] Natural smolt production and egg-to-emigrant survival estimates will be specific to release tributaries during NPIP and NPSP, and have been basin-wide during BDP1 and BDP2.

M&E Activity	Indicator	Strategy	Restoration Phases	Coordination with other programs
Harvest rates	Project Performance	CWT Scale analysis Database queries	BDP1, BDP2, NPIP, NPSP	Yes: Coordinated with harvest management agencies
NTTOC – Size structure	Species Interactions	Smolt trapping	BDP1, BDP2, NPIP, NPSP[3]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
NTTOC – Abundance and survival	Species Interactions / Status of NTTOC	Smolt trapping Underwater observation	BDP1, BDP2, NPIP, NPSP[3]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
NTTOC – Distribution	Species Interactions / Status of NTTOC	Redd counts Underwater observation	BDP1, BDP2, NPIP, NPSP[3]	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Competition	Species Interactions / Mechanisms of Interaction	Underwater observation Enclosures Size and growth	NPIP	No
Predation by naturally produced coho on spring Chinook fry	Species Interactions / Mechanisms of Interaction	Smolt trapping Emergence and emigration timing	NPIP	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Morphometrics and life history traits	Genetic Adaptability	Adult trapping Redd counts Carcass recovery Smolt trapping CWT	BDP1, BDP2, NPIP, NPSP	Yes: CCPUD/ DCPUD HCP Hatchery Programs; GCPUD Hatchery Programs
Contemporaneous life-history and survival rates	Genetic Adaptability	Paired releases of uniquely marked LCR and MCR coho	BDP2, NPSP	No
Genetic monitoring	Genetic Adaptability	Genetic sampling CWT	BDP1, BDP2, NPIP, NPSP	No

[3] Baseline NTTOC monitoring during BDP1 and BDP2, effect monitoring during NPIP and NPSP.

4.3.4 Program Cost Summary

This section summarizes estimated costs for all the program elements. Costs are based on a fish release plan that is expected to last for a minimum of 5 generations of natural production supplementation.

2017 Update: *The summary of costs presented in this section and the detailed costs presented in Chapter 8 were based on the program proposed in the 2010 Master Plan. The overall program evaluated in the Mid-Columbia Coho Restoration Program EIS was similar to the program outlined in the Master Plan, but cost estimates for operating the program were updated for the EIS; capital cost estimates remained the same as those presented in the Master Plan. Because BPA decided to fund the program in 2012 (BPA 2012), the costs in this version of the Master Plan have not been updated. Final cost estimates are expected to be presented to the Council during Step 3.*

Estimates of the capital and operating costs cover the project's lifetime. Capital costs are expected to total $6,730,000 and include land purchase and facility construction. To minimize capital costs, the proposed facility plan for the project makes extensive use of existing regional facilities, including those for brood capture, rearing, and acclimation.

Operating expenses include the operation and maintenance of the facilities, the monitoring and evaluation program, and general and administrative project costs. Operating costs will change over time. Expenses during years when release numbers and operating costs are at their maximum are estimated to be:

Table 4-7. Peak operating costs by basin

	Wenatchee	Methow	Total
Planning, Design, Permits	-	-	-
Rearing	$ 530,870	$ 388,385	$ 919,255
Tagging	$ 513,820	$ 375,911	$ 889,731
O&M	$ 955,706	$ 699,196	$ 1,654,902
M&E	$ 429,586	$ 314,286	$ 743,872
TOTAL OPERATING	**$ 2,429,982**	**$ 1,777,778**	**$ 4,207,760**

The program is being funded by the Bonneville Power Administration, Grant County PUD, and Chelan County PUD. The current program also shares rearing costs with National Oceanic and Atmospheric Administration (NOAA) through the Mitchell Act and the USFWS through the Grand Coulee Fish Maintenance Project; and it shares monitoring and evaluation costs with WDFW. This cost sharing is expected to continue.

4.3.5 Contingency Plans and Decision Processes

The proposed program is the project proponents' best estimate of a program that has a realistic ultimate goal while acknowledging that many unknowns exist because of the experimental nature of this goal. This section suggests alternate courses of action in case goals are not met within the timeframe proponents believe is reasonable.

In applying adaptive management principles, project proponents recognize that decision-makers must take into account political policies and ramifications as well as scientific methods and practices. Any changes to the approved original project must fall within legal limits established for the project, must still meet policy goals of many organizations at many levels, and must be scientifically credible. The following outline focuses on the changes to scientific methods and practices but does not attempt to predict, in most cases, the political or regulatory choices that it might also face if such a scientific course of action would be needed.

This contingency plan is not a rulebook: not all "ifs" can be identified, nor can the synergy between scientific and political factors be assessed in advance. The most definitive statement that can be made is that the formal decision process might need to be reopened if contingency actions are expected to change the impacts predicted in the environmental and regulatory processes that this project has undergone and must continue to undergo in order to proceed.

2017 Update: *Timeframes for obtaining approvals under NEPA and the need to identify and obtain approvals for replacement acclimation sites have delayed the start of the Natural Production Implementation Phase from that predicted in the 2010 Master Plan. As well, the projected timeframe for meeting Broodstock Development Phase 2 goals in the Wenatchee basin was optimistic and has required implementation of some contingency plans (see discussion in Section 5.2.1).*

Experience with low returns during recent drought conditions has demonstrated that we need to anticipate potential delays in moving to a new phase, particularly when moving to the Natural Production Implementation Phase, because this phase does not include an opportunity to repeat due to interaction concerns presented during the feasibility phase and recent ESA consultations. During years with extremely low returns, when annual production goals would be severely hampered (< 50% of broodstock goals attainable), it would be advantageous to the program to have the ability to incorporate gametes from other reintroduction coho programs (e.g., Nez Perce and Umatilla) that are demonstrating divergence from their lower Columbia River founder stock similar to this program. This would be a last-resort option if a return class is at the point of collapse and would severely delay program success.

1. **If BDP1 goals are not achieved within 3 generations:**

   When the Master Plan was first drafted, this seemed a necessary contingency to recognize. However, as of this writing, the program has achieved BDP1 goals in both the Wenatchee and Methow basins. A contingency plan for failure to meet BDP1 goals is now unnecessary.

2. **If BDP2 goals are not achieved within 2 generations:**

   a. Evaluate the cause for failure to achieve BDP2 goals[22]. Possible causes include, but are not limited to: poor trap efficiency, lower than expected SARs (due to migratory or ocean conditions), lower than expected egg-to-smolt survival (in hatchery), the local adaptation process does not proceed as quickly as expected, or we made incorrect assumptions regarding coho habitat and life history in mid-Columbia tributaries. Chapter 7 outlines the monitoring that would be done to help determine the causes, including whether there are physiological or phenotypic differences between fish collected at Dryden Dam and those collected at Tumwater Dam.

   b. Determine if the cause of failure to meet goals can be ameliorated.

[22] Note that the contingency plan is being implemented for the Wenatchee basin. See discussion in Section 5.2.1.

1. If the problem in the Wenatchee basin is that insufficient numbers of fish are able to ascend Tumwater Canyon, and monitoring shows phenotypic or physiological differences between fish collected at Dryden and those collected at Tumwater, then reduce the program enough to collect primarily from Tumwater (or select for the Tumwater-specific traits at Dryden). Repeat BDP2 (two generations) with new broodstock collection goals and/or protocols. If a similar problem exists in the Methow basin, the program could be reduced to accommodate broodstock collection solely at in-basin trapping sites[23].

2. If the problem in the Wenatchee basin is that insufficient numbers of fish are able to ascend Tumwater Canyon but the Methow population continues to progress, then bring some broodstock from the Methow population to breed with the Wenatchee population, to determine if the Methow population's adaptation to longer migration distances can improve the stamina of the Wenatchee population.

b.3 In either basin, if returning adults are failing to meet goals for reaching upper basin tributaries, consider scaling back the program and initiating NPIP in either the lower Wenatchee or lower Methow river.

b.4 If no corrective action can be made and the cause is determined to be due to out-of-basin effects, repeat BDP2 (no more than two generations).

b.5 If no corrective action can be made and the cause is not the result of out-of-basin effects, consider a harvest augmentation program.

3. Natural Production Phases Adaptive Management Process:

The natural production phases are designed to result in a fully integrated program, while decreasing domestication selection and increasing local adaptation in both the broodstock and the natural spawning population. To achieve this, we used the AHA model to address the loss of fitness associated with hatchery programs for five generations of broodstock management. The natural production phases are not measured against a success/failure scenario; rather, they represent an evaluation and decision process—an adaptive management process.

a. After one generation of the Natural Production Implementation Phase, release numbers will be reduced by 30%. The purpose of the Natural Production Implementation Phase is to cycle sufficient coho eggs through the natural environment to begin the local adaptation and naturalization process.

b. For the Support Phases, release numbers initially will be reduced by 30% (from Implementation Phase release numbers), with an initial target of 35% pNOB and 75% pHOS. (Note: AHA does not predict that pHOS objectives will be met until release numbers are further reduced.) If initial pNOB targets are not met within two generations (Support Phase 1), the program will be closely evaluated and adjusted depending upon the reason initial targets have not been reached. Possible reasons include but are not limited to 1) inadequate trapping facilities or protocols; or 2) lower than expected productivity, migratory survival, or marine survival.

[23] Note that this contingency is not necessary for the Methow, as BDP2 goals have been met in that basin. See discussion in Section 5.2.2.

i. If we determine that sufficient natural-origin brood are returning to the basin but we are unable to incorporate sufficient numbers into the broodstock, primary trap locations, operation schedules, or trap modifications may be required. New trap locations or modifications to trap equipment or operation likely would require an environmental and/or ESA review of the effects.

ii. If insufficient numbers of natural-origin coho are returning to the basin, then either productivity, migratory or marine survival are lower than expected and modeled. If the cause is lower than expected productivity, we would reduce program size (production and release numbers) to aid in reaching initial pNOB targets, in an attempt to accelerate the local adaptation process and achieve the program goal of PNI > 0.5. If the cause is migratory or marine survival, consider a harvest augmentation program or a longer-term supplementation program.

4.3.6 Why the Program is Expected to Succeed

The basic premise of the Mid-Columbia Coho Restoration Program is that non-local, domesticated hatchery stocks can be used to develop self-sustaining, naturally reproducing populations in targeted watersheds. Results to date have demonstrated that the concept is viable if properly implemented (Murdoch et al. 2004). The program presents a unique opportunity to develop methods for, and measure rates of, the conversion of hatchery stocks into naturally reproductive and viable populations in new habitats. The AHA model would be used to address the loss of fitness common with hatchery programs by reducing domestication selection and emphasizing local adaptation. This new line of research complements the past two decades of fishery genetics research, which has emphasized the risks of artificial propagation to natural populations, by exploring the potential for using abundant hatchery genetic resources to restore extirpated or demographically vulnerable populations. This is particularly important as regional fishery managers and funding entities consider the role of artificial propagation in the recovery of ESA-listed and non-listed populations and extirpated salmonids.

Previous efforts to transplant salmon populations to new environments show varying outcomes. There are many examples of unsuccessful attempts to develop new populations from both hatchery and natural transplants. Quinn (2005) discusses examples which include serious efforts to introduce: 1) an even-year pink run in Puget Sound, 2) Chinook in Chile, 3) pink salmon on the East Coast, and 4) sockeye in Upper Adams Lake, B.C. He discusses these failures as examples of "the importance of local adaptation to fitness."

Further evidence of the role of local adaptation comes from a coho study done at Big Creek Hatchery in Oregon. Unfertilized eggs and milt were brought to this hatchery from many hatchery locations and reared to smolt size for release. It was found that the distance between the release site and the river of origin had a large impact on survival rates (Reisenbichler 1988). Coho from within the same drainage showed similar and higher survival rates than those moved large distances.

A number of successful introductions demonstrate the potential effectiveness of transplanting donor stocks over long distances to develop new salmonid populations. Examples of successful transplants of anadromous fishes outside the species' range include:

- Pink, coho, Chinook salmon, and steelhead are now self-sustaining in all of the five Great Lakes as a result of hatchery plants in 1956 (Quinn 2005).
- Anadromous populations of Chinook salmon were established in New Zealand from releases to a single river system (the Waitaki) between 1901 and 1907 (McDowall 1994). Spawning Chinook were noted in the Hakataramea River within a few years and within 10 years had distributed to other large glacier-fed rivers on the east coast of the South Island where spawning presently occurs (Kinnison et al. 2001). Due to local adaptation, the New Zealand Chinook populations now phenotypically differ in morphometric and reproductive traits (Kinnison et al. 1998a, 1998b; Kinnison et al. 2001).
- Sockeye transplanted from Baker Lake (Washington) established a self-sustaining population in Lake Washington and Lake Sammamish after the indigenous population was extirpated by the construction of the Montlake Cut in 1917.
- Construction of a dam near the mouth of the Methow in 1915 extirpated the native spring Chinook stock. The Winthrop NFH helped re-establish the run with Chinook captured from the trap at Rock Island Dam after removal of the dam (Brannon et al. 2004).

These successes were probably a result of the transplanted populations having enough of the adaptive traits needed to be viable within the introduced environment. Evaluation of these successes demonstrates that:

1) introduced hatchery stocks have the capacity to quickly adapt to local conditions (Quinn 2005; Brannon et al. 2004; Hendry 2001), and

2) much remains to be learned about the critical elements of successful reintroductions.

The most relevant past attempts at coho reintroduction are in the mid-Columbia region. Mullan (1984) states that despite hatchery releases at Leavenworth, Entiat, and Winthrop National Fish Hatcheries from 1942 to 1975, "there is no evidence to indicate development of a self-sustaining population of coho salmon above threshold levels recorded in the 1930s." The failure to re-establish natural coho runs through these hatchery releases was "to have been primarily related to necessary reliance, because of severe depletion of upper river stock, upon short-run, late-spawning lower river stocks lacking genetic suitability."

In earlier attempts to restore coho, there were few aquaculture or genetic protocols to prepare the stock for local habitat conditions. The mid-Columbia coho program is expected to succeed for the following reasons:

This program emphasizes accelerating local adaptation of donor stocks.

- The phased approach described in detail in Chapter 5 moves broodstock capture and smolt release locations upstream as adaptive criteria, such as tissue lipid levels, skin color, run timing, maturation timing and condition factor increase in the returning adults. Naturalization is encouraged as an evolutionary process.
- Natural-origin fish will be preferentially selected for broodstock to maximize local adaptation and minimize further domestication. The target proportion of natural-origin fish in the broodstock increases and release numbers decrease as the program progresses.
- Improved fish culture techniques (e.g., rearing at low densities, acclimation in natural conditions, following natural growth profiles) have the potential to increase adult return

rates and provide a higher likelihood that enough adults will return to satisfy local broodstock development needs. The higher adult return rates also expand the genetic pool from which local, heritable traits will develop.

- Acclimation and release locations are proposed primarily in areas that have high-quality coho habitat.
- Coordinated efforts to improve habitat conditions for coho salmon and other salmonids should result in increased productivity and survival of naturally produced fish.

This program is taking advantage of improved post-release survival conditions.

- Tributary outmigration survival has increased due to improvements in irrigation screening systems.
- Mainstem Columbia hydro project operations now include water management and smolt protection systems that improve smolt survival.
- Mainstem predation control is provided by programs such as the northern pikeminnow sportfish reward program.
- Measures to improve survival of listed salmonids, such as those proposed under the Upper Columbia Recovery Plan (UCSRB 2007), will benefit coho as well.
- HCP-required survival criteria and tributary habitat improvements will be implemented.

Evidence that this approach is working comes from data collected during the feasibility and subsequent phases of the mid-Columbia coho reintroduction program. An important measure of the effect of local adaptation is smolt-to-adult return rate. The results presented in sections 3.1 and 3.3 show that this rate is increasing for this program.

2017 Update: *Evidence continues to mount that the program can be successful. Adult returns have been sufficient in several years, beginning in 2009, to implement fisheries:*

2009: Icicle Creek (Wenatchee basin)
2011: Icicle Creek and Wenatchee River
2014: Icicle Creek and Wenatchee and Methow rivers

Dam counts for programs when fisheries were implemented[24]*:*

2009: 16,230 Wenatchee
2011: 23,833 Wenatchee
2014: 34,448 Wenatchee; 9,730 Methow

4.4 Program Risks

Program risks generally fall into three categories:

1) species interaction risks,
2) facility development risks, and
3) operations risks.

[24] Wenatchee dam counts are coho counted at Rock Island Dam minus those counted at Rocky Reach Dam; Methow dam counts are made at Wells Dam.

During feasibility studies, the program studied interaction risks extensively. Results are summarized in Chapter 3. While we believe the proposed program poses little risk to other species, we recognize that some uncertainty remains and have proposed studies in the monitoring and evaluation plan to determine changes in status to other fish species and whether the change is caused by coho reintroduction (see Section 7.2).

***2017 Update**: Risks of developing the proposed new facilities were assessed in the Final EIS (DOE/BPA 2012) that was part of the Council's Step 2 process. The impacts to natural resources such as wetlands, floodplains, non-aquatic listed and sensitive species, water quality and quantity, and to property owners and nearby residents were evaluated. The risks of interactions between coho and other ESA-listed fish were also reviewed during NEPA and ESA analyses as part of the NPCC Step 2 process. In general these analyses have shown little impact or have resulted in modifications to the program to accommodate concerns.*

Operations risks include effects on listed and sensitive species of smolt and adult trapping, electro-shocking, and other M&E activities. Effects of any proposed changes in operation of existing traps, or locations of M&E activities, have been evaluated in NEPA and ESA analyses and are subject to conditions set during those processes. Operational risks are reduced by considering potential impacts during site location selection and facility design.

While the program has succeeded in developing and using a 100% mid-Columbia broodstock, natural spawning is occurring primarily in less than optimal habitat. In the Wenatchee basin, most fish are still returning to Icicle Creek; in the Methow, most fish are homing back to the Winthrop NFH. With the limited habitat in these areas and the large number of adults, high spawning densities results in poor productivity. Implementation of the natural production phases is expected to alleviate these concerns and increase productivity. However, because this repopulation effort using hatchery-origin fish is so experimental, and the rate of divergence and adaptation to the local environment is relatively unknown, the risk exists that the mid-Columbia brood will not adapt to allow coho, especially females, to develop the ability to consistently ascend gradient/velocity barriers in the Wenatchee (i.e., Tumwater Canyon) which could reduce their access to higher quality habitat. Section 4.3.5 Contingency Plans discusses the actions the program might take if such adaptation does not occur or occurs more slowly than anticipated.

4.5 Program Benefits

Coho reintroduction is an important part of a regional, integrated, ecological recovery strategy. Cultural, socio-economic, and ecological benefits are expected to result from the return of this species to areas where it was once abundant.

Salmon are a part of the spiritual and cultural identity of the four Columbia River treaty tribes. They also play an important role in the economic well-being of tribal members. Recovery of coho salmon to the Yakama Nation's "usual and accustomed" fishing places helps support regional tribal objectives.

The commercial value of Columbia Basin tribal, commercial, and recreational fisheries is estimated by the IAEB (2005) as contributing "about $142 million total personal income annually to communities on the West Coast." Coho salmon returning to Mid-Columbia watersheds will add to this value.

Marine nutrients deposited in the form of coho carcasses will improve stream rearing conditions for other species (Quinn 2005), including those that are ESA-listed. Juvenile steelhead, for example, congregate in areas where salmon carcasses are deposited and they show a dramatic increase in condition factor (Bilby et al. 1998). Coho salmon may be a particularly important link in nutrient cycling processes. Coho salmon spawn high in the watershed at the onset of winter, delivering nutrients to the uppermost reaches where all species downstream will benefit (Vannote et al. 1980). During winter, reduced primary production may limit the standing crop of invertebrates. The addition of carcasses at the onset of winter may provide an increased food base (Pearsons and Hopley 1999) and improve over-winter survival for all species. The Wenatchee Subbasin Plan (page 27) recognizes that "Restoration of individual populations may not be possible without restoration of other fish and wildlife populations with which they co-evolved." (NPCC 2004a).

The presence of both naturally produced and hatchery coho may increase prey densities, potentially reducing losses of ESA-listed species from predation. Coho eggs, fry, and smolts (natural and hatchery) will increase the availability of prey, providing increased food supply for aquatic species including steelhead and bull trout (Pearsons and Hopley 1999). Loss of prey likely has contributed to the decline in bull trout populations (Ratliff et al. 1996).

Ecological benefits of coho restoration could extend beyond the aquatic community to other ESA-listed species, including the bald eagle and grizzly bear. Salmon are an important food resource for these species. Bald eagles, over-wintering in the Wenatchee River, have been observed feeding on coho carcasses on Icicle Creek (C. Kamphaus, YN, pers. comm.). Riparian vegetation will also benefit from the nutrients derived from coho carcasses (Quinn 2005; Cederholm et al. 1999). For these reasons, salmon are recognized as a "keystone" species in vertebrate communities (Quinn 2005, Cederholm et al. 1999, Willson and Halupka 1995).

Other listed fish species will indirectly benefit from the presence of this missing native species. The justification for developing regional habitat conservation measures protecting all fish species will be strengthened. For example, restoring hydraulic functionality to currently isolated side channels will be an important habitat improvement for coho. Parts of these side-channel habitats may also be used by spring Chinook, steelhead, and bull trout.

The opportunity to study the local adaptation process in detail is a significant benefit to regional fish managers and researchers. There is very little literature available that evaluates the time or techniques required to develop locally adapted stocks or the traits that would define naturalization. The MCCRP will collect information on phenotypic traits such as migration timing, spawn timing, adult size, adult sex ratios, fecundity rates, and tissue lipid concentration as a measure of stored energy reserves (Section 7.3). Together with genotype measurements, these traits will be compared with those in the originating hatchery stock to track the rate and direction of adaptation to natural habitats in the mid-Columbia tributaries. Juvenile and adult survival rates will be documented and compared with other stocks and species considered to be locally-adapted natural stocks. This line of investigation will have system-wide application by providing the region with important new information regarding the role of hatcheries and hatchery stocks in restoring salmonid populations to natural habitats in the Columbia Basin.

In the words of the Endangered Species Act (1973):

> "various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation;…these species of fish, wildlife, and plants are of aesthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people."

Chapter 5.
Biological Program Details

Chapter 5. Biological Program Details

***2017 Update**: By 2006, feasibility studies had ended and the first iteration of this Master Plan for an implementation program was proposed. The proposal was the phased approach described in Section 4.3.1 and in this chapter, and it included criteria for determining when an initial broodstock development phase (Broodstock Development Phase 1) was successful. The NPCC did not recommend the proposed program for funding at that time; however, existing activities, including broodstock development using targets proposed in the Master Plan, continued with interim funding from BPA and, beginning in late 2007, from mid-Columbia area public utility districts (PUDs). Sections 5.1 and 5.2 report the results from the broodstock development phases.*

5.1 Broodstock Development Phase 1

5.1.1 Wenatchee

This phase has been completed in the Wenatchee basin. With adult returns in 2008, the project proceeded to the second phase. The goal for BDP1 in the Wenatchee basin was:

> *BDP1 will be considered successful when a mean trappable adult return of 1,064 coho adults (annual broodstock collection goal) in one 3-year period within 9 years is reached at Wenatchee basin trapping facilities (Dryden and Tumwater dams).*

Table 5-1, compiled from project annual reports (Murdoch et al. 2006; Kamphaus et al. 2008, 2009, 2010, 2011), provides a summary of coho handled and broodstock collected at trapping sites in the Wenatchee basin and shows that the BDP1 goal was met. All coho broodstock were transported to Entiat National Fish Hatchery (ENFH) and held until spawning.

Table 5-1. Wenatchee basin adult coho handled and collected during trapping, 2006 - 2009

Location	2006 Coho (*broodstock*)	2007 Coho (*broodstock*)	2008 Coho (*broodstock*)	3-year mean
Dryden Dam	1,473* (*1,229*)	2,262* (*728*)	696* (*580*)	1,477
Tumwater Dam	4* (*1*)	442* (*235*)	146* (*82*)	197
Icicle Cr. adult weir	1* (*0*)	n/a	n/a	0
Leavenworth NFH ladder trap	277* (*99*)	155* (*52*)	352* (*265*)	261
Total	1,755	2,859	1,194	**1,936**

*Actual number of coho handled during trapping; broodstock collected shown in parentheses.

5.1.2 Methow

During 2008 and 2009, the YN continued to implement BDP1 in the Methow basin. The goal for BDP1 in the Methow basin was:

> *BDP1 will be considered successful when a mean trappable adult return of 632 coho adults (annual broodstock collection goal) in one 3-year period within 9 years is reached at Methow basin trapping facilities (Wells Dam, WNFH, and Twisp weir). Successful completion of BDP1 will trigger the implementation of BDP2.*

BDP1 in the Methow was considered successful as of fall 2009. Table 5-2 summarizes the data from annual reports (Kamphaus et al. 2008, 2009, 2010, 2011).

Table 5-2. Methow basin adult coho handled and collected during trapping, 2006 - 2009

Location	2006 Coho (*broodstock)*	2007 Coho (*broodstock)*	2008 Coho (*broodstock*)	3-year mean
Winthrop NFH	223	590* (*369*)	199* (*195*)	337
Wells Dam East Ladder	86* (*78*)	124* (*82*)	18* (*18*)	76
Wells Dam West Ladder and Wells FH Adult Trap	33* (*30*)	369* (*287*)	300* (*294*)	234
Total	342	1,083	517	**647**

*Actual trappable coho numbers during broodstock collection efforts; broodstock collected shown in parentheses. Passed coho were recorded and allowed to migrate upstream.

5.2 Broodstock Development Phase 2

Both Methow and Wenatchee returns were used as broodstock for the entire mid-Columbia program, with each basin supplementing the other in years of basin-specific shortfalls. Should broodstock shortfalls occur in the future in *both* basins, the program will consider using coho returns to other above-McNary Dam locations to supplement its production needs if shortfalls are especially large. The intent is *not* to use lower river hatchery populations for future broodstock.

5.2.1 Wenatchee

BDP2 began in 2007 in the Wenatchee basin, where the YN has been releasing one million smolts annually. Approximately 500,000 have been released above Tumwater Dam in Nason Creek and Beaver Creek. The remaining 500,000 coho smolts continue to be released from Icicle Creek to ensure that broodstock collection goals are met while transitioning to upper basin collection sites.

We primarily trap broodstock at Tumwater Dam, Dryden Dam and/or Icicle Creek. Coho smolts released in upper basin tributaries and Icicle Creek are differentiated by the use of body tags (a blank wire tag placed in the adipose fin). Body tagging allows researchers to either pass or capture adult coho at Dryden Dam. The goal for BDP2 in the Wenatchee basin is:

> *Broodstock Development Phase 2 will be successfully completed when we have a mean adult return to Wenatchee River traps of 1,064 adult coho for one 3-year period within 9 years, with a minimum of 50% of the female broodstock collected at Tumwater Dam.*

2017 Update*: Since 2007 we have focused our broodstock collection efforts to the extent possible within permit and trap limitations. Collecting sufficient female broodstock from Tumwater Dam presents a challenge: the ratio of female to male coho is skewed in most years, averaging 17% female and 83% male since 2007 (Table 5-3). Due to the difficulty female coho salmon appear to have navigating Tumwater Canyon to Tumwater Dam, we have changed our BDP2 goals for the Wenatchee basin to reflect the need to collect 50% of our* ***female*** *broodstock from Tumwater Dam for a three-year period; the previous version of this Master Plan called for 50% of the* ***total*** *broodstock to be collected at the dam. Table 5-3 summarizes broodstock collection efforts to date at Tumwater Dam. In 2012, we initiated steps identified in the contingency plan (see Section 4.3.5, 2.a. and 2.b.1) to identify the factors that determine whether a female coho can successfully ascend Tumwater Canyon.*

Table 5-3. Numbers of male and female coho captured at Tumwater Dam and the proportion of females in Wenatchee program broodstock

Phase	Return Year	Tumwater Dam			Total Tumwater Broodstock	% Broodstock Collected at Tumwater Dam	
		Male	Female	%Female		Female	Total
BDP1	2004	11	1	8.3%	12	0.1%	0.8%
BDP1	2005	40	24	37.5%	64	3.6%	4.6%
BDP1	2006	0	1	100%	1	0.2%	0.1%
BDP2	2007	199	36	15.3%	235	7.4%	22.9%
BDP2	2008	63	10	13.7%	73	2.2%	7.9%
BDP2	2009	285	25	8.1%	310	4.9%	29.4%
BDP2	2010	281	69	19.7%	350	15.1%	36.9%
BDP2	2011	341	115	25.2%	456	28.3%	53.1%
BDP2	2012	335	138	29.1%	473	32.2%	17.7%
BDP2	2013	133	25	15.8%	158	6.4%	43.6%
BDP2	2014	393	40	9.2%	433	7.9%	21.8%

5.2.2 Methow

BDP2 began in 2010 in the Methow basin and was considered successfully completed by 2013. The goal for this phase in the Methow is:

> *BDP2 will be considered successful when a mean of 656 adult coho (broodstock collection goal for BDP2) are trapped at upstream trapping sites (WNFH and Methow FH for one 3-year period, with 1,312 adult coho (broodstock collection goal for Natural Production Implementation Phase) trappable at Wells Dam. Completion of BDP2 will trigger the Natural Production phases.*

During BDP2, YN released 500,000 smolts annually from the Methow River basin. Of these, 250,000-350,000 acclimated coho smolts were released from the Winthrop NFH. The remaining 150,000-250,000 smolts were released from acclimation site(s) on the Methow and/or Twisp rivers.

Although the goal for this basin was met by 2013, the new sites needed to acclimate and release the proposed numbers for NPIP had not completed NEPA, ESA, and other permitting processes that were required when some sites became unavailable after BPA issued its Record of Decision in 2012. Although sites would likely be available in 2018, the 2015 and 2016 adult returns were unexpectedly low and broodstock needed to expand the program was not available. If enough broodstock can be collected and adequate sites permitted and/or constructed, YN is prepared to move the program into the Natural Production Implementation Phase with BY2017 (for release in 2019).

5.3 Natural Production Phases

As has been demonstrated in the Methow, at the conclusion of BDP2, the program will have a hatchery broodstock that can successfully migrate back to the Wenatchee and Methow rivers. However, YN recognizes that the Wenatchee and Methow stocks will remain domesticated until they are locally adapted[25] to habitats in the natural environment. The Natural Production Phases described below represent the proposed transition from a domesticated hatchery program to locally adapted naturally reproducing populations in the Wenatchee and Methow basins.

Table 5-4. Proposed smolt release numbers and locations for the Natural Production phases in the Wenatchee basin

Location	Implementation Phase Release Number (one generation only)	Support Phase (1) Initial Release Number (est. 2 generations)	Support Phase (2) Final Release Number (PNI >0.5; est. 2 generations)
Chiwawa R.	350,000	245,000	122,500
White R.	150,000	112,000	56,000
Nason Cr.	210,000	147,000	73,500
Little Wenatchee R.	120,000	84,000	42,000
Upper Wenatchee R.	100,000	70,000	35,000
Chumstick Cr.	65,000	45,500	22,750
Brender Cr.	50,000	35,000	17,500
Icicle Cr.	100,000	70,000	35,000
Total	**1,155,000**	**808,500**	**404,250**

Table 5-5. Proposed smolt release numbers and locations for the Natural Production phases in the Methow basin

Location	Implementation Phase Release Number (one generation only)	Support Phase (1) Initial Release Number (est. 2 generations)	Support Phase (2) Final Release Number (PNI >0.5; est. 2 generations)
Mainstem Methow R.	350,000	245,000	122,500
Chewuch R.	300,000	210,000	105,000
Twisp R.	250,000	175,000	87,500
Beaver Cr. (Parmley)	50,000	35,000	17,500
Gold Cr.	50,000	35,000	17,500
Total	**1,000,000**	**700,000**	**350,000**

Implementation of the habitat initiatives described in Section 1.5 is important to successful restoration of the naturally reproducing coho populations. With the increased productivity resulting from habitat improvements funded under the 2008 Columbia Basin Fish Accords, plus other actions funded by the BOR, PUDs and others; and with a supplementation program designed to maximize local adaptation while reducing domestication selection, the program is designed to reach its self-sustaining goals and to be terminated after a minimum of five generations of natural production supplementation.

Secondary, supplemental measures to establish enough natural recruitment at sufficient levels for NPIP and Natural Production Support phase evaluations are being considered. YN proposes unconfined adult outplants of hatchery-origin returns (HORs) in tributaries in both basins where suitable acclimation sites for smolts are lacking. In these cases, YN would outplant adult equivalents in lieu of smolt releases. There would be no increase in overall proposed production, only

[25] We use the term "local adaptation" to refer to the process of naturalization: addressing the loss of fitness that occurs with hatchery stocks by emphasizing selection in the natural environment so that the population becomes adapted to habitats within each subbasin and ultimately achieves PNI > 0.5. "Local adaptation" is distinguished from "broodstock development," which selects for coho which can return to the Wenatchee and Methow rivers but does not address loss of fitness and adaptation to the natural environment.

redistribution to preferred habitats in the form of returning adults. Adult transplantation or relocation has been implemented in other regions with varying degrees of success. Examples include an opportunistic approach to increase Chinook spawner distribution in South Folk Salmon River (IDFG 1999). Results demonstrated that at least 83% of the outplanted females spawned with very little dispersal from their release location (approximately 2 km upstream/downstream), while males tended to travel further downstream. Researchers also inferred, since it was not one of the study objectives, that outplant timing affected dispersal rate and that fish released in July had a higher tendency to be located further away from release location than fish outplanted in August. Another case study, which implemented spring Chinook outplants into Shitike Creek in central Oregon documented a marked increase in redd counts once outplanting began (largest escapement since the mid-1980s; CTWSRO 2005). Also, through the recent advances of genetic-based parentage analyses, evaluations such as the reproductive success study conducted on Shitike Creek using hatchery-origin spring Chinook (Baumsteiger et. al. 2008) demonstrated that outplanting individuals can produce progeny to supplement natural production efforts.

This concept of transplanting adults seems especially fitting for coho salmon, since they typically demonstrate a high propensity to recolonize new habitats as a form of increasing long-term population viability. It is possible that spawning site and mate selection may override homing behavior, thus influencing transplanted individuals to remain in the new stream rather than exiting the system and moving downstream. Proposed use of adults as a supplemental tool, while not the preferred method to meet project goals, may be necessary to fully implement NPIP within targeted watersheds where limited acclimation sites would produce insufficient adult returns.

To place reasonable bounds on numbers for outplanting, an adult equivalent (AE) was established for multiple "typical" release-group-size scenarios. The AE was calculated by multiplying smolt release numbers by mean SARs for each respective basin. AEs were further refined to identify the total females required by applying a mean sex ratio from run-at-large collections in both basins. Once a defined number of females was established, an equal number of males was included to provide a 1:1 ratio for outplanting, to ensure a viable male would be proximal to each female (see Tables 5-6 and 5-7).

Table 5-6. Example of adult outplanting scenarios in the Wenatchee basin

Stream	RM	Name of release point	Acclimation group size	Mean SAR	Approx. number of pairs
Chiwawa River	11.7	Grouse Creek	75,000	0.30%	81
	13.8	Chikamin Creek			
	25.0	Atkinson Flats			
White River	7.7	Sears Creek Bridge	50,000	0.30%	54
	13.1	Napeequa River			
Little Wenatchee	5.5	Little Wenatchee Road	25,000	0.30%	27

Table 5-7. Example of adult outplanting scenarios in the Methow basin

Stream	RM	Name of release point	Acclimation group size	Mean SAR	Approx. number of pairs
Upper Methow	11.7	Early Winters Creek	100,000	0.25%	90
	57.0	Weeman Bridge			
White River	7.5	Newby Bridge Creek	25,000	0.25%	23
	13.1	Buttermilk Bridge			
Little Wenatchee	11.5	MSWA	50,000	0.25%	45
	7.5	Chewuch Bridge			

5.3.1 Natural Production Implementation Phase

The Implementation Phase is designed to begin the local adaptation and naturalization process by reintroducing coho in areas predicted by EDT to have the greatest chance of success[26]: the Chiwawa River, White River, Little Wenatchee River, Upper Wenatchee River, Chumstick Creek, Nason Creek, and various smaller tributaries in the Wenatchee basin; and in the mid- and upper reaches of the Methow River, the Chewuch River, Beaver Creek, the Twisp River, and various smaller tributaries in the Methow basin. The Implementation Phase seeks to initiate the local adaptation and naturalization process by releasing enough hatchery fish in the natural environment to result in a spawning aggregate in each tributary of sufficient size that natural selection can act upon the population; and with an adequate number of first-generation natural-origin adults to incorporate into the broodstock as the Natural Production phases continue (Tables 5-4 and 5-5). The Implementation Phase will last for one generation (three years).

During NPIP in the Wenatchee basin, broodstock capture will continue to focus on upper basin sites listed in BDP2. Wherever facilities exist, broodstock will be collected within the tributary of release. Facility operations and duration of trapping continue from BDP2.

The release numbers proposed for the Implementation Phase are generally based upon the predicted number of hatchery fish needed to initially seed the habitat. We used two methods to estimate the capacity of naturally produced smolts in the Wenatchee and Methow basins: 1) the smolt production model described by Zillges (1977) and 2) Ecosystem Diagnosis and Treatment (EDT) (Mobrand et. al. 1997).

The Zillges (1977) method is a smolt production model which has been used for Puget Sound and Washington coastal systems when actual data are not available (Seiler et al. 2004). The method described by Zillges (1977) uses stream length in larger tributaries, and stream area (length x width) in smaller tributaries to estimate coho smolt production. Bradford et al. (1997) found that coho salmon smolt abundance was primarily correlated with stream length, and that stream length was the most appropriate general measure of coho production. The number of smolts produced per unit of stream length was constant and independent of stream size (Bradford et al. 1997). Other variables such as discharge, stream gradient, and valley slope were not correlated with coho smolt production (Bradford et al. 1997). However, Bradford et al. (1997) cautioned that models which predict coho smolt production based on stream length, such as Zillges (1977), are suitable at the regional or watershed level, but the precision of a prediction for a single stream may be poor. Because different factors may be important in different streams at

[26] Additional sites in areas downstream from Tumwater Dam which are believed to have historically produced coho and which will facilitate the contingency plan are also included.

different times, there are no general predictive models that will yield precise estimates of coho smolt production potential (Bradford et al. 1997).

We also used EDT (Mobrand et al. 1997) to provide an estimate of juvenile and adult capacity in the Wenatchee and Methow rivers. In some cases, such as in the Little Wenatchee and the White River, both models yielded almost identical estimates, lending confidence to the capacity estimates in these tributaries. In other cases, such as Icicle Creek and Nason Creek, the EDT estimates appeared unrealistically low, based on data collected to date, and the Zillges (1977) method appeared unrealistically high. In cases with a discrepancy between the capacity estimates, YN used the mid-point between the two values.

The capacity values were used as upper limits for the program. To minimize potential species interactions, the actual release numbers will result in seeding levels below the estimated capacity, but are predicted to result in an adequate spawning escapement for which natural selection will begin the local adaptation process.

After three years (one coho generation) of Implementation Phase releases, we propose to reduce the release numbers by 30% as we enter the Natural Production Support Phases.

5.3.2 Natural Production Support Phases 1 and 2

To address the fitness loss commonly associated with hatchery programs, the Support Phases use the fitness computations in the AHA model to guide program management, with the goal of reducing domestication selection and increasing local adaptation. The support phases will begin following the 3-year Implementation Phase and will be terminated after a minimum of four generations (12 years) unless it can be demonstrated that continued natural production support and local adaptation is still required to reach project goals. The Support Phases will result in a fully integrated population which receives greater selective pressures from the natural environment than from the hatchery environment (PNI > 0.5), and eventually achieves a self-sustaining population.

Initial release numbers (Support Phase 1) will be reduced 30% from Implementation Phase release numbers. The initial proportion of natural-origin fish in the broodstock (pNOB) will be greater than or equal to 35%, with the proportion of hatchery-origin fish on the spawning grounds (pHOS) limited to 75%. When this initial goal is met (pNOB > 35%), we will continue to reduce the size of the supplementation program while increasing the pNOB (up to 80%) and limiting the proportion of hatchery fish on the spawning grounds (pHOS: 65%) until we have reached a PNI value of 0.50 or greater.

During the Support Phases in the Wenatchee, broodstock capture will continue to focus on upper basin collection from sites listed in BDP2 and NPIP. Where possible, broodstock will be collected at tributary facilities (Chiwawa River and/or other locations if developed outside of this program). Implementation success within multiple streams and watersheds will drive collection numbers during the Support Phases. Shortfalls in collection goals will result in utilizing Tumwater Dam and other in-basin sites (Dryden Dam, LNFH, and possibly small tributary weirs). Annual broodstock protocols will address collection numbers and bi-weekly quotas.

In the Methow, broodstock collection will continue in the same locations as in NPIP and in tributary traps if possible.

5.4 AHA Calculations

AHA computations for each release tributary depict the transition from a domesticated hatchery stock to a fully integrated supplementation program, and finally to a self-sustaining, naturally reproducing population. The computations assume the habitat improvements made as part of other programs will occur, and that habitat capacity and associated productivity will increase to their target values. A summary of the AHA calculations for each targeted tributary for coho restoration is in Tables 5-8 – 5-15 for the Wenatchee basin and in Tables 5-16 – 5-21 for the Methow basin.

We are aware of the need for caution when using the AHA or any other single model to generate specific objectives, numerical or otherwise, as described by the ISRP and ISAB (2005). However, project proponents have found minimal literature or empirical data to guide the transition from a non-local domesticated hatchery stock to a population locally adapted to the natural environment. The AHA model provides a framework from which the loss of fitness, or domestication, can be addressed in the form of a working hypothesis. The proposed mid-Columbia coho reintroduction plan presents a unique opportunity to test some of the assumptions of the AHA model, as they pertain to domestication and local adaptation, in the absence of genetic risk[27] to a native coho population.

[27] Genetic risk is the probability of an event or activity having and adverse genetic consequence. Adverse consequences include 1) extinction, 2) loss of within population genetic diversity, 3) loss of among-population genetic diversity, and 4) domestication (Busak and Currens 1995).

5.4.1 Wenatchee Basin AHA Calculations

Table 5-8. Natural production phase goals and expected results (based on AHA calculations) for the Chiwawa River

Natural Production Phase	Prod*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implementation	1.52	1435	350,000	10%	90%	10%	80%	0.12	1598	298	256	1294
Support (1)	1.52	1435	245,000	35%	75%	35%	74%	0.31	1145	371	267	1011
Support (2)	1.75	1435	113,00	80%	65%	80%	50%	0.62	445	532	423	850
Recovered (PFC)	2.10	1500	None	N/A	N/A	N/A	N/A	1.0	0	449	449	449

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement.

Table 5-9. Harvest rates used to project the results for Chiwawa River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	304
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	235
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	140
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	134

Table 5-10. Natural production phase goals and expected results (based on AHA calculations) for the White River

Natural Production Phase	Prod.*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Pre-dicted HOR	Avg. Pre-dicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implementa-tion	1.63	717	160,000	10%	90%	10%	77%	0.12	729	163	144	617
Support (1)	1.63	717	112,000	35%	75%	35%	68%	0.33	524	206	159	498
Support (2)	1.75	717	57,000	80%	65%	80%	51%	0.62	241	286	231	470
Recovered (PFC)	2.20	1077	None	N/A	N/A	N/A	N/A	1.0	0	.365	365	365

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement.

Table 5-11. Harvest rates used to project the results for White River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	142
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	112
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	77
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	109

Table 5-12. Natural production phase goals and expected results (based on AHA calculations) for Nason Creek

Natural Production Phase	Prod.*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implemen-tation	1.13	709	210,000	10%	90%	10%	85%	0.11	955	134	109	730
Support (1)	1.13	709	148,000	35%	75%	35%	83%	0.29	687	152	90	536
Support (2)	1.50	709	74,000	80%	65%	80%	64%	0.55	327	242	171	482
Recovered (PFC)	2.10	900	None	N/A	N/A	N/A	N/A	1.0	0	281	281	281

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement.

Table 5-13. Harvest rates used to project the results for Nason Creek natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	177
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	133
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	86
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	84

Table 5-14. Natural production phase goals and expected results (based on AHA calculations) for the Little Wenatchee River

Natural Production Phase	Prod.*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implemen-tation	1.50	447	120,000	10%	90%	10%	81%	0.12	548	99	84	440
Support (1)	1.50	717	84,000	35%	75%	35%	76%	0.32	392	117	82	336
Support (2)	1.65	717	42,000	80%	65%	80%	58%	0.58	186	171	130	306
Recovered (PFC)	2.10	1077	None	N/A	N/A	N/A	N/A	1.0	0	254	254	257

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement.

Table 5-15. Harvest rates used to project the results for Little Wenatchee River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	HOR/NOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	104
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	79
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	52
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	59

5.4.2 Methow Basin AHA Calculations

Table 5-16. Natural production phase goals and expected results (based on AHA calculations) for the mid and upper Methow River

Natural Production Phase	Prod*	Est. Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implemen-tation	1.19	1836	450,000	10%	90%	11%	83%	0.12	1694	275	221	1322
Support (1)	1.19	1836	315,,000	35%	80%	35%	81%	0.30	1242	317	186	993
Support (2)	1.35	1836	159,000	80%	65%	80%	66%	0.55	524	469	316	915
Recovered (PFC)	1.69	2000	None	N/A	N/A	N/A	N/A	1.0	0	354	354	354

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement.

Table 5-17. Harvest rates used to project results for mid-and upper Methow River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	318
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	322
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	165
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	106

Table 5-18. Natural production phase goals and expected results (based on AHA calculations) for the Chewuch River

Natural Production Phase	Prod.*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implemen-tation	1.10	1415	300,000	10%	90%	10%	84%	0.11	1367	209	173	1061
Support (1I)	1.10	1415	211,000	35%	80%	35%	80%	0.30	981	244	155	1092
Support (2)	1.45	1415	105,000	80%	65%	80%	57%	0.58	491	421	289	746
Recovered (PFC)	1.79	2000	None	N/A	N/A	N/A	N/A	1.0	0	456	456	456

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement

Table 5-19. Harvest rates used to project results for Chewuch River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	255
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	193
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	130
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	83

Table 5-20. Natural production phase goals and expected results (based on AHA calculations for Twisp River

Natural Production Phase	Prod.*	Adult Capacity	NPIP Smolt Release Number	pNOB Goal	pHOS Goal	pNOB Realized	pHOS Realized	PNI	Avg. Predicted HOR	Avg. Predicted NOR	Avg. NOR Escape-ment	Avg. Total Escape-ment
Implemen-tation	1.32	926	250,000	10%	90%	10%	83%	0.11	1140	187	143	898
Support (1)	1.32	926	176,000	35%	75%	35%	78%	0.31	820	222	148	681
Support (2)	1.45	926	88,000	80%	65%	80%	63%	0.55	411	291	206	563
Recovered (PFC)	1.64	1000	None	N/A	N/A	N/A	N/A	1.0	0	189	189	189

* Initial productivity rates are based on current conditions as predicted by EDT. Increased productivity is predicted to result from habitat improvement

Table 5-21. Harvest rates used to project results for Twisp River natural production phases

Natural Production Phase	Natural-origin Returns (NOR)			Hatchery-origin Return (HOR)			Total Harvest	
	Mixed Stock	Mainstem	Terminal	Mixed Stock	Mainstem	Terminal	NOR/HOR	Count
Implementation	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	214
Support (1)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	164
Support (2)	0.10	0.00	0.00	0.10	0.05	0.00	0.10/0.15	102
Recovered (PFC)	0.10	0.10	0.05	N/A	N/A	N/A	0.23/0.00	5857

It should be noted that wherever possible, we will seek to emphasize local adaptation which will include tributary-specific adaptation. However, we are not proposing to build additional weirs or capture facilities. We will promote local adaptation to the extent possible within the limitation of sub-population size, existing facilities and technology. This plan assumes that existing weirs and traps (i.e., Chiwawa and Twisp rivers,) and any capture facilities that may be constructed in the future would also be available for coho capture.

During the Natural Production phases, we recognize that abundance of adult returns may vary greatly from year to year. For this reason we have developed schedules for the disposition of returning adult coho within each Natural Production phase. These schedules are shown in Tables 5-22 – 5-24 for the Wenatchee and Tables 5-25 – 5-27 for the Methow. The tables are based on the goals for each Natural Production phase, including desired PNI, and the estimated adult capacity.

The gray shaded areas of these tables indicate that the success criteria for each of the Natural Production phases are being met. Successful implementation of habitat improvement programs in the basins (Section 1.5) will increase the proportion of time the population will remain in the shaded "goal range" and reduce dependence upon hatchery supplementation.

Table 5-22. Management schedule for the disposition of adult returns to the Wenatchee basin during the Natural Production Implementation Phase

Natural-origin Returns		Hatchery-origin Returns: ≥100	500	1000	1500	2000	4000	5000
≥100	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1274_B, 726_S, 0_H$	$1274_B, 2726_S, 0_H$	$1274_B, 3726_S, 0_H$
	NOR	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$
500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1210_B, 790_S, 0_H$	$1210_B, 2790_S, 0_H$	$1210_B, 3534_S, 256_H$
	NOR	$350_B, 150_S, 0_H$	$350_B, 150_S, 0_H$	$350_B, 150_S, 0_H$	$294_B, 206_S, 0_H$	$134_B, 366_S, 0_H$	$134_B, 366_S, 0_H$	$134_B, 366_S, 0_H$
1000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1210_B, 790_S, 0_H$	$1210_B, 2790_S, 0_H$	$1210_B, 3034_S, 756_H$
	NOR	$700_B, 300_S, 0_H$	$700_B, 300_S, 0_H$	$644_B, 356_S, 0_H$	$294_B, 706_S, 0_H$	$134_B, 866_S, 0_H$	$134_B, 866_S, 0_H$	$134_B, 866_S, 0_H$
1500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1210_B, 790_S, 0_H$	$1210_B, 2534_S, 256_H$	$1210_B, 2534_S, 1256_H$
	NOR	$1050_B, 450_S, 0_H$	$994_B, 506_S, 0_H$	$644_B, 856_S, 0_H$	$294_B, 1206_S, 0_H$	$134_B, 1366_S, 0_H$	$134_B, 1366_S, 0_H$	$134_B, 1366_S, 0_H$
2000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1210_B, 790_S, 0_H$	$1210_B, 2034_S, 756_H$	$1210_B, 2034_S, 1756_H$
	NOR	$1274_B, 726_S, 0_H$	$994_B, 1006_S, 0_H$	$644_B, 1356_S, 0_H$	$294_B, 1706_S, 0_H$	$134_B, 1866_S, 0_H$	$134_B, 1866_S, 0_H$	$134_B, 1866_S, 0_H$
4000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 194_S, 156_H$	$1210_B, 34_S, 756_H$	$1210_B, 34_S, 2756_H$	$1210_B, 34_S, 3756_H$
	NOR	$1274_B, 2726_S, 0_H$	$994_B, 3006_S, 0_H$	$644_B, 3356_S, 0_H$	$294_B, 3706_S, 0_H$	$134_B, 3866_S, 0_H$	$134_B, 3866_S, 0_H$	$134_B, 3866_S, 0_H$
5000	HOR	$70_B, 30_S, 0_H$	$244_B, 0_S, 256_H$	$244_B, 0_S, 756_H$	$244_B, 0_S, 1256_H$	$244_B, 0_S, 1756_H$	$244_B, 0_S, 3756_H$	$244_B, 0_S, 4756_H$
	NOR	$1274_B, 3726_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for the Implementation Phase are being met. Implementation Phase Objectives: B=1344 (10% NOR, 90% HOR), no restrictions on pHOS. Assumptions include an adult capacity of 3900.

Table 5-23. Management schedule for the disposition of adult returns to the Wenatchee basin during the Natural Production Support Phase 1

Natural-origin Returns		Hatchery-origin Returns: ≥100	500	1000	1500	2000	4000	5000
≥100	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$831_B, 669_S, 0_H$	$831_B, 1169_S, 0_H$	$831_B, 3169_S, 0_H$	$831_B, 3830_S, 339_H$
	NOR	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$
500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$586_B, 414_S, 0_H$	$586_B, 914_S, 0_H$	$586_B, 1414_S, 0_H$	$586_B, 3414_S, 0_H$	$586_B, 3715_S, 699_H$
	NOR	$350_B, 150_S, 0_H$	$350_B, 150_S, 0_H$	$315_B, 185_S, 0_H$	$315_B, 185_S, 0_H$	$315_B, 185_S, 0_H$	$315_B, 185_S, 0_H$	$315_B, 185_S, 0_H$
1000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$586_B, 414_S, 0_H$	$586_B, 914_S, 0_H$	$586_B, 1414_S, 0_H$	$586_B, 3215_S, 199_H$	$586_B, 3215_S, 1199_H$
	NOR	$700_B, 300_S, 0_H$	$551_B, 449_S, 0_H$	$315_B, 685_S, 0_H$	$315_B, 685_S, 0_H$	$315_B, 685_S, 0_H$	$315_B, 685_S, 0_H$	$315_B, 685_S, 0_H$
1500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$586_B, 414_S, 0_H$	$586_B, 914_S, 0_H$	$586_B, 1414_S, 0_H$	$586_B, 2715_S, 699_H$	$586_B, 2715_S, 1699_H$
	NOR	$831_B, 669_S, 0_H$	$551_B, 949_S, 0_H$	$315_B, 1185_S, 0_H$	$315_B, 1185_S, 0_H$	$315_B, 1185_S, 0_H$	$315_B, 1185_S, 0_H$	$315_B, 1185_S, 0_H$
2000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$586_B, 414_S, 0_H$	$586_B, 914_S, 0_H$	$586_B, 1414_S, 0_H$	$586_B, 2215_S, 2801_H$	$586_B, 2215_S, 2199_H$
	NOR	$831_B, 1169_S, 0_H$	$551_B, 1449_S, 0_H$	$315_B, 1685_S, 0_H$	$315_B, 1685_S, 0_H$	$315_B, 1685_S, 0_H$	$315_B, 1685_S, 0_H$	$315_B, 1685_S, 0_H$
4000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$586_B, 414_S, 0_H$	$586_B, 215_S, 699_H$	$586_B, 215_S, 1199_H$	$586_B, 215_S, 3199_H$	$586_B, 215_S, 4199_H$
	NOR	$831_B, 3169_S, 0_H$	$551_B, 3449_S, 0_H$	$315_B, 3685_S, 0_H$	$315_B, 3685_S, 0_H$	$315_B, 3685_S, 0_H$	$315_B, 3685_S, 0_H$	$315_B, 3685_S, 0_H$
5000	HOR	$0_B, 0_S, 100_H$	$0_B, 0_S, 500_H$	$0_B, 0_S, 1000_H$	$0_B, 0_S, 1500_H$	$0_B, 0_S, 2000_H$	$0_B, 0_S, 4000_H$	$0_B, 0_S, 5000_H$
	NOR	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$	$901_B, 3900_S, 199_H$

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for Support Phase 1 are being met. Support Phase 1 Objectives: Broodstock = 901 (35% NOR, 65% HOR), pHOS = 75%. Assumptions include an adult capacity of 3900.

Table 5-24. Management schedule for the disposition of adult returns to the Wenatchee basin during the Natural Production Support Phase 2

Natural-origin Returns		Hatchery-origin Returns ≥100	500	1000	1500	2000	4000	5000
≥100	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	376_B, 624_S, 0_H	376_B, 1124_S, 0_H	376_B, 1624_S, 0_H	376_B, 2797_S, 827_H	376_B, 2797_S, 1827_H
	NOR	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H
500	HOR	70_B, 30_S, 0_H	96_B, 404_S, 0_H	96_B, 904_S, 0_H	96_B, 1404_S, 0_H	96_B, 1904_S, 0_H	96_B, 3750_S, 154_H	96_B, 3750_S, 1154_H
	NOR	350_B, 150_S, 0_H	350_B, 150_S, 0_H	350_B, 150_S, 0_H	350_B, 150_S, 0_H	350_B, 150_S, 0_H	350_B, 150_S, 0_H	350_B, 150_S, 0_H
1000	HOR	70_B, 30_S, 0_H	90_B, 410_S, 0_H	90_B, 910_S, 0_H	90_B, 1410_S, 0_H	90_B, 1910_S, 0_H	90_B, 3256_S, 654_H	90_B, 3256_S, 1654_H
	NOR	376_B, 624_S, 0_H	356_B, 644_S, 0_H	356_B, 644_S, 0_H	356_B, 644_S, 0_H	356_B, 644_S, 0_H	356_B, 644_S, 0_H	356_B, 644_S, 0_H
1500	HOR	70_B, 30_S, 0_H	90_B, 410_S, 0_H	90_B, 910_S, 0_H	90_B, 1410_S, 0_H	90_B, 1910_S, 0_H	90_B, 2756_S, 1154_H	90_B, 2756_S, 2154_H
	NOR	376_B, 1124_S, 0_H	356_B, 1144_S, 0_H	356_B, 1144_S, 0_H	356_B, 1144_S, 0_H	356_B, 1144_S, 0_H	356_B, 1144_S, 0_H	356_B, 1144_S, 0_H
2000	HOR	70_B, 30_S, 0_H	90_B, 410_S, 0_H	90_B, 910_S, 0_H	90_B, 1410_S, 0_H	90_B, 1910_S, 0_H	90_B, 2346_S, 1564_H	90_B, 2346_S, 2564_H
	NOR	376_B, 1624_S, 0_H	356_B, 1554_S, 0_H	356_B, 1554_S, 0_H	356_B, 1554_S, 0_H	356_B, 1554_S, 0_H	356_B, 1554_S, 0_H	356_B, 1554_S, 0_H
4000	HOR	70_B, 30_S, 0_H	90_B, 256_S, 154_H	90_B, 256_S, 654H	90_B, 256_S, 1154_H	90_B, 256_S, 1654_H	90_B, 256_S, 3654_H	90_B, 256_S, 4654_H
	NOR	376_B, 3624_S, 0_H	356_B, 3644_S, 0_H	356_B, 3644_S, 0_H	356_B, 3644_S, 0_H	356_B, 3644_S, 0_H	356_B, 3644_S, 0_H	356_B, 3644_S, 0_H
5000	HOR	0_B, 0_S, 100_H	0_B, 0_S, 500_H	0_B, 0_S, 1000_H	0_B, 0_S, 1500_H	0_B, 0_S, 2000_H	0_B, 0_S, 4000_H	0_B, 0_S, 5000_H
	NOR	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H	446_B, 3900_S, 854_H

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for the Support Phase 2 are being met. Support Phase 2 Objectives: Broodstock = 446 (80% NOR, 20% HOR), pHOS = 65%. Assumptions include an adult capacity of 3900.

Table 5-25. Management schedule for the disposition of adult returns to the Methow basin during the Natural Production Implementation Phase

Natural-origin Returns		≥100	500	1000	1500	2000	4000	5000
≥100	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1141_B, 859_S, 0_H$	$1141_B, 2860_S, 0_H$	$1141_B, 3859_S, 0_H$
	NOR	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$	$70_B, 30_S, 0_H$
500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1087_B, 913_S, 0_H$	$1087_B, 2913_S, 0_H$	$1087_B, 3524_S, 389_H$
	NOR	$350_B, 150_S, 0_H$	$350_B, 150_S, 0_H$	$350_B, 150_S, 0_H$	$161_B, 339_S, 0_H$	$124_B, 376_S, 0_H$	$124_B, 376_S, 0_H$	$124_B, 376_S, 0_H$
1000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1087_B, 913_S, 0_H$	$1087_B, 2913_S, 0_H$	$1087_B, 3024_S, 889_H$
	NOR	$700_B, 300_S, 0_H$	$700_B, 300_S, 0_H$	$511_B, 489_S, 0_H$	$161_B, 839_S, 0_H$	$124_B, 876_S, 0_H$	$124_B, 876_S, 0_H$	$124_B, 876_S, 0_H$
1500	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1087_B, 913_S, 0_H$	$1087_B, 2524_S, 389_H$	$1087_B, 2524_S, 1389_H$
	NOR	$1050_B, 450_S, 0_H$	$861_B, 639_S, 0_H$	$511_B, 989_S, 0_H$	$161_B, 1339_S, 0_H$	$124_B, 1376_S, 0_H$	$124_B, 1376_S, 0_H$	$124_B, 1376_S, 0_H$
2000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 450_S, 0_H$	$1087_B, 913_S, 0_H$	$1087_B, 2024_S, 889_H$	$1087_B, 2024_S, 1889_H$
	NOR	$1141_B, 859_S, 0_H$	$861_B, 1139_S, 0_H$	$511_B, 1489_S, 0_H$	$161_B, 1839_S, 0_H$	$124_B, 1876_S, 0_H$	$124_B, 1876_S, 0_H$	$124_B, 1876_S, 0_H$
4000	HOR	$70_B, 30_S, 0_H$	$350_B, 150_S, 0_H$	$700_B, 300_S, 0_H$	$1050_B, 61_S, 389_H$	$1087_B, 24_S, 889_H$	$1087_B, 24_S, 2889_H$	$1087_B, 24_S, 3889_H$
	NOR	$1141_B, 2859_S, 0_H$	$861_B, 3139_S, 0_H$	$511_B, 3489_S, 0_H$	$161_B, 3839_S, 0_H$	$124_B, 3876_S, 0_H$	$124_B, 3876_S, 0_H$	$124_B, 3876_S, 0_H$
5000	HOR	$70_B, 30_S, 0_H$	$21_B, 0_S, 479_H$	$21_B, 0_S, 979_H$	$21_B, 0_S, 1479_H$	$21_B, 0_S, 1979_H$	$21_B, 0_S, 3979_H$	$21_B, 0_S, 4979_H$
	NOR	$1141_B, 8859_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$	$1100_B, 3900_S, 0_H$

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for the Implementation Phase are being met. Implementation Phase Objectives: B=1211 (10% NOR, 90% HOR), no restrictions on pHOS. Assumptions include an adult capacity of 3900.

Table 5-26. Management schedule for the disposition of adult returns to the Methow basin during the Natural Production Support Phase 1

Natural-origin Returns		Hatchery-origin Returns						
		≥100	500	1000	1500	2000	4000	5000
≥100	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	700_B, 300_S, 0_H	778_B, 722_S, 0_H	778_B, 1222_S, 0_H	778_B, 3222_S, 0_H	778_B, 3870_S, 352_H
	NOR	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H
500	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	551_B, 449_S, 0_H	551_B, 949_S, 0_H	551_B, 1449_S, 0_H	551_B, 3449_S, 0_H	551_B, 3697_S, 752_H
	NOR	350_B, 150_S, 0_H	350_B, 150_S, 0_H	297_B, 203_S, 0_H	297_B, 203_S, 0_H	297_B, 203_S, 0_H	297_B, 203_S, 0_H	297_B, 203_S, 0_H
1000	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	551_B, 449_S, 0_H	551_B, 949_S, 0_H	551_B, 1449_S, 0_H	551_B, 3197_S, 252_H	551_B, 3197_S, 1252_H
	NOR	700_B, 300_S, 0_H	498_B, 502_S, 0_H	297_B, 703_S, 0_H	297_B, 703_S, 0_H	297_B, 703_S, 0_H	297_B, 703_S, 0_H	297_B, 703_S, 0_H
1500	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	551_B, 449_S, 0_H	551_B, 949_S, 0_H	551_B, 1449_S, 0_H	551_B, 2697_S, 752_H	551_B, 2697_S, 1752_H
	NOR	778_B, 722_S, 0_H	498_B, 1002_S, 0_H	297_B, 1203_S, 0_H	297_B, 1203_S, 0_H	297_B, 1203_S, 0_H	297_B, 1203_S, 0_H	297_B, 1203_S, 0_H
2000	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	551_B, 449_S, 0_H	551_B, 949_S, 0_H	551_B, 1449_S, 0_H	551_B, 2197_S, 1252_H	551_B, 2197_S, 2252_H
	NOR	778_B, 1222_S, 0_H	498_B, 1502_S, 0_H	297_B, 1703_S, 0_H	297_B, 1703_S, 0_H	297_B, 1703_S, 0_H	297_B, 1703_S, 0_H	297_B, 1703_S, 0_H
4000	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	551_B, 197_S, 252_H	551_B, 197_S, 752_H	551_B, 197_S, 1252_H	551_B, 197_S, 3252_H	551_B, 197_S, 4252_H
	NOR	778_B, 3222_S, 0_H	498_B, 3502_S, 0_H	297_B, 3703_S, 0_H	297_B, 3703_S, 0_H	297_B, 3703_S, 0_H	297_B, 3703_S, 0_H	297_B, 3703_S, 0_H
5000	HOR	0_B, 0_S, 100_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H
	NOR	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H	848_B, 3900_S, 252_H

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for the Support Phase 1 are being met. Support Phase 1 Objectives: Broodstock = 848 (35% NOR, 65% HOR), pHOS = 75%. Assumptions include an adult capacity of 3900.

Table 5-27. Management schedule for the disposition of adult returns to the Methow basin during the Natural Production Support Phase 2

Natural-origin Returns		≥100	500	1000	1500	2000	4000	5000
≥100	HOR	70_B, 30_S, 0_H	350_B, 150_S, 0_H	354_B, 646_S, 0_H	354_B, 1146_S, 0_H	354_B, 1646_S, 0_H	354_B, 3646_S, 0_H	354_B, 3870_S, 776_H
	NOR	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H	70_B, 30_S, 0_H
500	HOR	70_B, 30_S, 0_H	85_B, 415_S, 0_H	85_B, 915_S, 0_H	85_B, 1415_S, 0_H	85_B, 1915_S, 0_H	85_B, 3739_S, 176_H	85_B, 3739_S, 1176_H
	NOR	350_B, 150_S, 0_H	339_B, 161_S, 0_H	339_B, 161_S, 0_H	339_B, 161_S, 0_H	339_B, 161_S, 0_H	339_B, 161_S, 0_H	339_B, 161_S, 0_H
1000	HOR	70_B, 30_S, 0_H	85_B, 915_S, 0_H	85_B, 915_S, 0_H	85_B, 1415_S, 0_H	85_B, 1915_S, 0_H	85_B, 3239_S, 676_H	85_B, 3239_S, 1676_H
	NOR	354_B, 626_S, 0_H	339_B, 661_S, 0_H	339_B, 661_S, 0_H	339_B, 661_S, 0_H	339_B, 661_S, 0_H	339_B, 661_S, 0_H	339_B, 661_S, 0_H
1500	HOR	70_B, 30_S, 0_H	85_B, 915_S, 0_H	85_B, 915_S, 0_H	85_B, 1415_S, 0_H	85_B, 1915_S, 0_H	85_B, 2739_S, 1176_H	85_B, 2739_S, 2176_H
	NOR	354_B,1126_S, 0_H	339_B, 1161_S, 0_H	339_B, 1161_S, 0_H	339_B, 1161_S, 0_H	339_B, 1161_S, 0_H	339_B, 1161_S, 0_H	339_B, 1161_S, 0_H
2000	HOR	70_B, 30_S, 0_H	85_B, 915_S, 0_H	85_B, 915_S, 0_H	85_B, 1415_S, 0_H	85_B, 1915_S, 0_H	85_B, 2239_S, 1676_H	85_B, 2239_S, 2676_H
	NOR	354_B,1626_S, 0_H	339_B,1661_S, 0_H	339_B,1661_S, 0_H	339_B,1661_S, 0_H	339_B,1661_S, 0_H	339_B,1661_S, 0_H	339_B,1661_S, 0_H
4000	HOR	70_B, 30_S, 0_H	85_B, 231_S, 184_H	85_B, 239_S, 676H	85_B, 239_S, 1176_H	85_B, 239_S, 1676_H	85_B, 239_S, 3676_H	85B, 239S, 4676H
	NOR	354_B,3626_S, 0_H	339_B,3661_S, 0_H	339_B,3661_S, 0_H	339_B,3661_S, 0_H	339_B,3661_S, 0_H	339_B,3661_S, 0_H	339_B,3661_S, 0_H
5000	HOR	0_B, 0_S, 100_H	0_B, 0_S, 500_H	0_B, 0_S, 1000_H	0_B, 0_S, 1500_H	0_B, 0_S, 2000_H	0_B, 0_S, 4000_H	0_B, 0_S, 5000_H
	NOR	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H	424_B, 3900_S, 676_H

B=broodstock, S= spawning escapement, H=terminal harvest.

Gray shaded cells indicate that objectives for the Support Phase 2 are being met. Support Phase 2 Objectives: Broodstock = 424 (80% NOR, 20% HOR), pHOS = 65%. Assumptions include an adult capacity of 3900.

Chapter 6.
Proposed Facilities

Chapter 6. Proposed Facilities

2017 Update: *Some facilities proposed at the time the Master Plan was submitted to the Council in 2010 were changed during the development and review of the EIS. After the Final EIS was published in March 2012, new information and circumstances required further changes to some sites, including the proposed hatchery site and several acclimation sites in each basin. Locations could continue to change as new sites are evaluated to replace those eliminated. Each proposed new site must undergo NEPA and ESA review; and if any construction is required, surveys for various other resources such as cultural and historic resources and wetlands must be conducted. In addition, other federal, state, and local permitting processes must be completed.*

The program attempts to adhere to the basic principle that, if possible, two acclimation sites will be located in each major tributary of each of the two basins. Also, any site proposed must be acceptable to the property owner. Feedback from the monitoring and evaluation plan could also modify facility locations.

The program will adjust the number of smolts released at the approved sites so as not to exceed the basin-wide release numbers and release numbers in each tributary that were evaluated in the EIS, as shown in Tables 5-4 and 5-5 in Chapter 5, Section 5.3.

The Mid-Columbia Coho Restoration Plan continues the reintroduction of coho salmon in the Wenatchee and Methow basins through artificial production, acclimation and release of the progeny of locally captured broodstock. Hatchery rearing is proposed due to the high egg-to-pre-smolt survival rates that result from a controlled environment. Acclimation is proposed to provide smolts with a gradual introduction to the wild and to imprint them on areas that have suitable habitat.

The Broodstock Development phases of the project used primarily existing facilities. For the Natural Production phases, the program plans to rely primarily on existing adult traps as close to spawning habitat as possible; on existing out-of-basin hatcheries for rearing; and on multiple small ponds in upstream areas for most acclimation.

A number of variations to this approach are included in the plan. This diversity increases program flexibility and allows adaptation to changing conditions. Variations include:

- Back-up adult capture at hatcheries that also acclimate and release smolts.
- Rearing at an in-basin hatchery.
- Acclimation below, adjacent to, and above spawning habitat.
- Over-winter and spring-only acclimation on ground and surface water.
- Adult plants and acclimation in a variety of rearing environments.

Figures 6-1 and 6-2 show the locations of facilities proposed for this program, both existing and new.

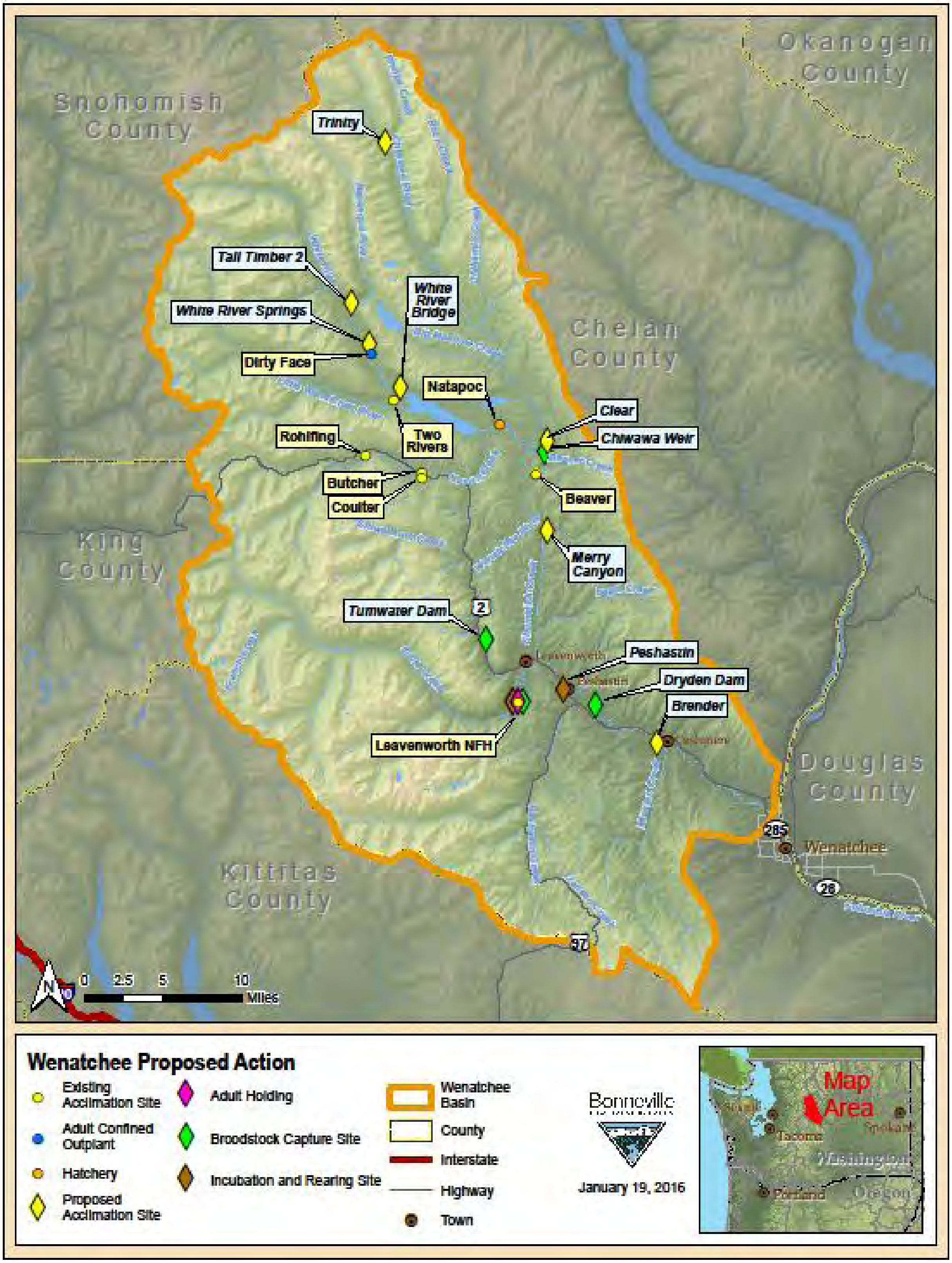


Figure 6-1. Wenatchee Basin Facilities, Existing and Proposed

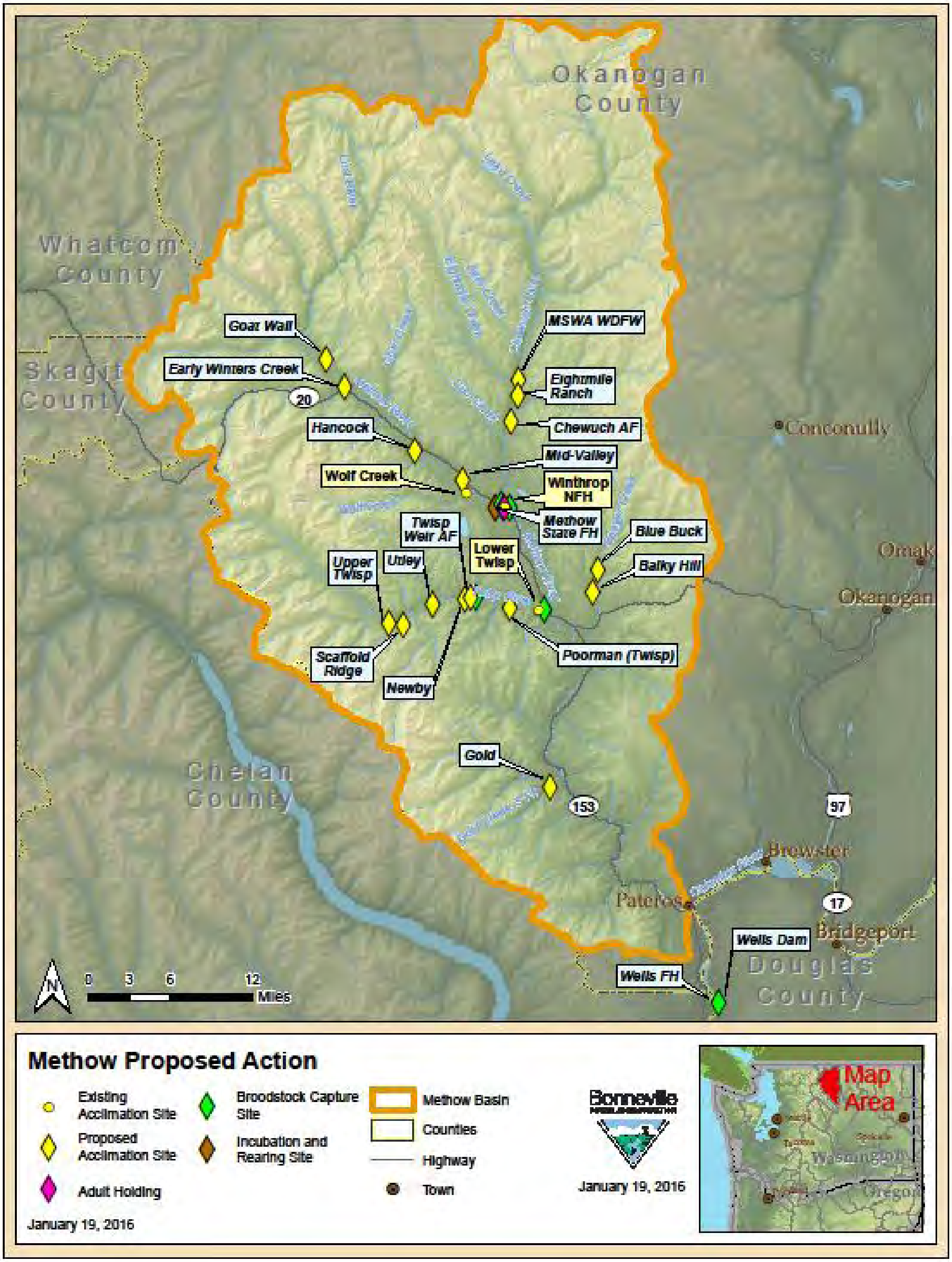


Figure 6-2. Methow Basin Facilities, Existing and Proposed[1]

1. Not all these sites would be used; however, they have been the subject of NEPA and ESA reviews. Table 4-4 in Section 4.3.2 lists the sites currently expected to be used.

6.1 Broodstock Capture Facilities

The project proposes to use broodstock capture facilities in the two basins that currently exist or are planned for future development by other agencies. Trap operation protocols for the existing facilities may need to change to meet broodstock collection goals for the coho program. The effects of operational changes on listed and sensitive species were evaluated in the EIS and in Biological Assessments for NMFS and USFWS as part of ESA consultations.

Broodstock Development Phase 1 emphasized adult capture locations in downstream areas in both basins (figures 6-1 and 6-2). Hatcheries and dams in the Wenatchee and Methow basins were the primary adult capture sites.

During BDP2 and the natural production phases, trapping locations closer to spawning habitat increase in importance. One tributary trap in the Wenatchee basin (Chiwawa) and one in the Methow basin (Twisp) are currently in operation for other existing programs might be proposed for future use by the coho program. If they are proposed for use by the coho program, additional ESA review might be required. Other tributary traps have been proposed by other supplementation programs and, if constructed, could be used.

6.1.1 Wenatchee Basin

6.1.1.1 Broodstock Development Phase 1

The primary locations for capture of adults during the BDP1 were Dryden Dam and Leavenworth NFH (LNFH). Although this phase has been completed in the Wenatchee basin, these facilities also will be used as capture locations in future phases.

Dryden Dam

The Dryden Dam collection facility is located at RK 28.2 on the Wenatchee River. This facility is owned and maintained by Chelan County PUD (CCPUD). WDFW and YN are co-operators, collecting steelhead, summer Chinook and coho broodstock for various supplementation and reintroduction programs. Dryden has been a key site for coho broodstock collection since the program’s inception.

There are two trapping facilities within the Dryden Dam structure: left bank and right bank. The left bank trap is located on the north shore of the river and operates passively. As fish enter the trap, a series of ladders provide upstream passage into the collection area. Once through the ladder system, an in-line, V-trap weir collects fish in the holding area. While operating, the left bank trap is checked at least once a day to provide brood collection and/or upstream passage of adult fish. Past years have required multiple checks at this facility each day, due to large numbers of summer Chinook and coho encountered.

Dryden right bank is located directly across and upstream from the left bank facility and is also a passive trap. A small concrete apron spans approximately half the Wenatchee River. An expandable/retractable, water-filled bladder is positioned atop the apron to provide blockage for migrating fish. This bladder is monitored daily and adjusted to account for changing flow regimes encountered during the trapping seasons. Fish entering the right bank facility are shunted into a holding area via a V-trap weir. When it is operating, the trap is checked daily to either pass or collect fish.

On non-operating days, holding areas are closed to provide unimpeded, upstream movement through the facilities. Collection efficiencies during operation depend on Wenatchee River flows. Higher flows result in reduced trapping efficiencies due to a portion of river between Dryden right bank and left bank that is accessible for passage of migrating fish.

Dryden operates 5 days a week, 24 hours a day from September 1 through December 7 (NMFS 2014).

Leavenworth National Fish Hatchery

The LNFH volunteer ladder will be used for broodstock collection on Icicle Creek when trapping goals at other locations are not met. This collection facility is owned and operated by USFWS and is located at RK 4.5 on the left bank shore. Broodstock migrate through a series of ladders until they enter a V-trap weir downstream of the hatchery adult holding ponds. This trap allows coho to be collected while juvenile spring Chinook are being reared in the adult holding ponds. If needed, the LNFH ladder trap could operate 7 days a week, 24 hours a day, from September 1 through December 7 (NMFS 2014).

6.1.1.2 BDP2 and Natural Production Phases

The primary BDP2 and natural production adult capture facility in the Wenatchee basin is Tumwater Dam. Leavenworth NFH and Dryden Dam will continue to be used during both the broodstock development and natural production phases as needed, acting as back-up locations if collection goals are not met at the primary capture facilities.

Tumwater Dam

Tumwater Dam is located at RK 49.4 on the Wenatchee River. The facility is owned and maintained by CCPUD; YN and WDFW are co-operators. Tumwater Dam can be actively or passively operated, depending on fish numbers and available personnel. In 2004, YN entered into a cost-share with CCPUD to modify and update the trapping facility. These modifications improved functionality for multiple species, helping meet the needs of both WDFW and YN.

Passive trapping operations allow migrating fish to move through a series of ladders and enter a holding facility. Once in the holding facility, fish migrate up a Denil ladder where they are shunted into a holding chamber. Prior to working up the fish, the chamber is de-watered and a hopper hauls fish out of the holding area where they are sorted, identified, and either kept for broodstock or passed upstream. YN and/or WDFW check the trap at least once a day during passive operation.

Active operation follows the same procedures except that once fish move up the Denil, a sampler is present to shunt fish to various holding tanks. During large salmon runs, it is necessary to actively trap Tumwater Dam to prevent overloading the hopper/holding area. For non-trapping days, Tumwater Dam is opened for passage; a video monitoring system records all migrating fish species.

In the Wenatchee basin, BDP1 is completed and BDP2 is ongoing. YN is allowed to operate Tumwater solely for coho collections no more than 3 days per week, 16 hrs per day from September 1 through December 7 (NMFS 2014). During trap operations, YN personnel check the trap at least once a day. Longer collection periods are allowed if WDFW is on-site trapping steelhead and coho are being incidentally handled.

Chiwawa Adult Weir

The Chiwawa weir is located adjacent to the Chiwawa Acclimation Facility on the Chiwawa River (RK 2.0). This tributary trap may be important for collections during natural production phases because it selects adults that have traveled nearly the full distance back to the spawning grounds. Current plans identify Tumwater Dam as the primary source of brood collection for the program during the broodstock collection phases. If additional tributary trapping facilities (i.e., weirs in White River, Little Wenatchee River, and Nason Creek) were available, it would warrant re-prioritizing Chiwawa weir as a primary collection source.

6.1.1.3 Natural Production Phases—Supplemental Capture Sites

Other trapping facilities, such as tributary weirs, have been proposed for other species by other fisheries agencies in the region but may not be built. If the facilities are constructed, the MCCRP project would likely use them.

6.1.2 Methow Basin

6.1.2.1 Broodstock Development Phase 1

The primary facilities used for adult capture during BDP1 in the Methow basin were Wells Dam and the Winthrop NFH.

Wells Dam

Wells Dam is located at RK 829.6 on the Columbia River. Unlike the Wenatchee basin, the Methow does not have a lower river trapping facility, so this Columbia River mainstem location is used to supplement collections at Winthrop NFH.

There are two trapping facilities at Wells Dam, the east and west fish ladders. All facilities are owned and maintained by Douglas County PUD (DCPUD) and are operated by WDFW and YN. Both traps are positioned within the middle portions of the fish ladders.

For the west ladder, adults negotiate a chute where they are either shunted into a holding area at Wells FH or bypassed back to the ladder on the upstream side of the collection point. The fish shunted into the hatchery holding area are sorted at least once a week, depending on numbers.

Fish using the east ladder trap ascend a series of pools to the trap. Fish negotiate a steep-pass Denil, then swim down a chute where they are either passed to an anesthetic tank or returned to the ladder. Fish collected in the tank are identified, baseline biological information is collected, and then they are placed in a transport truck for delivery to Winthrop NFH. On non-trapping days, the trapping weirs are closed and gates that block the ladder passage are re-opened.

Trapping operations at the dam for YN’s coho program are as follows (NMFS 2014):

Sept 1 - Sept 26: 3 days/week, 16 hours/day
Sept 27 - Oct 9: 5 days/week 9 hours/day
Oct 10 - Dec 7: 7days/week, 16 hours/day

This phased trapping alleviates incidental take of steelhead. Additional trapping opportunities are available if WDFW is operating the trap for their steelhead program.

Wells Fish Hatchery Volunteer Ladder

Wells Fish Hatchery is situated adjacent to the Wells Dam west ladder. This hatchery, funded by DCPUD but operated by WDFW, raises summer Chinook and steelhead for mitigation and restoration purposes. The volunteer trap is located at the lower portion of the facility and is the primary brood collection source for Wells summer Chinook. WDFW and YN have operated this trapping facility as a supplemental trapping location when upstream trapping locations failed to produce sufficient collection number. This trap would be operated on an as-needed basis during the months of October and November.

Winthrop National Fish Hatchery

WNFH is located at RK 80.6 on the Methow River and is operated by the USFWS. Fish volitionally enter the hatchery adult ponds through Spring Creek, a tributary to the Methow River. Coho collected at Winthrop NFH are held until spawning. Trap operation is 7 days a week, 24 hours a day, from September 1 through December 7.

Methow Fish Hatchery

Methow Fish Hatchery is a DCPUD-owned facility near Winthrop NFH on the Methow River and is operated by the WDFW. Fish volitionally enter a v-weir trap located at the hatchery's exit. Trap checks/collections occur from September 1 through December 7, 7 days a week, 24 hours a day.

6.1.2.2 BDP2 and Natural Production Phases

The primary BDP2 and natural production adult capture facilities are Winthrop NFH (described above) and possibly at the Twisp Weir, supplemented as needed by trapping at Wells Dam.

Twisp Adult Weir

The adult weir is located at RK 6.4 on the Twisp River. Currently this trap is not used for coho. If it is proposed for use in the future, it would be operated 7 days a week, 16 hours a day, from September 1 to December 7; however, dates could be modified to avoid impacts to bull trout migration. Bi-weekly quotas would be developed in annual broodstock protocol documents, written by June 30 each year, in cooperation with DCPUD and the members of the HCP Hatchery Committee. Shortfalls at this and other tributary trap locations would require increased collections at Wells Dam.

The Twisp River floating weir is funded by DCPUD and operated by WDFW. Improvements to the weir were made in 2007 to increase trapping efficiency during all flow conditions.

Wells Dam

During BDP2, Wells Dam collection procedures ensure that broodstock collection goals are met while allowing sufficient coho migration past the facility. The proportion of Wells coho incorporated into the broodstock depends on trapping success in-basin. During the natural production phases, Wells Dam would continue to operate from September 1 through December 7; the number of trapping days per week would be adjusted as necessary.

6.1.2.3 Natural Production Phases—Supplemental Capture Sites

Other trapping facilities, such as tributary weirs, have been proposed for other species by other fisheries agencies in the region but may not be constructed. If they are, the MCCRP project would likely use them, particularly those being considered in areas where coho may have a high likelihood of repopulating.

6.2 Rearing Facilities

During the broodstock development phases, the MCCRP has been using existing facilities for rearing. To help meet the objectives of the natural production phases, multiple alternatives for the rearing component of the project were evaluated. Guidelines were developed to select the basic types of systems and specific sites that would support the natural production phase rearing plans, as described in Appendix B.1 of the 2010 Master Plan.

The rearing environment in which fish are cultured is critical to meeting project goals. The availability of the correct amount and quality of reliable water supplies and the capability of sites to include effective rearing units are important requirements. Other siting guidelines involve construction and operating costs, the environmental impacts of construction and operation, the flexibility to meet changing needs, and operational considerations.

The different basic types of fish rearing system options evaluated were:

- Existing public hatcheries
- A new, large, central hatchery
- Several small rearing facilities located in the watersheds
- Extended rearing at acclimation sites
- Constructed and existing habitat
- Combinations of the above

Specific sites included existing YN, USFWS, and Mitchell Act-funded hatcheries; existing acclimation sites with long-term rearing capability that are owned by the PUDs; and locations that require new development and construction.

These production systems and sites were compared; from them, a rearing plan was proposed. The plan emphasizes the use of existing hatcheries due to cost considerations. Hatcheries that would continue to provide long-term rearing (eyed-egg to pre-smolt) through the natural production phases are Cascade FH and Willard NFH on the lower Columbia River, as well as Winthrop NFH in the Methow basin. A new hatchery is proposed for the Wenatchee basin. Pending the outcome of environmental evaluations, this facility would provide adult holding and spawning and early incubation for the Wenatchee basin population. Approximately 75% of this number would then be transferred to Cascade FH or Willard NFH. Up to 200,000 pre-smolts would be reared full term, with final acclimation and release from off-site acclimation ponds in the basin.

Summary descriptions of these facilities are in the following sections. Details, including site drawings and additional photographs, are in Appendices C.1 and C.2 of the 2010 Master Plan.

6.2.1 Lower Columbia River Rearing Facilities

6.2.1.1 Cascade Fish Hatchery

The Cascade FH would be used to rear coho destined for release in the Wenatchee basin; in the future it might also take Methow eggs. Cascade, operated by the Oregon Department of Fish and Wildlife (ODFW), is on Eagle Creek, near Bonneville Dam. The number of coho reared at Cascade changes throughout the life of the program (see Section 6.2.2).

Cascade FH was authorized under the Mitchell Act and began operating in 1959 as part of the Columbia River Fisheries Development Program. The hatchery is supplied with surface water from Eagle Creek and has full rearing capability, with the following facilities (IHOT 1996):

- Adult holding: 1 concrete adult holding pond - 22,500 cubic feet
- Incubation: Vertical stack incubators
- Raceways: 30 concrete raceways at 16 feet by 78 feet by 2.5 feet deep; 3,120 cubic feet each.

In the recent past, production goals for Cascade FH were 700,000 coho for the mid-Columbia coho program, 1,000,000 coho for the Confederated Tribes of the Umatilla Nation, and 600,000 coho for the Clatsop Economic Development Commission. The MCCRP production from Cascade FH is planned to stay at up to 700,000 for the NPIP phase.

Water is supplied through a gravity-fed system from Eagle Creek. The total water right is 20,200 gpm (45 cfs) with an actual average water usage of about 7,117 gpm (16 cfs). Eagle Creek water temperatures typically fluctuate between 2° C in December/January to 17° C in July/August. High summer temperatures create some disease problems but the large natural fluctuations may help produce smolts that survive to adulthood in increased numbers (see Appendix A).

Predicted fish sizes for the February/March transport dates for the MCCRP are 23-25 fish/lb., depending on release location and rearing strategy. Volume densities in the raceways will range from 0.6 - 0.7 lbs. per cubic foot.

In 2005, a predator net system consisting of wires and netting enclosing the coho raceways allocated for the YN program was constructed. This structure has reduced avian predation significantly (pers. comm., Mark Traynor, ODFW, 2007).

6.2.1.2 Willard National Fish Hatchery

Willard NFH would be used to rear coho destined for release in both Wenatchee and Methow basins. The proposed numbers of fish produced at Willard NFH would change throughout the life of the program (see Section 6.2.3).

Willard NFH is located on the Little White Salmon River near Cook, Washington. It was authorized by the Mitchell Act in 1946 and constructed in 1952. The facility was originally planned as a fall Chinook hatchery but changed to spring Chinook and coho because of cold water temperatures, and then switched completely to coho in the mid-1960s. Currently, this facility has returned to rearing coho, spring and fall Chinook. It operates on surface water and has full rearing capability, with the following facilities (information from IHOT 1997):

- Early rearing: 52 concrete starter tanks - 91 cubic feet each
- Raceways: 50 concrete raceways – 8 feet by 73 feet by 2.4 feet; 1,408 cubic feet each.
- 24 vertical stack incubation trays (16 trays per stack; 384 trays total).

Current hatchery production focuses on tribal programs. To keep rearing densities below 0.3 in the nursery tanks (which is difficult at Willard), the production goal would be a maximum of 1.3 million smolts. If tank densities are in the vicinity of 0.35 to 0.38, 1.6 million smolts could be reared. In 2007, the hatchery reared approximately 500,000 coho for the MCCRP. This production is expected to rise to 1,000,000 during the NPIP phase, if space is available. If space is not available, other alternatives will need to be considered.

The Willard NFH concrete raceways are narrow and shallow, which may have a negative impact on smolt quality (see Appendix A of the 2010 Master Plan). A-frame, overhead covers were installed in 2005 which provide effective shade, predator control, and working space for the crew. The general condition of the hatchery is good. A recent intake rebuild has improved water supply reliability.

The hatchery is exempt from a National Pollutant Discharge Elimination System (NPDES) discharge permit because the effluent disappears into porous lava before reaching the Little White Salmon River. Cold water disease has been an issue in the past but has recently been controlled with improved fish culture techniques. As with Cascade FH, fish produced from Willard NFH will need to be trucked long distances to acclimation sites on the Wenatchee and Methow rivers.

6.2.2 Wenatchee Basin Rearing Facilities

6.2.2.1 Existing Facilities

For the duration of the program, project proponents propose to continue to rear coho from the eyed-egg stage through pre-smolt at the existing Willard NFH and Cascade FH on the lower Columbia River (Table 6-1). Because programs and circumstances have changed at Willard and Cascade, numbers reared at each hatchery could vary year to year; however, the total number reared at both hatcheries would be as shown in the table. Due to the distance of these sites from the Wenatchee basin, the project proposes that adult holding and early incubation take place within the Wenatchee basin. Entiat NFH had been used for these functions; however, this hatchery became unavailable in 2010. The coho program transitioned to Leavenworth NFH to improve program logistics for adult transportation, fish health and egg transportation.

Table 6-1. Wenatchee rearing locations and numbers

	Project Phase			
Hatchery	Broodstock Development	Natural Production Implementation	Natural Production Support 1	Natural Production Support 2
Willard/Cascade	1,000,000	955,000	608,500	205,250
Natapoc		200,000	200,000	200,000
Total	**1,000,000**	**1,155,000**	**808,500**	**404,250**

Until a new in-basin hatchery is constructed, early incubation, from green to eyed, will continue to occur at the Peshastin Incubation Facility and Leavenworth NFH. Once the Natapoc site is operational, the Peshastin Incubation Facility might be used in some limited capacity.

Peshastin Incubation Facility

This facility in the Wenatchee basin was set up for the Mid-Columbia Coho Feasibility Studies on property owned by Peshastin Hi-Up, a fruit cooperative in the town of Peshastin. It was intended to be a temporary facility. The water source is non-chlorinated city water from Peshastin Water District, one of the only cities in the area whose waters do not need chlorination. Supplemental groundwater is available through Peshastin Hi-Up and has been used in the past as a back-up water supply. Incoming water is run through charcoal and oyster shell filter beds for conditioning. Three deep-trough incubation systems can rear approximately half the Wenatchee program until the eyed stage.

Leavenworth NFH

The facility provides vertical stack incubation trays, in isolation from other on-station spring Chinook production, and will have UV treatment located on the water outflow. This system will be able to early rear approximately half the existing Wenatchee eyed-egg program.

6.2.2.2 Proposed Natapoc Hatchery

2017 Update: *The 2010 version of the Master Plan proposed a new hatchery at Dryden. Due to water quality constraints identified during the EIS process, it was determined that the new hatchery would need to be at the backup site identified in the EIS, at the time called the George site, now called Natapoc. Natapoc is on the upper Wenatchee River approximately 2 miles downstream from Lake Wenatchee (Figure 6-3). The design and location of facilities at that site changed from what was evaluated in the EIS, so a Supplement Analysis is currently being prepared to evaluate the effects of those changes. The proposed facility as described below has been reviewed by USFWS and NMFS as part of the project's revised Biological Assessments under the Endangered Species Act, and no modifications to the proposal were required. The facility has received clearance from the Washington Department of Archaeology and Historic Preservation. Project staff also have been working closely with Washington Department of Ecology to ensure that the proposed hatchery meets water quality requirements.*

If all permitting reviews are successful, the new multifunctional facility would be operational by spring 2019. This facility would provide a centrally located site for handling and spawning local broodstock, incubation of eggs to the eyed stage, and some long-term juvenile rearing (up to 200,000), which would replace some of the production at either Cascade FH and/or Willard NFH. The benefits of having an in-basin facility include reduced inter-watershed disease transmission, improved logistics, reduced transportation stress, additional program control, and added in-basin juvenile imprinting. Proposed adult holding units could serve a dual purpose and be used to overwinter 100,000 to 200,000 Wenatchee pre-smolts. Fish would be delivered from lower river hatcheries in November, after adults have been spawned and ponds disinfected, and would be reared until transport to upper basin acclimation sites in the spring. This process would improve localized imprinting of juveniles to target water sources, subsequently reducing adult straying.

To reduce water demands, the facility is being designed for recirculation and water treatment. Due to water quality constraints on the Wenatchee River imposed by a TMDL, the project would need to land-apply discharged water after passing through a settling pond to remove sources of unwanted phosphorus before the water enters the river. The project currently is pursuing water rights for the facility, both consumptive and non-consumptive, based on current TMDL restrictions in the Wenatchee and the possibility to land-apply discharge water during the critical months outlined in the TMDL (March through May and July through October).

Proposed project elements include:

- ***Buildings:*** *1) a hatchery building that accommodates 27,000 square feet of rearing space and 6,000 square feet for administrative activities; 2) a 900-square-foot waste treatment building; 3) an 1,800-square-foot shop and storage building; 4) two staff residences with garages, occupying 2,400 square feet. The proposed site layout is shown in Figure 6-4.*
- ***Groundwater supply:*** *1) two hatchery water supply wells and one domestic water supply well; 2) a groundwater headbox and aeration columns inside the hatchery building.*
- ***Process water systems:*** *1) five reuse modules that include rearing equipment and water reuse systems for each coho life stage in the hatchery (see Figure 6-5); 2) two 20-ton chillers.*
- ***Waste disposal:*** *1) one effluent pump station; 2) waste treatment equipment consisting of two gravity thickeners (equipment to remove solids from discharge water) and associated piping; 3) one buried concrete manure tank for seasonal storage of settled solids from the waste treatment equipment, required because discharge is not permitted into the Wenatchee River*

from March through May and July through October; 4) three septic systems, one for each residence and one for the hatchery building.

- ***Irrigation:*** *1) a one-acre irrigation storage pond; 2) an irrigation pump station installed near the pond to distribute rearing system overflow into the pond and irrigation pump wet well, or to the river in the winter; an irrigation spray field and associated piping and sprinkler heads, required to land-apply the treated system discharge water during the TMDL periods.*
- ***Hatchery water discharge piping and outfall:*** *For winter use, when TMDL is not in effect.*
- ***Piping:*** *All piping for process supply water, overflow drain, hatchery drain, domestic water, and sanitary pipe from the proposed buildings.*
- ***Roads:*** *Grading and improvements to the entrance road and river access road.*
- ***Liquid oxygen storage tank:*** *For ozone treatment****.***
- ***Electrical:*** *1) electrical service to the site, including underground service to a new on-site utility transformer; 2) underground electrical distribution system to buildings and facilities; 3) control, communication, and alarm systems; 4) one diesel standby generator.*

The proposal also includes an intake that could be installed in the Wenatchee River in the future to deliver surface water to the facility during certain time periods if needed.

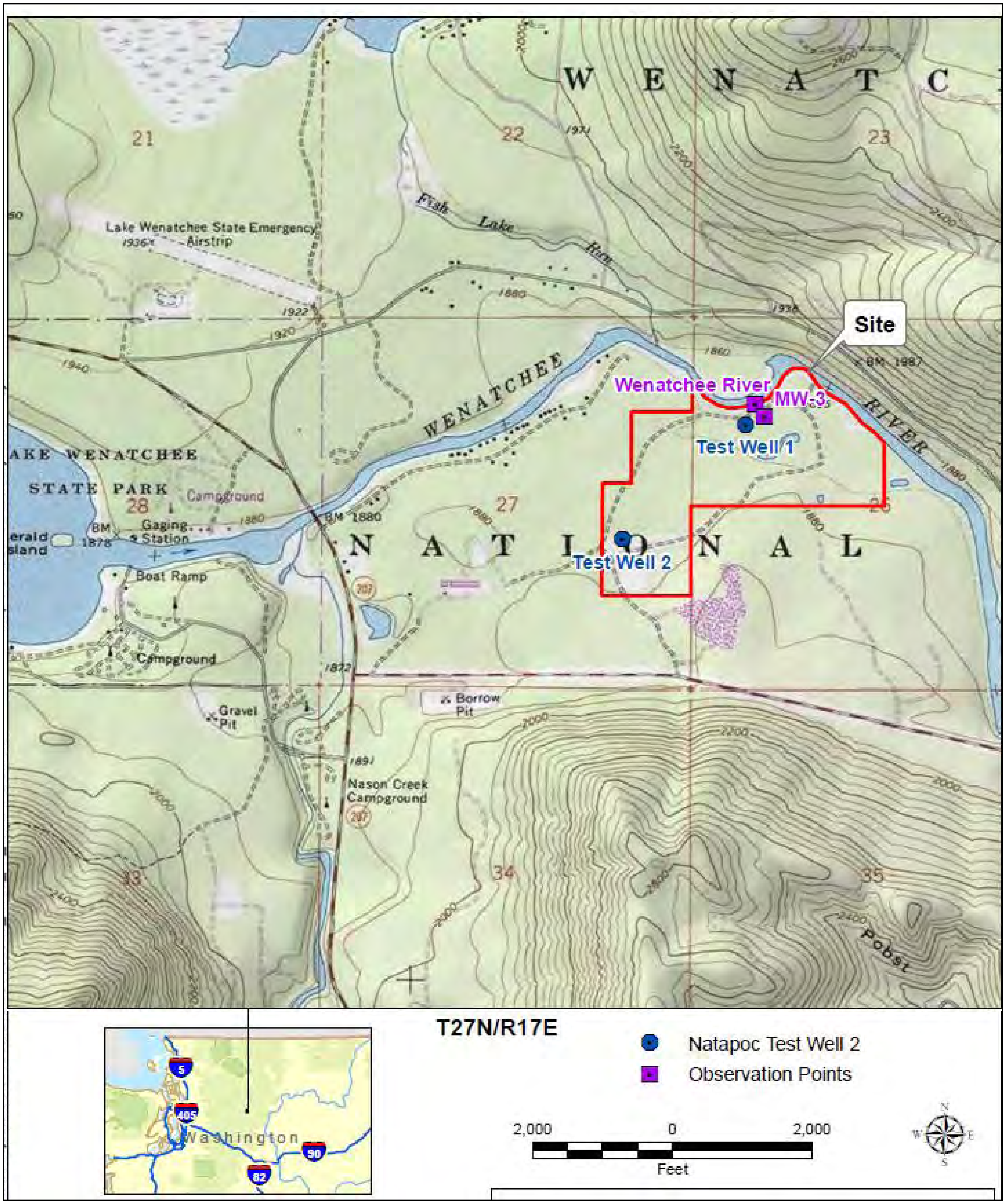


Figure 6-3. Location of Proposed Natapoc Hatchery in Wenatchee Basin

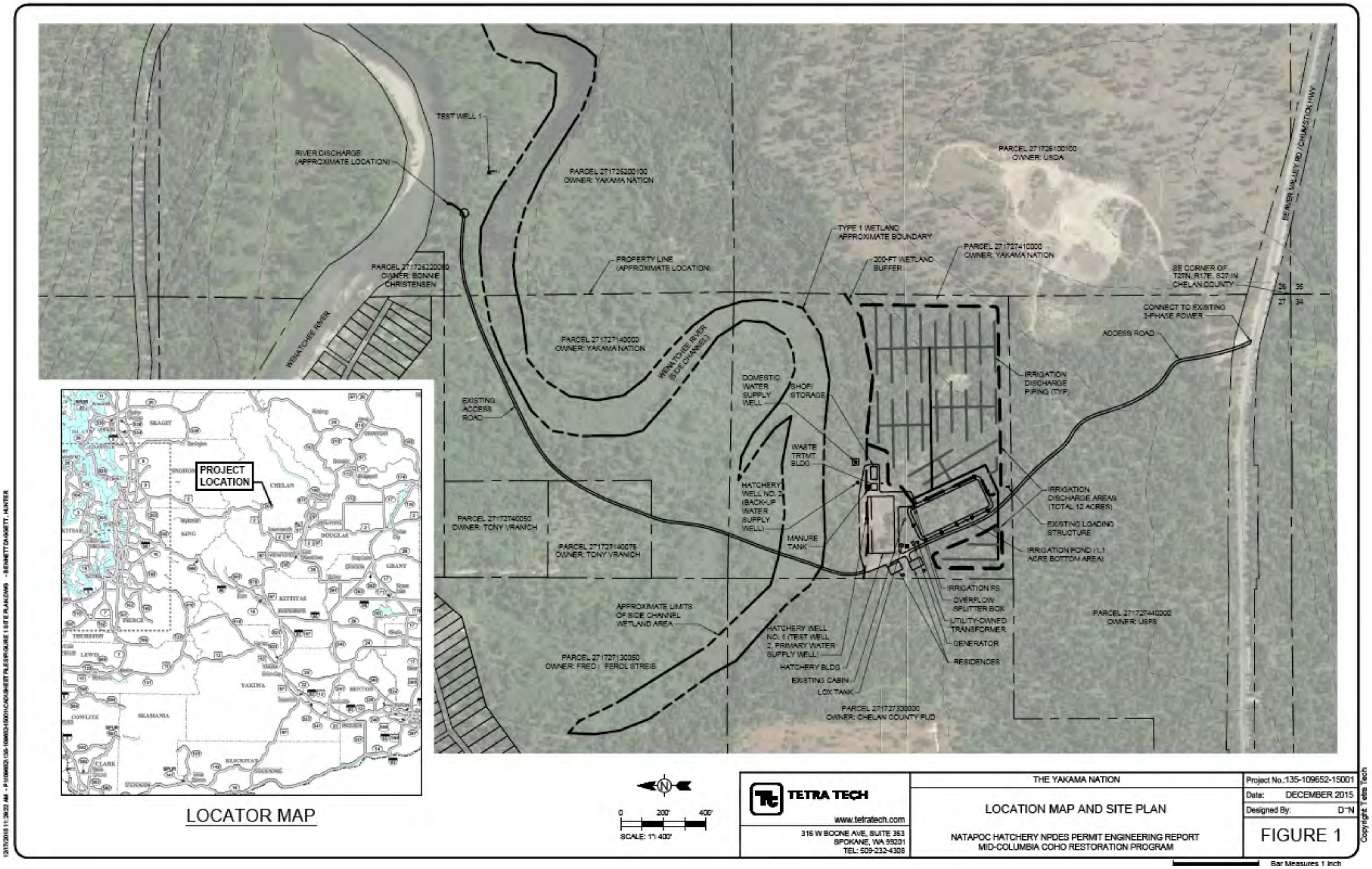


Figure 6-4. Natapoc Hatchery Proposed Facilities

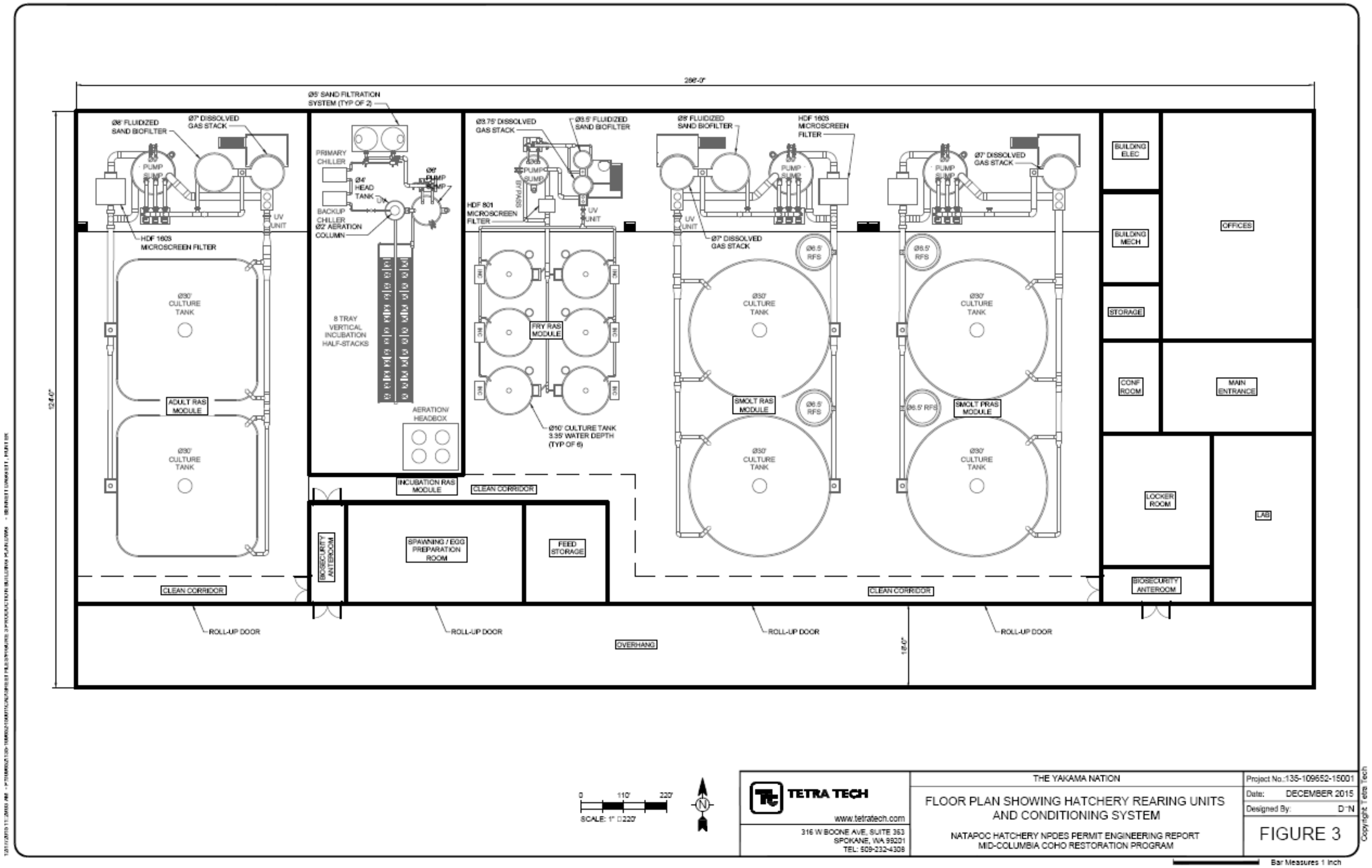


Figure 6-5. Proposed Natapoc Hatchery Building Design with Rearing Modules

6.2.3 Methow Basin Rearing Facilities

In the Methow basin, the program proposes to rear coho at the existing Willard NFH and Winthrop NFH. The total reared per year at each location for Methow release is shown in Table 6-2. Detailed plans for Methow rearing are described in Appendix C.1 of the 2010 Master Plan. Conditions at Willard NFH and Cascade FH are described in Section 6.2.1.2. As noted in that section, the number of coho reared at each of the two hatcheries could change year-to-year, but the total reared in both hatcheries will not change.

Table 6-2. Methow rearing locations and numbers

	Project Phase			
Hatchery	Broodstock Development	Natural Production Implementation	Natural Production Support 1	Natural Production Support 2
Willard/Cascade	250,000	750,000	450,000	
Winthrop	250,000	250,000	250,000	250,000
Total	**500,000**	**1,000,000**	**700,000**	**350,000**

Winthrop National Fish Hatchery

The proposed plan calls for the continued long-term rearing of 250,000 pre-smolts at WNFH plus an additional 100,000 pre-smolts from Lower River hatcheries to be acclimated in the hatchery back-channel. Starting with NPIP, only part of this production will continue to be released on-station to maximize upper basin acclimated releases for increased distribution.

WNFH currently holds all captured Methow broodstock. The facility holds a maximum of 1,240 adults and 1,300,000 eggs.

WNFH was originally authorized as part of the Grand Coulee Fish Maintenance Project. It began operation in 1942 to compensate for fish losses in the upper Columbia River drainage caused by the construction of Grand Coulee Dam. The funding agency is the U.S. Bureau of Reclamation and the operating agency is the USFWS.

The following information is from Integrated Hatchery Operations Team (IHOT) 1998 and the 2002 HGMP (YN et al. 2002) and represents current conditions at the hatchery. The hatchery has water rights totaling 29,930 gpm from the Methow River, Spring Branch Spring, and two infiltration galleries (6,000 gpm). Water use ranges from 8,528 to 27,686 gpm, with the Methow River providing the majority of the flow. Rearing systems include:

Adult Holding Ponds: 2 concrete ponds at 25,000 cft each that currently are unused.

Incubation: 150 iso buckets, 150 vertical stack trays, and bulk incubators.

Early Rearing Tanks: 34 fiberglass, 16 feet x 2 feet x 2.8 feet.

Raceways: 30 at 80 feet x 8 feet x 2.3 feet — 1,470 cft each (design flow of 300 gpm).

Raceways: 7 at 100 feet x 12 feet x 1.8 feet — 2,200 cft each (design flow of 350 gpm).

Foster-Lucas Ponds: 7 at 2,750 cft each (design flow of 350 gpm), currently not used for fish production.

6.3 Acclimation and Release Facilities

During the Broodstock Development phases, the purpose of most smolt releases has been the efficient collection of returning adults. Releases from the Leavenworth NFH and Winthrop NFH are important during these phases, and returns are captured at downstream dams and at the hatcheries themselves. Acclimation also occurs at several existing facilities to begin developing a stock that is adapted to other return locations. During later program phases, releases will be spread to more areas near coho habitat.

The primary objective of the Natural Production acclimation plan is to produce quality smolts that return as adults in high numbers to habitat areas that will support natural production. The impact of acclimation systems on overall adult survival rates; return rates to natural production areas; capital and operating costs; flexibility to adapt to changing release numbers, locations, and methods; and site development considerations helped determine the program design. Guidelines based on these elements were used to evaluate both general types of acclimation system alternatives and specific sites that comprise those systems (see Appendix B.2 in the 2010 Master Plan).

Project proponents evaluated multiple factors to develop the conceptual design for the natural production acclimation component of the project. Factors included:

- Length of acclimation period.
- Number of release locations.
- Smolt carrying capacity based on EDT modeling.
- Location of sites within watershed.
- Types of water supplies.
- Types of acclimation rearing systems.

Appendix B.2 from the 2010 Master Plan presents the evaluation in more detail. The evaluation led project proponents to conclude that a program based on multiple, low-density, natural ponds located near coho habitat that are fed by gravity-flow surface water is the most cost-effective system to meet program objectives. This acclimation technique has been well-tested during the feasibility phase of the Mid-Columbia and Yakima coho projects. Other acclimation methods, including in-river acclimation, were evaluated in the EIS.

The proposed acclimation and release system has the following characteristics:

- One or more release sites in each major tributary stream.
- A total of 25 release sites in the Wenatchee and Methow basins, of which one in each basin will be a site for confined adult plants (Hancock and Dirty Face).
- Up to 12 unconfined adult plant sites.

This acclimation system is expected to produce high adult return rates, spread fish into appropriate habitat, and have low overall project costs. It will also have the flexibility to adapt to planned and unplanned changes in program release protocols.

Smolts are proposed to be released from 13 locations in the Wenatchee watershed and 12 in the Methow watershed. Tables 5-4 and 5-5 in Chapter 5 show sample release plans for each basin. Figures 6-1 at the beginning of this chapter shows the locations of the acclimation sites that form the proposed plan in the Wenatchee basin. Figure 6-2 includes sites in the Methow basin that have been or are in process of being evaluated; not all are likely to be used. Figures 6-6 and 6-7 below show proposed unconfined adult outplant sites.

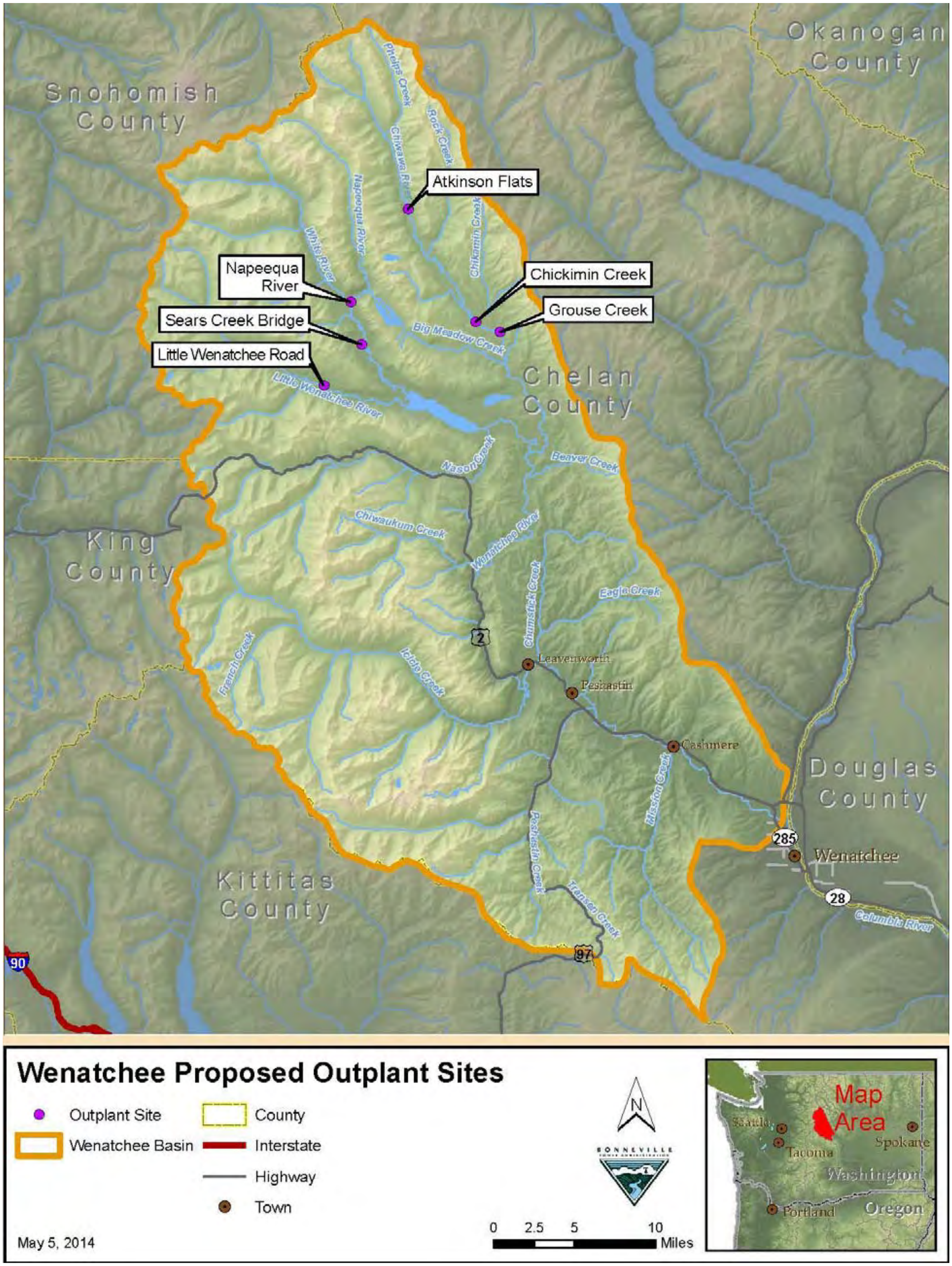


Figure 6-6. Wenatchee Proposed Adult Outplant Sites

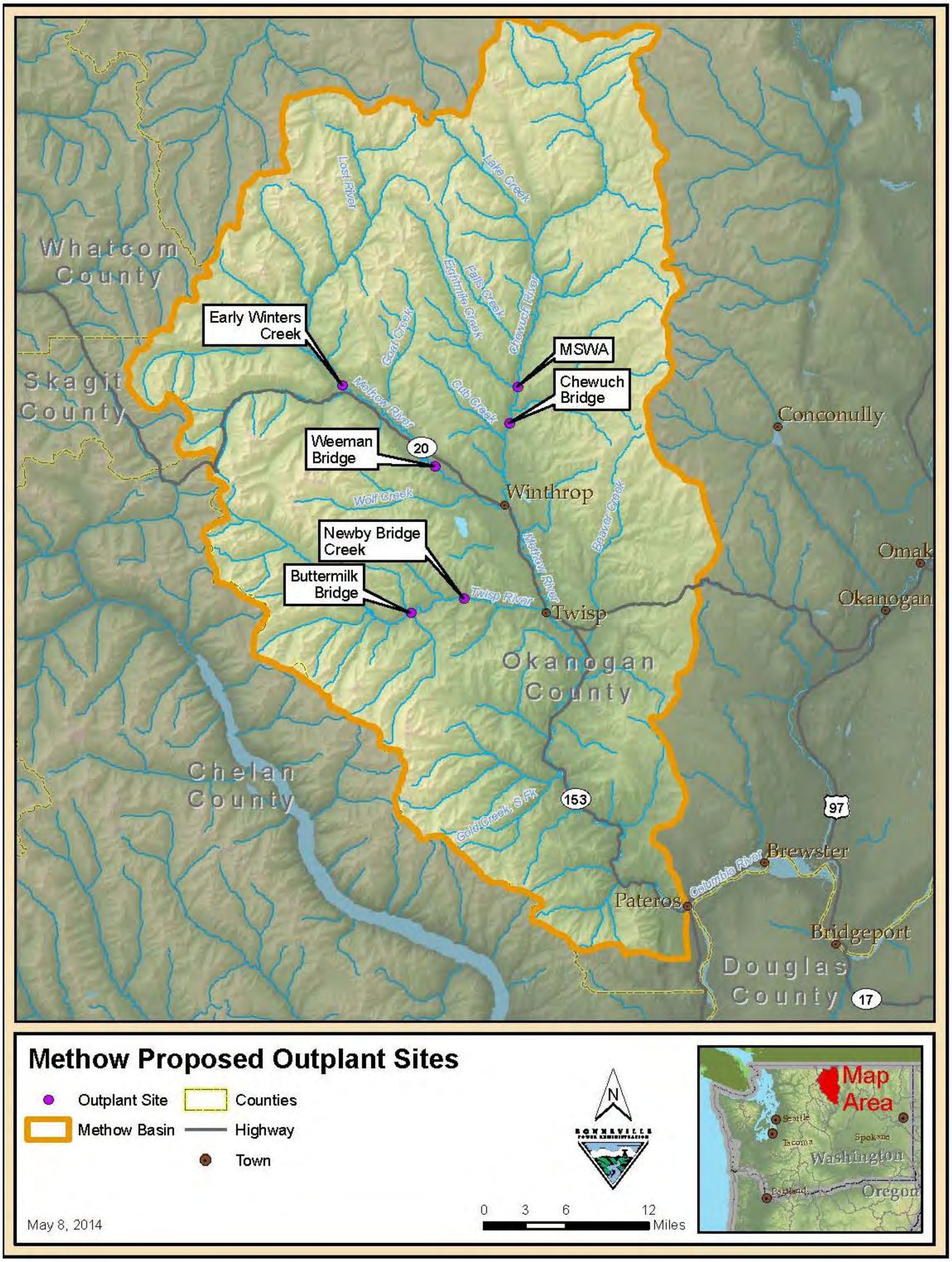


Figure 6-7. Methow Proposed Adult Outplant Sites

Chapter 7.
Monitoring and Evaluation Plan

Chapter 7. Monitoring and Evaluation Plan

The goal of the M&E program is to monitor and evaluate the results of reintroduction so that operations can be adaptively managed to optimize hatchery and natural production while minimizing any negative ecological impacts. Pursuing this goal, research data collection and analysis endeavors to: 1) demonstrate when the reintroduction program is meeting the established phased restoration goals; 2) determine whether a change in status of sensitive species is occurring and whether it is a result of coho reintroduction; and 3) provide science-based recommendations for management consideration.

The M&E plan is organized into three distinct categories: Project Performance Indicators, Species Interactions, and Genetic Adaptability. Project performance indicators are intended to evaluate how well reintroduced hatchery fish and the resulting naturally produced fish are surviving and adapting, whether certain reintroduction or hatchery practices can be modified to improve benefits achieved, and whether harvest levels threaten project success. Monitoring of project performance indicators will allow for adaptive management and evaluation of project progress toward successful reintroduction. Species interaction evaluations include monitoring the status of non-target taxa of concern (NTTOC) and investigating mechanisms of interaction (i.e., predation and competition). The species interactions evaluations described in this plan expand on issues examined during the feasibility phase and are integrated with other species monitoring ongoing or proposed in the two basins. Monitoring of genetic adaptability to local conditions is designed to determine whether the project is successfully creating a local broodstock distinct from lower Columbia River stocks in terms of genetic divergence and life history traits; and to determine the biological significance of the changes.

M&E results and plan objectives will be reviewed and revised every six years (two generations) to allow for modification of actions and adaptive management. NTTOC monitoring will continue until program termination, 5 generations (15 years) after starting the natural production phases.

Note: We have left references to Broodstock Development Phase 1 in the text, even though BDP1 has been completed in both basins, to show the continuity of the M&E program throughout the project.

7.1 Project Performance Indicators

7.1.1 Release-to-McNary Smolt Survival

Objective: To estimate smolt-smolt survival (release to McNary Dam) for hatchery coho released in mid-Columbia tributaries.

Metric*:* Smolt-to-smolt survival index (Neeley 2004)

$$\text{Smolt-to-Smolt Survival Index to McNary} = \frac{\sum_{\text{Strata}} \text{Estimated Number of tagged Fish passing McNary during stratum}}{\text{Number of Fish tagged or released}}$$

Rationale: Mullan et al. (1992) and Chapman et al. (1994a; 1994b; 1995a; 1995b) recognize that a central limitation to building self-sustaining populations of anadromous fish in Wenatchee and Methow basins is the high smolt and adult mortalities incurred at the numerous hydropower facilities on the mainstem Columbia River. Mortalities related to hydropower facilities can severely reduce the escapement numbers. Salmon abundance is also heavily influenced by ocean conditions. Freshwater conditions reflect variability within a broader spectrum of population abundance that is largely controlled by ocean conditions (Mullan et al. 1992; Nickelson 1986). Therefore, we feel it is important to monitor survival of hatchery juveniles in freshwater to help partition smolt-to-adult survival of hatchery reared program fish into the components of freshwater and marine mortality.

Smolt-to-smolt survival rates will be used to compare the "quality of smolt" produced by different rearing strategies, acclimation sites, acclimation duration, and time of release. Smolt-to-smolt survival indices will be used to evaluate rearing strategies and rearing facilities, to include current and proposed facilities, evaluations of growth rates, acclimation length, and smolt size. Knowing how rearing and environmental conditions affect smolt survival allows researchers to adaptively manage the reintroduction effort to maximize survival. Smolt-to smolt survival indices will be used to parse out that portion of mortality that is occurring during emigration.

Restoration Phases: BDP1, BDP2, NPIP. Smolt-to-smolt survival rates will be measured during the Support Phases if smolt-to-adult rates are not meeting program goals and further investigation into survival is warranted.

Methods: Groups of juvenile coho, ranging from 3,500 to 8,000 individuals, depending upon release location, will be PIT-tagged 3-6 months prior to release. PIT-tagged coho will be released from a minimum of one upper Wenatchee River acclimation site, LNFH, and Methow River site. PIT groups will also be released from ponds which have not previously been used for coho acclimation and from sites where smolt-to-adult survival rates are below expectations. All PIT tagging will follow protocols described in the PIT TAG Marking Procedures Manual (CBFWA 1999). When possible, volitional releases will be monitored for PIT tags. Survival estimates will be calculated based on subsequent PIT detections at McNary, John Day, and Bonneville Dams following methods described in Neeley 2007.

7.1.2 In-Pond Survival

Objective: To estimate in-pond (transport-to-release) survival of hatchery coho.

Metric: In-pond survival estimate based on PIT tag releases (Neeley 2007) or predator and mortality observations (Kamphaus et al. 2008).

Rationale: In-pond survival estimates will increase the accuracy of smolt-to-adult and smolt-smolt survival estimates. In-pond survival estimates will be used to evaluate the success of acclimation ponds and predator control strategies, allowing researchers to maximize survival through adaptive management.

***Restoration Phases*:** All phases.

Method: Groups of approximately 3,500 to 8,000 juvenile coho will be PIT tagged 3-6 months prior to release (see **Section 7.1.1 Release-to McNary Smolt Survival**). In-pond survival estimates based on PIT tags are possible only in ponds with monitored releases. In-pond survival based on PIT tags will be calculated following methods described in Neeley 2007. In-pond survival rates from acclimation sites that do not have PIT tag detection capability will be estimated based on moribund fish, numbers of predators observed, and predator consumption rates (Kamphaus et al. 2008).

7.1.3 Pre-Release Fish Condition

Objective: To provide a comparative measure of fish condition and stage of smoltification prior to release.

Metric: Stage of smoltification will be measured as the proportion of fish which, upon visual examination, appear to be smolts, transitional (in the process of becoming a smolt), or parr. Fish condition will be assessed not only on size and growth accrued during acclimation but also on morphological and physiological measures such as overall condition of fins and eyes; of internal organs (e.g., kidney, liver, spleen, etc.); and of mesenteric fat levels and blood components (% volume of red and white blood cells, plasma protein levels).

Rationale: Pre-release fish condition examinations are intended to assess the normality or overall health of the population. These examinations will allow researchers to compare fish condition between ponds and between years as a measure that may affect survival.

Restoration Phases: All phases.

Methods: A random sample of 100 fish from each acclimation pond will be used to measure stage of smoltification and growth weekly until release. The pre-release fish condition assessment will be done once within 72 hours of release. Detailed methods describing how stage of smoltification is determined and how pre-release fish condition examinations are conducted can be found in Kamphaus et al. 2008.

7.1.4 Volitional Release Run-Timing and Tributary Residency

Objective: To describe volitional release patterns, peak migration from acclimation ponds, duration of time spent in tributaries post-release, and run timing to McNary Dam.

Metric: Run timing, in hours, calculated from PIT tag detections during monitored releases to recapture in tributary traps (i.e., smolt traps), in-stream PIT tag arrays, and Columbia River PIT detection facilities.

Rationale: Knowing tributary residence time will enable researchers to better understand the potential for interaction between hatchery coho and listed and sensitive species (see **Section 7.2 Species Interactions**). We will examine the relationship between volitional exit date and tributary residence time, allowing for programmatic changes to minimize potential negative interactions. The correlation between volitional exit date and smolt-smolt survival may also enable researchers to maximize survival of hatchery fish by releasing hatchery coho at an optimal time.

Run timing is a life history attribute which may change with the development of a local broodstock (see **Section 7.3.1 Morphometrics and Life History Traits**). As natural production increases during the NPIP and Support Phases, run timing will be measured for both naturally produced and hatchery coho based on the distribution of migrating naturally produced coho captured in tributary smolt traps.

Method: Using the same groups of 3,500 to 8,000 PIT-tagged juvenile coho as described in **Section 7.1.1 Release-to-McNary Smolt Survival**, tributary residence time will be calculated from ponds with PIT tag detection capabilities (e.g., Butcher Creek Pond, Rohlfing's Pond, Beaver Creek Pond Coulter Creek Pond, Winthrop NFH back-channel and Lower Twisp Ponds). Dates and times of reported recaptures in tributary traps and PIT tag interrogation facilities will be used to calculate residence time and run timing. On rare occasions coho pre-smolts may escape from the acclimation pond early due to predator damage to nets or other unforeseen incidents. If a small number of fish escape early, we will make every attempt to quantify and report the number of escapees; but because that number is typically limited in space and time and does not represent the primary release of smolts from the pond, any early escapees will be excluded from the tributary residence time calculations.

7.1.5 Spawning Escapement and Distribution

***Objective*:** To estimate in-basin spawning escapement and distribution for both hatchery-origin returns (HORs) and natural-origin returns (NORs).

Metric: Annual redd counts, escapement estimates and spawning ground composition.

***Purpose*:** Redd counts will provide an estimate of spawning escapement and distribution of reintroduced coho salmon. The counts, along with spawning composition (pNOS and pHOS) and distribution, will allow researchers and managers to determine the efficacy of the reintroduction effort, collect empirical productivity data and determine whether spawning ground composition goals for each phase are being met.

Hypotheses:

- Implementation Phase – H_o: pHOS ≤ 90%
- Support Phase (1) – H_o: pHOS ≤ 75%
- Support Phase (2) – H_o: pHOS ≤ 65%

Restoration Phases: All phases.

Method: Spawning escapement and distribution will be evaluated in terms of redd counts and an estimate of fish per redd (based on sex ratio observed at in-basin trapping facilities). Spawning ground surveys will be conducted in all tributaries where juvenile coho have been released and other tributaries that have coho spawning attributes such as low gradient, adequate winter flow and small gravel (about 25 mm) (Quinn 2005). Radio-telemetry or PIT tagging techniques could be used, particularly during the natural production phases, to identify previously unknown coho spawning locations, to ensure that all spawning reaches are surveyed, and to identify spawning locations of straying coho. A description of protocols for both spawning ground surveys and radio telemetry can be found in Murdoch et al. 2005.

A PIT tag approach to estimating escapement to the Methow and Wenatchee basins and to tributaries within each basin may be used. A PIT tag approach may allow for a more precise estimate of hatchery- and natural-origin escapements both at the basin level and within tributaries. Up to 15% of the run would be PIT tagged and sampled at Priest Rapids Dam; subsequent detection would occur on the extensive network of instream arrays in the Wenatchee and Methow basins. A PIT tag approach may be pursued in addition to foot and boat surveys. Under some conditions, coho redds can be difficult to locate and carcass recovery can be complicated by high-water events common during the coho return.

7.1.6 Natural Smolt Production

Objective: To provide a population estimate of naturally produced coho smolts emigrating from the Wenatchee and Methow rivers.

Metric: Population estimates of both spring and fall emigrating coho with 95% confidence intervals.

Rationale: Natural smolt production estimates are a measure of productivity. Smolt production estimates will be used to evaluate program progress and success in terms of egg-to-emigrant survival rates and smolt-to-adult survival rates. Natural smolt population estimates during all phases are essential to accurately measure key project performance indicators, such as smolt-to-adult survival rates.

While the broodstock development phases primarily focus on the development of a local broodstock rather than on natural production, some natural production will occur during these early phases, likely in a geographically limited area. Fish trapping facilities at Dryden Dam are not 100% efficient, presumably resulting in some natural production on a limited geographical scale. It is important to collect data regarding natural production during the broodstock development phases because early measures of productivity (e.g., smolts per spawner, egg-to-emigrant survival, etc.) on a basin-wide scale will provide a rough baseline measure of the success of natural spawners prior to the natural production phases.

Restoration Phases: All Phases.

Methods: Operation of rotary smolt traps, protocols for fish handling, and data analysis will proceed as described in Murdoch et al. (2005) and Hillman (2004). Traps will be operated annually between March 1 and November 30.

Broodstock Development Phases: During broodstock development phases we will coordinate with ongoing monitoring activities to reduce duplication of activities. Currently in the Wenatchee basin, WDFW operates a rotary smolt trap in the lower reach of the Wenatchee River. Through a cooperative effort, this trap will be used to provide population estimates for naturally produced coho as it was during the feasibility phase. The YN-operated smolt trap in Nason Creek will provide a tributary-specific population estimate. Similar coordination with WDFW in the Methow basin should provide a basin-wide coho population estimate for the Methow.

Natural Production Phases: All monitoring efforts, including population estimates during the natural production phases, will be coordinated with other co-managers and recovery processes to avoid unnecessary duplication of efforts and cumulative handling effects. In addition to the traps identified above (Wenatchee River, Nason Creek, and Methow River), smolt traps currently operate in the White (YN), Chiwawa (WDFW), and Twisp (WDFW) rivers. These tributary traps will provide additional tributary-specific estimates of coho smolt production and productivity.

7.1.7 Egg-to-Emigrant Survival Rates

Objective: To estimate egg-to-emigrant survival rates for naturally produced coho salmon in mid-Columbia tributaries.

Metric: Egg-to-Emigrant Survival (S) will be expressed as the ratio of the estimated number of emigrant coho (C_e) and the estimated number of eggs deposited (E_d).

$$S = C_e/E_d$$

Rationale: The egg-to-emigrant survival rate will provide data to determine which tributaries are most productive for coho production. The relationship between egg-to-emigrant survival and seeding level will assist researchers in developing tributary-specific empirically derived estimates of carrying capacity.

We assume that the freshwater productivity (expressed as an egg-to-emigrant survival rate) will increase as domestication selection is reduced, local adaptation is emphasized and habitat improvement projects are implemented.

Hypothesis:

- H_o: Egg-to-Emigrant Survival $_{\text{Broodstock Development Phases}}$ $\geq$ Egg-to-Emigrant Survival $_{\text{Implementation Phase}}$ $\geq$ Egg-to-Emigrant Survival $_{\text{Support Phase}}$

Restoration Phases: Egg-to-emigrant survival rates will be calculated on a basin-wide scale during the broodstock development phases (i.e., total number of redds vs. total number of emigrants). During the natural production phases we will calculate egg-to-emigrant survival independently in each tributary of reintroduction where existing sampling infrastructure exists (Twisp River, White River, Nason Creek, and Chiwawa River).

Methods: The number of emigrant coho will be estimated from tributary trap data as described in **Section 7.1.6 Natural Smolt Production**. The number of eggs deposited will be calculated from the number of redds observed (see **Section 7.1.5 Spawning Escapement and Distribution**). Both basin-wide and tributary specific estimates will be calculated.

7.1.8 Smolt-to-Adult Survival (SAR)

Objective: To measure smolt-to-adult survival for hatchery and natural-origin coho.

Metric: Smolt-to-adult survival will be calculated as follows:

$$S_{smolt\text{-}adult} = \text{Adults and Jacks}_{\textbf{broodyear X}} / \text{Smolts}_{\textbf{broodyear X}}$$

Where $S_{smolt\text{-}adult}$ is the estimated smolt-to-adult survival rates; Adults and Jacks $_{\textbf{broodyear } X}$ is the number of adult coho to return from broodyear *X* ; Smolts $_{\textbf{broodyear } X}$ is the population of emigrating smolts.

Rationale: For hatchery fish, smolt-to-adult survival will be used to test the premise that SARs will increase with the development of a local broodstock. SARs will also be used to compare the "quality of smolt" produced by different rearing strategies, acclimation sites, acclimation duration, and time of release. Knowing how smolt-to-adult survival indices correlate with rearing and environmental conditions will allow researchers to adaptively manage the reintroduction effort to maximize survival. The SARs will be used to evaluate rearing strategies and rearing facilities to maximize survival. Evaluations will include facility comparisons (currently ongoing), comparisons of growth rates, smolt size, and acclimation length (currently ongoing).

We assume that the survival of Wenatchee and Methow coho will increase as domestication selection is reduced, local adaptation is emphasized and habitat improvement projects are implemented.

Hypothesis:

- H_o: Smolt-to-Adult Survival $_{\text{Broodstock Development Phases}}$ ≥ Smolt-to-Adult Survival $_{\text{Implementation Phase}}$ ≥ Smolt-to-Adult Survival $_{\text{Support Phases}}$

Methods: SARs will be calculated for both naturally and hatchery produced coho. We plan to mark 100% of the hatchery fish released under this program with CWTs. CWTs will be used to calculate SARs from each release group and location, and will be used to distinguish hatchery from natural fish (no CWT). Pre-release CWT retentions will be used to estimate the number of fish with CWTs released. To verify origin, scale samples will be taken from all adult coho that do not have a CWT. During the broodstock development phases, SARs for hatchery and naturally produced coho will be calculated based upon the number of smolts released (hatchery), smolt emigration estimates from WDFW's Methow and Wenatchee river smolt traps, and CWTs recovered from hatchery and naturally produced coho collected at Dryden Dam for broodstock. During the natural production phases, tributary-specific SARs may be based on carcass recovery and tributary population estimates, in addition to the basin-wide metric described above.

7.1.9 Adult-to-Adult Productivity

Metric: Adult productivity will be measured in the Wenatchee and Methow broodstock collection facilities and on the spawning grounds (through carcass recovery) for naturally spawning fish. Adult-to-adult survival will be calculated as follows:

$$P_{adult} = S_2/S_1$$

Where P_{adult} is the estimated adult-to-adult survival; S_2 is the number of returning adults (including jacks); and S_1 is the number of adults from the parent brood year producing the S_2

returning adults. A P_{adult} value that averages greater than 1.0 over several generations indicates that the population is increasing.

Rationale: The adult-to-adult survival rate measures the productivity of reintroduced coho, providing an overall indicator of project success. During the NPIP, P_{adult} may indicate which tributaries are the most productive.

We assume that the productivity of Wenatchee and Methow river coho salmon will increase as domestication selection is reduced, local adaptation is emphasized and habitat improvement projects are implemented.

Hypothesis:

- H_o: $P_{\text{Broodstock Development Phases}} \geq P_{\text{Implementation Phase}} \geq P_{\text{Support Phases}}$

Restoration Phases: Natural Production Phases

Methods: Coho collected for broodstock and naturally spawning coho carcasses will be interrogated for the presence of CWTs. Scales will be taken from coho that are not marked with a CWT to confirm origin. These data will be used in calculations described under ***Metric***.

7.1.10 Harvest Rates

Objective: Estimate out-of-basin harvest rates of program fish in order to determine if harvest rates are likely to limit project success.

Rationale: Harvest may have been a significant factor in the disappearance or reduced number of coho in both the distant and recent past. Currently, the majority of coho in the Columbia River are produced and released below Bonneville Dam. The historical intent of this production was to supply coho for the 80-90% exploitation rate by ocean and lower Columbia River fisheries. However, since the period 1988-1993, harvest rates of coho (commercial ocean troll and recreational) have decreased by approximately 25% (PFMC 1999). Harvest reductions were the result of mixed stock fishery issues related to the Endangered Species Act. Coho released under this project are subject to the following fisheries: ocean commercial troll fisheries, ocean recreation fisheries, Buoy 10 recreational fisheries, lower Columbia River commercial fisheries, lower Columbia River recreational fisheries, Zone 6 (Bonneville to McNary dams) Treaty Indian commercial fisheries, and above-BIonneville Dam recreational fisheries. All recreational fisheries and the ocean commercial troll fisheries are selective for adipose-fin-clipped fish. Harvest mortality for project fish in these fisheries will primarily be limited to incidental mortality, so we have no ability to recover CWTs from these fisheries. The Columbia River commercial coho fisheries (Buoy 10 to Bonneville Dam) do intercept both adipose-clipped and non-clipped fish. All coho captured in this fishery are examined for the presence of a CWT, with an approximate sampling rate of 20%. Presently, harvest monitoring of Treaty Indian fisheries does not include recovery of CWT. Although the total harvest rate on adipose-clipped fish could be as high as 50-60%, the total harvest rate on non-adipose-fin-clipped fish is substantially lower (20-25%) due to the selective fisheries that are likely to remain in place for many years as a result of ESA constraints.

Restoration Phases: All phases.

Methods: We will coordinate with agencies responsible for harvest management (WDFW, ODFW, USFWS, CRITFC, etc.) to estimate the harvest rates of target stocks by querying existing databases that may contain harvest or stray information for program fish.

7.2 Species Interactions

During the feasibility phase, 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 (see **Chapter 3**). Stream dwelling salmonids that have evolved in sympatry have developed mechanisms to promote coexistence and to partition the available habitat. Studies with coho salmon and steelhead trout (Hartman 1965; Johnson 1967; Fraser 1969; Allee 1974), Chinook salmon and steelhead trout (Everest and Chapman 1972), Chinook salmon and coho salmon (Lister and Genoe 1970; Stein et al. 1972; Murphy et al. 1989), coho salmon and cutthroat trout (Bjornn 1971; Bustard and Narver 1975; Sabo and Pauley 1997) and coho salmon and dolly varden (Dolloff and Reeves 1990) all support this statement.

Mechanisms to measure negative interactions between hatchery fish and other species have been studied by others (Larkin 1956; Fraser 1969; Stein et al. 1972; Glova 1986; Marnell 1986; Cannamela 1993; Riley et al. 2004), but impacts to non-target species in terms of abundance, distribution and size have not been conclusively measured (Fresh 1997, Pearsons et al. 2004) on a basin-wide scale. Interactions between reintroduced coho and listed and sensitive species will be evaluated through an integrated NTTOC monitoring program. A basin-wide NTTOC monitoring program has been implemented in the Yakima River (Busak et al. 1997, Hubble et al. 2004; Pearsons et al. 2004).

NTTOC status monitoring (**Section 7.2.1**) answers the question "Are there adverse changes in the status of NTTOC in tributaries where coho have been introduced?" NTTOC status monitoring does not answer questions of whether coho caused the changes in NTTOC status or the mechanism of change (e.g., predation, competition, etc.). The studies outlined in **Section 7.2.2** address those causal questions.

Species interaction monitoring will continue for a minimum of six years (two coho generations) during the Support Phases, but may continue longer pending results.

7.2.1 Status of Non-Target Taxa of Concern (NTTOC)

During the feasibility phase of the Mid-Columbia Coho Reintroduction Program, the HGMP (YN et al. 2002) and the mid-Columbia Coho Technical Workgroup (TWG) identified a number of critical uncertainties associated with coho reintroduction and species interactions. Studies implemented during the feasibility phase (see Chapter 3) answer many of those uncertainties, including the rates of predation by hatchery coho on spring Chinook fry and on sockeye fry. One main question remains unanswered, that of the predation rate of naturally produced coho on spring Chinook fry. As stated in Chapter 3, numbers of naturally producing coho were not sufficient to undertake a meaningful study (Murdoch et al. 2005). The study described in **Section 7.2.2.2** proposes to address this remaining question.

With most of the critical uncertainties answered, the proposed NTTOC monitoring plan is designed to integrate the coho reintroduction effort with other ongoing programs to monitor the status of listed and sensitive species. The non-target taxa monitoring program will focus on the status and freshwater residence of spring Chinook and steelhead, but data on all other species encountered, such as bull trout, cutthroat trout, lamprey and sockeye, will also be collected.

We define status as the interaction of abundance, distribution, and size. A change in status is the deviation from baseline conditions. **A change in status of a listed species does not indicate causation, but if coho reintroduction has a negative impact on listed and sensitive species, decline in status correlated with increased numbers of coho would occur. If a decline in status correlated to coho abundance is detected, further investigations into the mechanism of interaction and source of decline are warranted** (see **Section 7.2.2**).

To provide baseline data for evaluating effects of coho reintroduction, monitoring will begin during the broodstock development phases when the hatchery coho are released on a geographically limited scale and numbers of naturally spawning coho in tributaries containing spring Chinook and steelhead will be minimal. Baseline monitoring will be done in most tributaries proposed for future coho releases during the natural production phases. Monitoring of changes in tributaries with no previous coho release will occur during the Implementation Phase. The study design will include both a temporal and spatial control. Baseline data collected prior to coho reintroduction will function as a temporal control from which to compare any change in NTTOC status.

The NTTOC monitoring plan builds on, and will be coordinated with, ongoing monitoring efforts in the Wenatchee, Entiat and Methow basins, thus avoiding duplication of efforts and minimizing cumulative handling effects and costs. Existing programs currently collecting data that may be used to help determine a change in status for NTTOC include the Chelan, Grant and Douglas County PUD HCP hatchery compensation monitoring and evaluation programs.

This NTTOC monitoring program is designed to provide data to measure the effects of both Type I and Type II interactions. Type I interactions are those that occur between hatchery fish and wild fish, while Type II interaction may occur between NTTOC and the naturally produced offspring of hatchery fish (Pearsons and Hopley 1999).

7.2.1.1 NTTOC Risk Assessment

As one part of the Monitoring and Evaluation Plan for HCP Hatchery Compensation programs (Murdoch and Peven 2005; DCPUD 2005) and the Monitoring and Evaluation Plan for Grant PUD Salmon and Steelhead Supplementation programs (GCPUD 2009), coho salmon will be included in a NTTOC risk assessment. An expert panel will conduct the assessment to evaluate risks associated with potential effects of supplemented Plan Species (including coho salmon) on non-target taxa using an approach similar to that used in the Yakima basin (Ham and Pearsons 2001). The process is intended to focus on assessing the risks to NTTOC and on identifying interactions, the actions that could be taken to minimize risks, and the level of uncertainty. Both positive and negative species interactions are included in the assessment; a list of interactions and species considered is shown in Table 7-1. The list of species was decided upon by consensus of the Chelan and Douglas County PUD HCP Hatchery Committees.

Table 7-1. List of species and interactions to be considered in the NTTOC risk assessment

NTTOC	Negative Interactions Considered	Positive Interactions Considered
Spring Chinook Steelhead Sockeye	Competition Behavioral anomalies Pathogenic Predation	Prey Nutrient Enhancement

2017 Update: *The NTTOC Risk Assessment is now complete. The study assessed the risks of the effects of multiple hatchery programs on NTTOC species in the Wenatchee and Methow basins, including but not limited to ESA-listed species. Based on the modeling performed for the assessment, the only estimated hatchery coho mortality effects that exceeded 1% were the effects of hatchery coho on Methow summer Chinook (at 1.06%), well within the containment objective of 10% mortality on this species (Mackey et al. 2014). The full report is in Appendix 2.*

7.2.1.2 Reference Stream Comparisons

In the last version of this Master Plan, we proposed to use the Entiat River as a reference population of Chinook and steelhead from which any observed changes in abundance (as measured through egg-to-emigrant survival rates), distribution, or size could be gauged.

The Entiat River was proposed by the resource managers (NOAA, WDFW, YN, USFWS, Colville Tribe), Chelan PUD and Douglas PUD as a potential reference stream for both spring Chinook and steelhead, to measure the success of the PUDs' HCP hatchery programs (Murdoch and Peven 2005). As such, analysis to determine the ultimate suitability of the Entiat River as a reference stream for spring Chinook and steelhead, along with collection of the data required to compare changes in size, abundance and distribution, was undertaken as part of the HCP monitoring activities funded by CCPUD and DCPUD hatchery compensation programs (Murdoch and Peven 2005). Reference stream suitability criteria were adapted from the Chelan and Douglas HCP hatchery compensation program M&E plan (Murdoch and Peven 2005) and include the following:

- No recent (within the last 5-10 years) hatchery releases directed at target species
- Similar information of hatchery contribution on the spawning grounds
- Similar fluvial-geomorphologic characteristics
- Similar out-of-basin effects
- Similar historic records of productivity
- Appropriate scale for comparison
- Similar in-basin biological components, based upon analysis of empirical information.

The USFWS generates population estimates of juvenile salmonids through rotary trap operation, uses underwater observation techniques to estimate juvenile rearing distribution, and conducts spawning ground surveys for spring Chinook, summer Chinook, and steelhead in the basin. The use of the Entiat River as a potential reference stream for steelhead and spring Chinook precludes the release of these species in the Entiat basin, making the Entiat River similarly a reference stream to gauge potential NTTOC interactions as a result of coho reintroduction in the Wenatchee and Methow.

Although use of the Entiat as a reference stream for the proposed coho program is still a possibility, the continued status of the Entiat River as a reference from which to gauge changes in the status of NTTOC in the Wenatchee and Methow rivers is currently uncertain. Spring Chinook spawning habitat is upstream of the ENFH, and the USFWS rotary smolt trap used to calculate population abundance is located near the facility. A portion of the steelhead production and likely all bull trout production also are upstream of the ENFH.

Use of the Entiat River as a reference stream may also be complicated due to the intensive habitat restoration that is currently ongoing and planned. The Upper Columbia Salmon Recovery Board (UCSRB) is supporting an accelerated schedule for the implementation of 75-80 in-stream habitat actions defined in Entiat Watershed Plan (CCCD 2004) within a short time frame (goal of 5 years). In relation to the size of the Entiat basin, this schedule represents a substantially faster rate of habitat improvement than will take place in the Wenatchee or Methow basins, potentially resulting in a population increase that could preclude the use of the Entiat River as a reference stream. In addition to the coho restoration effort, multiple hatchery programs for multiple species exist in the Wenatchee and Methow River basins (spring Chinook, summer Chinook, and steelhead). If, for example, the status of spring Chinook were to change in the Entiat River, it will be difficult if not impossible to ascertain individual effects of multiple hatchery programs simultaneously.

7.2.1.3 Status of NTTOC

We define a change in status of NTTOC as a change in size, abundance, or distribution. The following sections describe how we plan to monitor any change in status of NTTOC as we proceed with coho restoration in the Wenatchee and Methow basins. NTTOC status updates will be reported every six years or two coho generations, beginning with the start of the Natural Production Phases of the coho restoration program.

Spring Chinook and steelhead metrics required for status reporting are currently collected through the extensive monitoring programs designed to evaluate the Chelan, Grant, and Douglas County PUD hatchery programs (Hillman et al. 2013). Metrics which will be considered are smolt size, survival and freshwater productivity, and adult spawner distribution.

Smolt Size

Objective: To monitor size (length and K-factor) of NTTOC and juvenile coho in tributaries proposed for coho reintroduction.

Rationale**:** The size and condition of NTTOC and juvenile coho, combined with abundance and productivity data, will be used to evaluate the effect, if any, of coho reintroduction. Baseline monitoring during the broodstock development phases will establish trends in size, abundance and distribution of NTTOC prior to the natural production phases. Baseline monitoring in most tributaries with proposed coho releases will provide a temporal control in which to evaluate any changes in NTTOC size.

Hypotheses:

- H_o: NTTOC Size $_{\text{before reintroduction}}$ < NTTOC Size $_{\text{after reintroduction}}$
- H_o: NTTOC Size $_{\text{treatment stream}}$ < NTTOC Size $_{\text{reference stream}}$

- H_o: β = 0; There is no relationship between the size or condition of NTTOC smolts and abundance of coho smolts

Restoration Phases**:** Baseline monitoring during broodstock development phases; change monitoring during the natural production phases.

Methods: At each rotary trap in the Wenatchee, Entiat, and Methow basins, fork length and weight are routinely collected from captured smolts of all species. The length and K-factor of smolts emigrating from Nason Creek, White River, Chiwawa River, Wenatchee River, Methow River, and Twisp River will be regressed against the abundance of coho smolts. Regression analysis will be used to determine if there is a relationship between naturally produced coho smolt abundance and smolt size for Chinook and steelhead.

We will collect size and condition factor information from the various smolt traps operating within the Wenatchee, Entiat and Methow basins (Nason Creek, Chiwawa River, White River, Wenatchee River, Entiat River, Twisp River and Methow River). Currently the Nason Creek smolt trap is operated by the YN as a cost-sharing effort between two BPA projects (Project # 1996-040-00 and #2003-017-00) and Grant County PUD. The White River smolt trap is operated by the YN and funded by Grant County PUD. The Chiwawa River trap is operated by WDFW. In the Methow basin, traps in the Twisp and Methow rivers are operated by WDFW. The USFWS operates two rotary smolt traps in the Entiat River (reference populations).

Abundance and Freshwater Productivity

Objective: To measure the abundance and corresponding survival rates for NTTOC in target tributaries.

Rationale: See **Smolt Size** above. Abundance of NTTOC, in-terms of population size and survival rates (egg-to-emigrant survival), will be used to evaluate the effect, if any, of coho reintroduction. Baseline monitoring during the broodstock development phases will establish trends in abundance and survival prior to the natural production phases. Abundance and survival monitoring for spring Chinook and steelhead in Nason Creek, Chiwawa River, White River, Wenatchee River, Twisp River, Methow River, and Entiat River are currently on-going. We propose to continue this monitoring as baseline and effect monitoring throughout the broodstock development and natural production phases.

Hypotheses:

- H_o: NTTOC Egg-to-Emigrant Survival $_{\text{before reintroduction}}$ < NTTOC Egg-to-Emigrant Survival $_{\text{after reintroduction}}$
- H_o: NTTOC Egg-to-Emigrant Survival $_{\text{treatment stream}}$ < NTTOC Egg-to-Emigrant Survival $_{\text{reference stream}}$
- H_o**:** β = 0; There is no relationship between NTTOC egg-to-emigrant survival and abundance of coho smolts
- H_o: β = 0; There is no relationship between NTTOC smolt abundance and abundance of coho smolts

Methods: It is important to monitor NTTOC abundance in terms of egg-to-emigrant survival in both the treatment and reference streams before reintroduction of coho.

Currently, such monitoring is ongoing in Nason Creek, Chiwawa River, White River, Peshastin Creek, Twisp River, Methow River, and Entiat River. Because seeding levels and intra-specific competition directly influence the egg-to-emigrant survival rate (stock-recruitment curve) of each population, a careful analysis of the relationship between seeding levels, survival, and growth should be established in each tributary.

Current on-going smolt trapping programs in Nason Creek, Chiwawa River, White River, Wenatchee River, Twisp River, Chewuch River, Methow River and Entiat River will form the basis for the NTTOC abundance and survival estimates. Regression analysis will be used to determine if there is a relationship between the abundance of spring Chinook and steelhead smolts and the abundance of naturally produced coho smolts.

In addition, efforts to PIT tag naturally rearing spring Chinook and steelhead in Nason Creek, the Chiwawa River, and the Twisp River are ongoing. All Chinook and steelhead longer than 60 mm captured at all smolt traps are currently being PIT tagged. Parr rearing in the tributaries that are captured either by seine nets, electro-fishing, or hook and line are also being PIT tagged. This intensive tagging effort is expected to provide life-stage-specific survival rates for spring Chinook and steelhead rearing in tributary streams over time.

Smolt trap operation for emigrant population analysis will proceed as described in Hillman (2004) and Prevatte and Murdoch (2004). The same index sites will be monitored annually. Any correlation between egg-seeding level, indexed rearing density, egg-to-emigrant survival, and emigrant population estimates will be analyzed using multiple regression techniques (Zar 1999).

Restoration Phases: Baseline monitoring will proceed as described above during the broodstock development phases in all tributaries proposed for future coho releases. Monitoring of changes will be done during the natural production phases. Any change in NTTOC status during this monitoring will be closely evaluated in subsequent studies such as those described Section 7.2.2, to determine if the coho reintroduction efforts are causing the observed change or if other factors may be involved.

Distribution of NTTOC

Objective: To evaluate the status of NTTOC in terms of their distribution throughout each basin.

Rationale: Data on the distribution of NTTOC spawners and spawning coho will enable researchers to evaluate changes in NTTOC status during the coho reintroduction process.

Hypotheses:

- H_o: NTTOC Spawner Distribution $_{\text{before reintroduction}}$ < NTTOC Spawner Distribution $_{\text{after reintroduction}}$
- H_o: NTTOC Spawner Distribution $_{\text{treatment stream}}$ < NTTOC Spawner Distribution $_{\text{reference stream}}$
- H_o: $\beta = 0$; There is no relationship between NTTOC spawner distribution and abundance of coho spawners

Restoration Phases: Same as for size and abundance monitoring.

Methods: It is important to monitor NTTOC spawning and rearing distribution in both the treatment and reference streams before reintroduction of coho. Currently NTTOC monitoring is ongoing in Nason Creek, Chiwawa River, White River, Peshastin Creek, Twisp River, Methow River, and Entiat River. A careful analysis of the relationship between seeding levels, survival, and distribution should be established in each tributary (treatment and reference) in order to gauge the change.

Distribution will be evaluated in terms of adult spawning distribution (adult spawning distribution data are collected by WDFW and CCPUD).

7.2.2 Mechanism of Interaction

7.2.2.1 Competition

Objective: To continue to evaluate competition for space and food between naturally produced coho and NTTOC.

Rationale: If the status of NTTOC is determined to have declined and is correlated with increasing abundance of naturally produced coho salmon, continued investigations into competition between reintroduced coho and NTTOC will help determine the cause of the decline and, if necessary, programmatic changes that can be made to minimize negative interactions between coho (hatchery and/or natural) and NTTOC.

Hypotheses: Possible hypotheses to investigate include the following:

- H_o: NTTOC microhabitat $_{\text{with coho}}$ = NTTOC microhabitat use $_{\text{without coho}}$
- H_o: NTTOC growth $_{\text{with coho}}$ = NTTOC growth $_{\text{without coho}}$
- H_o: Coho microhabitat use = NTTOC microhabitat use

Methods: Competitive interactions between species are often investigated using two general techniques: controlled field studies or laboratory investigations (using aquaria or enclosures). Field studies can lack statistical power but are seldom criticized for lacking relevance to actual conditions. Studies in aquaria or enclosures more easily achieve statistical power through replication, but the natural conditions which closely parallel the stream ecosystem are difficult to duplicate.

To investigate competition, a combination of approaches may be used, including field studies similar to those conducted during the feasibility phase (Murdoch et al. 2004, Murdoch et al. 2005) or direct measures of competition such as growth and condition of NTTOC in small-scale enclosures with varying abundance of competitors under differing habitat and environmental conditions. Together competition studies may help ascertain conditions under which competition may have a negative effect on NTTOC.

7.2.2.2 Predation by Naturally Reared Coho on Spring Chinook Fry

Objective: To quantify predation rates by naturally produced coho on spring Chinook fry.

Rationale: The extent to which naturally produced coho may prey upon NTTOC in the Wenatchee and Methow rivers is largely unknown. Preliminary investigations during the feasibility phase documented that some naturally produced coho smolts will consume fry-sized fish. Due to the low numbers and abundance of naturally produced coho in areas of

ESA-listed spring Chinook production during the feasibility phase, it was not possible to accurately measure incidence of predation (Murdoch et al. 2005).

Restoration Phases: Predation evaluations will occur during the NPIP. The tributary(s) chosen for the predation evaluation(s) will be based on the natural production rates and resources for fish capture.

Methods: A study to determine the incidence of predation and an estimate of the total number of spring Chinook fry consumed will follow methods described in Murdoch et al. (2005). The study may be replicated in more than one tributary as deemed necessary to adequately assess the extent that predation may occur.

7.3 Genetic Adaptability

Few opportunities in the Columbia Basin exist to investigate the local adaptation process required for a species reintroduction project to be completely successful. This coho reintroduction plan presents such an opportunity to understand the natural selection intensities on naturalized coho. Success of this coho reintroduction program relies on the use of hatchery fish to develop naturalized spawning populations. Until recently the project has relied entirely upon the transfer of lower Columbia River hatchery coho to produce adult coho returns. If a viable self-sustaining population of coho is to be re-established in the Wenatchee and Methow basins, parent stocks must possess sufficient genetic variability to allow the newly founded population to respond to differing selective pressures between environments of the lower Columbia River and the mid-Columbia region. Some changes in the life history characteristics of the introduced broodstock are likely, due to multiple factors such as longer migration distance, differing environmental conditions of inland rivers, and historical artificial selection on donor stocks. Several of the life history characteristics that might be expected to differ could be endurance, run timing, sexual maturation timing, fecundity, egg size, length at age, juvenile migration timing, sex ratio, and allele frequencies of non-neutral loci. Therefore, a long-term monitoring effort will be continued to track changes over several generations.

Implementation of the proposed study plan would be a valuable contribution to the science of salmon recovery by quantitatively addressing the following questions:

1) Is divergence at neutral and adaptive SNP (Single Nucleotide Polymorphism)[28] loci a useful measure of reproductive isolation and adaptation?

2) Is phenotypic divergence (if observed) a useful proxy for local adaptation, or are observed differences simply the result of phenotypic plasticity?

3) What is the biological significance to perceived local adaptation/naturalization?

4) What is the mechanism leading to local adaptation, and how quickly can stocks react to alternative natural selection regimes?

7.3.1 Morphometrics and Life History Traits

Metric: We will measure traits such as fecundity, body morphometry, run timing, maturation timing, length-at-age and spawn timing.

[28] SNP – Single nucleotide polymorphism: an alteration of one base in the genome of an organism (e.g., A⇔G or C⇔T).

Rationale: Because conditions in mid-Columbia tributaries are likely to be different from coastal streams and the lower Columbia River where the broodstock used for reintroduction originated, life history characteristics of reintroduced coho are likely to change. For one, the migration distance is much greater between the ocean and the mid-Columbia than, for example, between the ocean and Cascade Fish Hatchery. Optimal maturation rates and spawn timing are likely to be different between these two areas. In order to determine if the stock used has adequate genetic variance and phenotypic plasticity to adapt to local conditions, the life history characteristics of the coho broodstock should be monitored over the length of the program.

Monitoring life history traits and morphometrics of mid-Columbia coho will contribute to answering broader questions about the rate of genetic drift when a broodstock is established in a basin.

Methods: Through sampling efforts in the Wenatchee and Methow basins, we will collect morphometric and life history data from the reintroduced population. From adult coho captured for broodstock (HORs and NORs) we will collect data from phenotypic traits such as fecundity, body morphometry and maturation timing. Similar data will be collected from HORs and NORs recovered on the spawning grounds. Trend monitoring will be used to ascertain changes in life history or morphometry for each generation.

7.3.2 Phenotypic Traits at Tumwater and Dryden Dams

Metric: We will measure traits such as lipid levels, run timing, state of maturation (measured by hormone levels), fish size, fish shape, and gender.

Rationale: In addition to tracking any changes in phenotypic traits over time for the population as a whole, during Broodstock Development Phase 2 (BDP2) we plan to assess whether there is any measurable difference in phenotypic traits between coho salmon that are able to ascend Tumwater Canyon and those that cannot. Knowledge of any potential phenotypic difference between fish that can ascend the canyon and those that cannot, could be used to revise our broodstock collection efforts if we are unsuccessful in completing BDP2 as described in Section 5.2 of this Master Plan. However, because targeting broodstock collection for certain traits would reduce genetic diversity and could also result in the inadvertent selection for deleterious traits, such measures would be a last resort.

Hypotheses: Possible hypotheses to investigate include the following:

- H_o: Lipid Levels $_{\text{successful coho}}$ = Lipid Levels $_{\text{unsuccessful coho}}$
- H_o: State of Maturation $_{\text{successful coho}}$ = State of Maturation $_{\text{unsuccessful coho}}$
- H_o: Run Timing $_{\text{successful coho}}$ = Run Timing $_{\text{unsuccessful coho}}$
- H_o: Morphometrics $_{\text{successful coho}}$ = Morphometrics $_{\text{unsuccessful coho}}$

Methods: Coho smolts released upstream of Tumwater Dam will be marked with a blank wire in the adipose fin. Upon return, adults headed upstream of Tumwater Dam will be identifiable at downstream trapping sites. During broodstock collection efforts at Dryden Dam, all coho destined for the upper Wenatchee basin will be scanned for a PIT tag; if no PIT tag is found, a tag will be applied. Phenotypic data described above will be collected. Fish that successfully ascend Tumwater Canyon to the dam will either be re-collected or detected on the antenna arrays (2) within the fishway. Data from phenotypic data from fish that have arrived at Tumwater Dam will then be compared to the data collected from the fish that did not successfully ascend the canyon.

2017 Update: *This study was completed in 2015 (Murdoch and Jeffries 2015 [Appendix 1]). Adult female coho are ascending Tumwater Canyon only in limited numbers; study results show differences between successful and unsuccessful females in several phenotypic traits that appear to correlate with run timing. The full report is in Appendix 1.*

7.3.3 Contemporaneous Life-History and Survival Rates

2017 Update: *This study has been added since the 2010 version of the Master Plan; the study of reproductive success from the 2010 plan has been eliminated.*

Objective: To determine the biological significance of changes in phenotypic or genetic traits.

***Rationale*:** Neither neutral genetic data nor phenotypic differentiation can be used exclusively as a direct measure of local adaptation. Therefore we propose to directly measure how the accumulation of useful traits affects a suite of life history metrics and survival rates using contemporaneous releases of the original stocks used for the reintroduction project and locally adapted broodstock.

Hypothesis:

- H_o: Survival $_{\text{source stock}} \geq$ Survival $_{\text{locally adapted stock}}$

***Restoration Phases*:** We plan 5 years of contemporaneous paired releases during BDP2, and 3-5 years of contemporaneous paired releases near the end of the natural production phases.

***Methods*:** We would implement paired releases of uniquely marked LCR coho and MCR coho (100,000 in each treatment and control group). Both groups ideally will come from the same rearing facility and be released from the same acclimation site. The uniquely marked LCR smolts would be removed at trapping sites, as they would be used for this study only and are not intended for use in the broodstock.

From the returning LCR adults we will document metrics for a suite of life history characteristics, which would include run timing, maturation timing, fecundity, egg size, length at age, sex ratio, smolt-to-adult survival rates and smolt-smolt survival rates; and compare them to the same characteristics found in returning MCR adults.

7.3.4 Genetic Monitoring

Objective: To determine whether the project is successfully creating a local broodstock distinct from lower Columbia River coho salmon stocks; to measure the rate of divergence at neutral markers, and to determine the biological significance of local adaptation.

Metric: We will measure the rate and direction of divergence in neutral and adaptive allele frequencies of coho stocks that are used for reintroduction in mid-Columbia rivers.

Rationale: A sound understanding of the genetic structure of the species is a prerequisite for the assessment of the genetic impacts of human activities such as introductions, transfers, or stock enhancement on natural populations. A measure to assess the impact of human activities on natural populations is the degree to which the population structure responds to applied management action. This can be done by measuring the frequencies of alleles at specific loci through time in a population (Allendorf and Phelps 1981; Utter 1991; Allendorf 1995). Such a database permits the determination of temporal and geographic (degree of isolation) variance components.

Within the body of peer-reviewed literature, scientific views remain mixed regarding the scale and biological significance of perceived local adaptations (Taylor 1991b; Purdom 1994). Utilizing both neutral and adaptive SNP loci provides the opportunity to evaluate the biological significance of genetic differentiation among stocks. The coho reintroduction effort in the mid-Columbia provides an ideal framework for studying rates of genetic and phenotypic divergence.

Restoration Phases: Broodstock development phases will focus on collecting genetic samples from hatchery returns to measure the rate of divergence. Genetic analysis during natural production phases will include naturally spawning coho as described above.

Methods: We propose to measure genetic divergence using 35 SNP markers. To do so, we intend to sample tissue from a minimum of 60 adult coho from each of four study groups: 1) adults destined for natural spawning; 2) adults collected for broodstock; 3) naturally produced smolts; and 4) hatchery-origin smolts. Over time the data will allow us to estimate three types of genetic drift:

1) Changes in allele distribution between parent and progeny life history stages (e.g., drift occurring between the adult spawning population and their progeny) relative to the amount of genetic divergence expected to result from genetic sampling error attributed to reproductive events (Weir 1996). In addition, by measuring changes in composite haplotype[29] frequencies we can quantify variation in reproductive success on a very broad scale. These data will be used to scale the relevance of statistical tests of genetic differentiations (e.g., genetic sampling error will be included as a component of variance when assessing differentiation between hatchery and natural-origin adults and progeny).

2) Genetic variation present in the hatchery broodstock compared to the naturally spawning population component. This will allow us to determine whether broodstock collection methods are effectively achieving a representative sample of returning adults. These data will be helpful in optimizing broodstock collection protocols.

3) Over time, as broodstock development progresses, we will be able to determine the length of time necessary to genetically recognize mid-Columbia coho salmon as a distinct spawning population from the lower river source populations.

[29] Haplotype: The composite genotype of multiple loci that can provide a “fingerprint” for various lineages, populations, or individuals.

Chapter 8.
Schedules and Cost Estimates

8.1 Project Schedules

8.2 Capital Costs

8.3 Operating Costs

8.4 Funding

8.5 Total Program Cost Schedule

Chapter 8. Schedules and Cost Estimates

This chapter presents project schedules and estimated costs for all program elements. Timetables for fish production, smolt releases, environmental reviews, facility development, and the monitoring and evaluation plan are based on program objectives described in Chapters 4, 5, and 7. Future costs change based on these project schedules, and income and expenses estimates are made for the expected duration of the program.

2017 Update: *The schedules and estimates in this chapter were written before the NEPA/Step 2 process began. They represent estimates made in 2008 and last revised in 2009. Because BPA made its decision to fund the program in July 2012 based on the analysis in the Final EIS, the schedules and cost estimates in this Master Plan have not been changed. Cost estimates for 100% design will be provided during the Council's Step 3 process.*

It should be noted that nothing in this chapter has been updated, including references to other parts of the Master Plan. It should also be noted that the calendar years shown were to provide a context for the phases and were not meant to be the driving factor for when to move from phase to phase.

8.1 Project Schedules

The MCCRP fish production and release plans, environmental reviews, facility development tasks, and monitoring and evaluation plan are scheduled to meet the changing management strategies of the phased approach to coho restoration. An important transition is from the Broodstock Development phases to the Natural Production phases, expected to occur in 2013 for both basins. New facilities needed to make this transition will be permitted and developed prior to this time, and the biological strategy will change significantly during the transition.

Table 8-1. Project phases

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Wenatchee																				
Broodstock Dev																				
Phase 1																				
Phase 2	■	■	■	■	■															
Natural Production																				
Implementation						■	■	■												
Support Phase 1									■	■	■	■	■	■						
Support Phase 2															■	■	■	■	■	■
Methow																				
Broodstock Dev																				
Phase 1	■	■																		
Phase 2			■	■	■															
Natural Production																				
Implementation						■	■	■												
Support Phase 1									■	■	■	■	■	■						

8.1.1 Smolt Release, Fish Rearing, and Adult Capture

The program's brood capture, adult holding, rearing, and acclimation schedules are summarized in Table 8-2. They are based on the overall biological program description in Chapters 4 and 5 and the facilities plan in Chapter 6. Timeline details for broodstock capture are shown in Section 5.1; for rearing, in Section 6.2 (Tables 6-2 and 6-3); and for acclimation, in Section 6.3 (Table 6-4).

Table 8-2. Fish production schedule

WENATCHEE	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
BROOD CAPTURE																				
Dryden Dam	BD	BD	BD																	
Leavenworth NFH	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Tumwater Dam	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Chiwawa Weir				NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Tributary Traps						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
ADULT HOLDING																				
Entiat	BD	BD	BD	NP	NP															
Dryden						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
REARING																				
Cascade	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Willard	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
ACCLIMATION																				
Nason	BD	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Chiwawa		BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Little Wenatchee						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Upper Wenatchee	BD	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Chumstick						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Small Tributaries						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Leavenworth NFH	BD	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

METHOW	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
BROOD CAPTURE																				
Wells Dam	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Winthrop NFH	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Twisp Weir				NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Tributary Traps						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
ADULT HOLDING																				
Winthrop NFH	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
REARING																				
Willard	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Winthrop	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Eightmile						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
ACCLIMATION																				
Chewuch						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Upper Methow						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Winthrop NFH	BD	BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Beaver				BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Twisp		BD	BD	BD	BD	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Small Tributaries						NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Wells FH	BD																			

Key: Broodstock Development (hatched) Natural Production (orange)

8.1.2 Environmental Reviews and Facility Development

Development of the project requires that several evaluation processes be conducted, that designs be completed, and that permits be obtained for new facilities. Table 8-3 shows the planned schedule for each of the environmental review and facility development elements and the tasks that support the completion of those elements.

New facilities are required for the Natural Production phases and will need to be operational by 2013. These new sites include a hatchery in the Wenatchee basin and new acclimation sites that involve varying degrees of construction (see Chapter 6 and Appendices C1, C2, C3, and C4).

Table 8-3. Planning, design, permitting and construction schedule

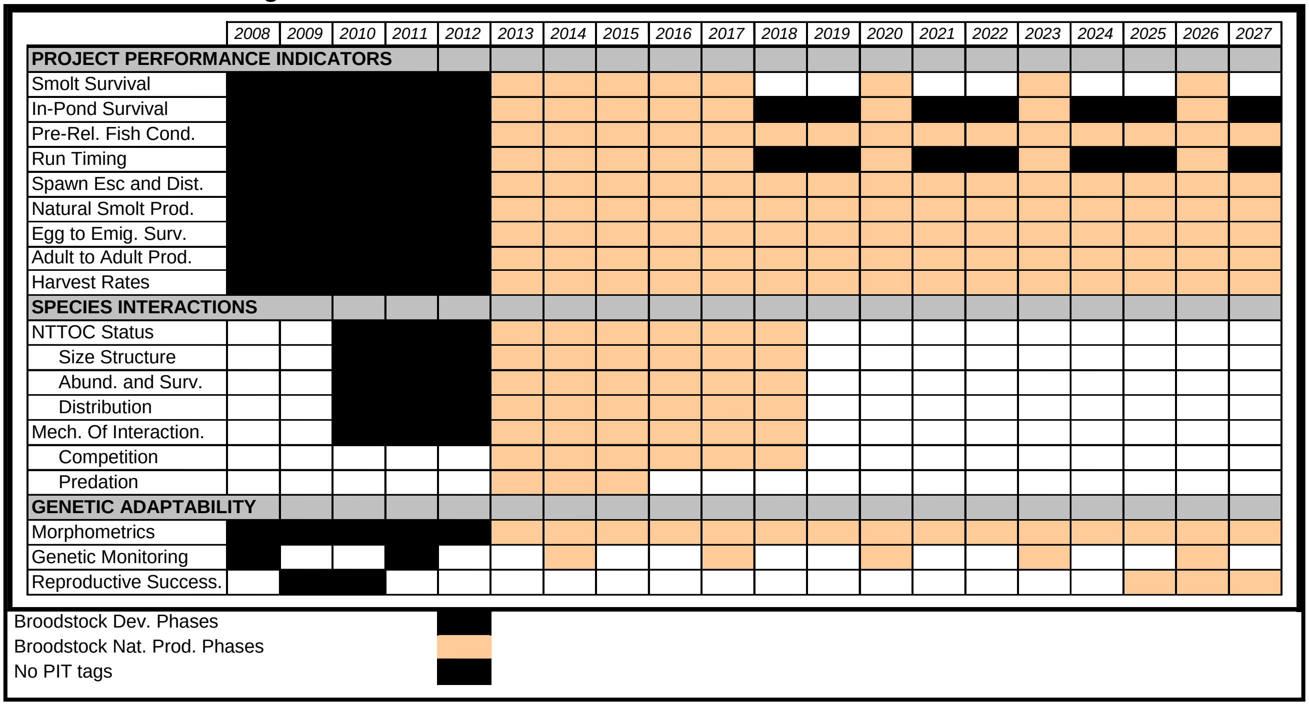
	2008				2009				2010				2011				2012			
	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND
PLANNING, DESIGN																				
Planning																				
Master Plan			■																	
NPPC Step Review				■							■					■				
Site Data Collection				■	■	■	■	■	■	■	■									
Preliminary Design																				
Wenatchee					■	■	■	■	■	■										
Methow					■	■	■	■	■	■										
Final Design																				
Wenatchee												■	■	■	■	■				
Methow												■	■	■	■	■				
PERMITS																				
Surveys, Studies																				
Cultural Resources						■	■													
Wetlands, Plants						■	■													
Flood						■	■													
Ground Water				■	■	■	■													
Surface Water				■	■	■	■													
Listed Species			■	■	■	■	■	■												
Discharge Impacts				■	■	■	■	■												
Other Environ. Elements						■	■	■	■	■										
NEPA																				
Scoping					■	■														
Draft EIS							■	■	■											
Public/Agency Review									■											
Final EIS, ROD										■	■									
ESA																				
HGMP, BA					■	■	■	■	■	■	■	■	■	■	■	■				
Public/Agency Input														■	■	■				
Facility																				
Water Rights				■	■	■	■	■	■	■	■	■	■	■	■	■				
JARPA												■	■	■	■	■				
Construction												■	■	■	■	■				
NPDES												■	■	■	■	■	■	■	■	■
CONSTRUCTION																				
Land Options/Leases				■	■															
Land Purchase																	■			
Wenatchee Con.																		■	■	
Methow Con.																		■	■	

This is an aggressive schedule that assumes the NEPA environmental review process will be completed by the third quarter of 2010 and that all design and facility permitting will be completed by the end of 2011. To meet this timetable, facility permitting time periods could be shortened from those normally experienced by submitting key applications before final designs are completed; and land purchase could be expedited by conducting preliminary discussions with land owners at proposed facility locations before all permits are obtained.

8.1.3 Monitoring and Evaluation

Table 8-4 shows the planned schedule for the monitoring and evaluation tasks. The tasks are described in detail in Chapter 7.

Table 8-4. Monitoring and evaluation schedule



Project performance indicators will be monitored throughout the duration of the restoration project. Several studies of interactions between listed and sensitive species and hatchery-origin coho were completed during the previous feasibility phase. Interactions between naturally produced coho and these species will be evaluated starting with NPIP. Additional future interaction studies will emphasize other taxa of concern. Another major M&E activity will involve the genetics of the local adaptation process. Key genetic questions involving restoration science will be addressed throughout the project.

8.2 Capital Costs

Capital costs include land purchase, facility construction, and equipment that is considered an integral part of the facility. The total future estimated project capital cost is $6,730,000 as shown in Table 8-5. Of this total, $1,145,000 is programmed for land purchase. All the capital costs, except the purchase of a field office in the Methow watershed (completed in 2008 for $600,000), are estimated to be incurred in 2012, one year before NPIP facilities need to be operational.

Table 8-5. Facility construction cost

	2012
NEW HATCHERY	$ 4,565,000
ACCLIMATION SITES	$ 2,165,000
TOTAL	**$ 6,730,000**

Existing hatcheries that have no associated capital cost will provide the bulk of pre-smolt production. The new hatchery proposed at the Dryden site will require land purchase, water supply development, and facility construction.

Like other aspects of the proposed program, acclimation also relies on existing sites with little capital cost. The facilities (see Section 6.3 and Appendices C.3 and C.4 for details) have low costs relative to other acclimation sites in the region due to their use of constructed or existing natural ponds and existing water supplies where available.

Land purchase is not expected at acclimation sites; they are on private land where lease agreements will be developed. Acclimation site capital costs include pond construction at one site and water supply development, including new wells and surface water intakes, at several.

At the adult capture sites, hatchery, and acclimation sites, capital equipment includes such items as chillers, pumps, generators, aerators, alarm systems, and trailers.

8.3 Operating Costs

Operating costs include all the expenses required to manage the MCCRP. They are divided into three main elements: planning, design, and permitting; general operation and maintenance; and monitoring and evaluation. General operation and maintenance includes the costs of rearing and tagging smolts, of conducting the other components of the fish release program, and of providing office and administrative support for these project functions.

Estimates of future year Operation and Maintenance (O&M) and M&E costs are based on recent MCCRP program costs. These recent costs are adjusted as described in the following sections to produce future year estimates, which are shown in the full program cost schedule in Table 8-11.

8.3.1 Planning, Design, and Permits

Table 8-6 summarizes the subcontractor and permitting agency costs for the planning, design, and permitting elements of the proposed program by task and by year. Yakama Nation personnel will be major contributors to these efforts; their costs are included under Other O&M.

Table 8-6. Planning, design, and permits cost summary

	2008	*2009*	*2010*	*2011*	**TOTAL**
Planning	$ 90,000	$ -	$ 20,000	$ 30,000	**$ 140,000**
Design	$ 20,000	$ 260,000	$ 310,000	$ 450,000	**$ 1,040,000**
Permits	$ 10,000	$ 560,000	$ 160,000	$ 50,000	**$ 780,000**
TOTAL	**$ 120,000**	**$ 820,000**	**$ 490,000**	**$ 530,000**	**$ 1,960,000**

The planning task involves completion of the master plan and assisting with the NPCC reviews of the preliminary and final designs (the Step process). Cost estimates were based on past expenses for completing a draft Master Plan and supporting a review by the NPCC.

Design includes site data collection and the preliminary and final engineering plans for the facilities. Information such as property ownerships, land topography, site conditions, and surface and ground water supplies will support creation of facility plans. Site data collection costs are expected to total approximately $150,000. The site data to meet engineering design needs also will be used to support project environmental evaluations and permit applications, but additional data for environmental evaluations will need to be collected. Preliminary designs will be produced to the level required for permit application and final design to a level that supports construction. Preliminary design costs are estimated to be 5% of construction costs and final design, 10%.

The direct permitting costs (which do not include the $150,000 site data collection costs) are estimated to be $780,000. Many of the ESA, permit, and study cost assessments were derived from similar projects completed by the Yakama Nation in the recent past and a NEPA process cost estimate provided by Nancy Weintraub (BPA, Team Lead for Fish and Wildlife Environmental Review). Table 8-7 lists all potential fish facility permits that may be needed prior to construction. All permits listed will not be required for each site due to differing levels of development and local conditions. Facility permitting work will be coordinated with NEPA and ESA environmental reviews. Data collection for each of these efforts will be done concurrently.

Table 8-7. Environmental process and permit requirements

	AGENCY	COMMENTS
SEPA and NEPA		
ENVIRONMENTAL CHECKLIST (SEPA)	Lead Agency	Agency makes Determination of Significance (DS) or Mitigated Determination of Non Significance (MDNS) decision based on checklist. DS (forces an EIS).
DRAFT EIS	Lead Agency	Scoping helps determine the content of the EIS
FINAL EIS	Lead Agency	Addresses comments received during 45-day draft EIS comment period
ROD	Lead Agency	Record of Decision
JARPA - Joint Aquatic Resource Permits Application		
HYDRAULIC PROJECT APPROVAL (HPA)	WDFW	Use, divert, obstruct, or change natural flow
SHORELINES SUBSTANTIAL DEVELOPMENT	Local Govt	In 100-yr. floodplain or within 200 ft. of high water > $2,500
COMPLIANCE WITH CRITICAL AREAS STANDARDS	Local Govt	Critical areas are designated by local governments
FLOODPLAIN MANAGEMENT	Local Govt	
401 WATER QUALITY CERT.	WDOE	Filling or excavating in water or wetlands
EXCEEDANCE OF WATER QUALITY STANDARDS	WDOE	Temporary exceedance (may not be included in new JARPA)
SECTION 404 PERMIT	US ACE	Locating structures, filling, or excavating in water or wetlands
OTHER STATE PERMITS		
ARCHAEOLOGICAL EXCAVATION	Ofc. of Arch. & Historic Pres.	Federal projects require section 106 review
NPDES - GENERAL PERMIT FOR UPLAND HATCHERIES	WDOE	Receiving water quality standards impact permit
PRELIMINARY WATER RIGHT PERMIT	WDOE	Required for drilling and testing
CERT. OF WATER RIGHT	WDOE	Water use permit is the original application
CHANGE OF WATER RIGHT	WDOE	Location or use changes require permit
FISH/EGG TRANSPORT	WDFW	Main tool for WDFW to control movement of fish
OTHER LOCAL PERMITS		
CONSTRUCTION	Local govt	Building, grading, electrical, etc permits
CONDITIONAL USE	Local govt	Activities use subject to public hearings
ZONING CODE VARIANCE	Local govt	
ESA RELATED PERMITS		
BIOLOGICAL EVALUATION (BE or BA)	USFWS, NMFS	Consultation used to show minimal impacts; if services agree, a concurrence letter is written
BIOLOGICAL OPINION (BO)	USFWS, NMFS	Issued after formal consultation
HATCHERY & GENETICS MGMT PLAN (HGMP)	NMFS	Replaces the BE for NMFS purposes
OTHER		
WETLAND AND FLOODPLAIN ASSESSMENT	BPA	Normally part of the NEPA document; requirement for federally funded projects
ENVIRONMENTAL LAND AUDIT	BPA	

The combined cost for direct permitting and site data collection is estimated to total $930,000. As a check of this estimate, it was compared with the permit costs of other projects:

- NE Oregon Hatchery Project: Approximately $1,000,000 (personal communication Mickey Carter, Supervisory Environmental Protection Specialist, BPA).
- Average EIS costs of a wide range of Department of Energy (DOE) projects completed in 2005 (DOE 2005): $1,434,000.

The MCCRP permit cost estimates are somewhat lower than these values because significant amounts of environmental evaluation have been completed during the feasibility phase of this project. Impacts on listed fish have been studied for several years by the MCCRP M&E program in coordination with the project's Technical Work Group (TWG), whose members helped guide study designs and reviewed results. Also, work done during master plan development will be applied to permitting, further reducing costs.

8.3.2 General Operation and Maintenance

Future operation and maintenance costs use 2009 MCCRP expenses as a basis. Current budgets are well defined and allow relatively accurate predictions to be made about future costs. Adjustments used to estimate costs for future years are based on levels of program activity, which in turn are based on the numbers of fish being released and the numbers of sites being operated. Costs are assumed to inflate at a rate of 2.5% per year to match the BPA MOA funding inflation rate (see Section 8.4).

8.3.2.1 Rearing

The rearing costs for 2009 shown in Table 8-8 are for production of fish to pre-smolt size while in hatcheries. Rearing costs include adult holding, spawning, and incubation of Methow brood at Winthrop and Wenatchee brood at Entiat under contract with the U.S. Fish and Wildlife Service (USWFS); and smolt transportation under contract with the Oregon Department of Fish and Wildlife. Wenatchee brood and egg handling will be done by Yakama Nation personnel when the Dryden facility is completed. Costs are assumed to be equivalent to those for Entiat. The 2013 estimated rearing budget (in 2009 dollars, inflation not shown) is also included in the table to demonstrate how costs change after new facilities begin operation. Rearing costs at the public hatcheries do not rise with increased fish production in 2013 because the increase is planned to come from Willard NFH. Willard costs are independent of production numbers and an annual fee is charged.

Table 8-8. Rearing cost detail

	2009	*2013*
HATCHERIES		
Cascade	$ 277,300	$ 277,300
Willard	$ 319,600	$ 319,600
Winthrop	$ 207,400	$ 207,400
Entiat	$ 288,400	$ -
Dryden	$ -	$ 465,200
SUBTOTAL	**$ 1,092,700**	**$ 1,269,500**
COST SHARING		
Rearing	$ 436,700	$ 436,700
TOTAL	**$ 656,000**	**$ 832,800**

Hatchery rearing cost estimating procedures are detailed in Appendix B.1. They are based on the average operating costs of five existing Columbia River hatcheries.

The last cost element in Table 8-8 is cost sharing, which is the amount contributed by fishery agencies to the MCCRP for hatchery operations. NOAA, through the Mitchell Act, supports operation of Willard ($128,000 per year) and Cascade ($277,000 per year) hatcheries. The USFWS also contributes a portion (10% of the total, or $31,400 per year) of the maintenance fees for operating the Leavenworth, Entiat, and Winthrop hatcheries.

8.3.2.2 Tagging

Tagging includes both CWT and PIT tags and is a major operating expense. Estimates for future years are based on current tagging costs. The USFWS CWT tagging subcontract for 2009 is $429,900; and PIT tags alone, not including personnel and other costs of applying the tags, amount to $63,700. CWT costs were changed for future years proportionate to the numbers of fish released per year. The number of PIT tags used annually is expected to remain approximately the same in the future, independent of release numbers; however, during the natural production support phases, fish will be PIT-tagged only one year out of three.

8.3.2.3 Other O&M

This cost element covers all the facility operating and maintenance costs except planning, design and permitting; monitoring and evaluation; rearing; and tagging. Included are costs of operating acclimation and brood collection facilities, providing office and management support, renting land, leasing vehicles, and purchasing equipment.

The 2009 Operations and Maintenance budget is shown in Table 8-9. Future costs are estimated by making adjustments to the 2009 values that reflect changes in the number of fish produced and facilities operated.

Table 8-9. Operation and maintenance budget (2009)

	2009
COST ELEMENT	
Wages	$ 399,710
Fringe	$ 83,207
Small contracts (<$5,000)	$ 15,624
Training	$ 3,916
Office Supplies	$ 8,109
Supplies and Equip. (<$500)	$ 38,626
Repair & Maintenance	$ 10,983
Operating Supplies (consumables)	$ 35,697
Rental vehicles, building	$ 50,923
Land Rental	$ 19,971
Electricity	$ 6,643
Water	$ 1,485
Telephone	$ 10,165
Cell phones	$ 11,849
Insurance	$ 8,313
Travel	$ 18,366
Property Tax Expense	$ 2,824
Indirect (overhead)	$ 121,001
Professional Services (>$5,000)	$ 92,933
Equipment (>$5,000)	$ 22,339
TOTAL	**$ 962,700**

8.3.3 Monitoring and Evaluation

Estimates of the program costs for the monitoring and Evaluation (M&E) tasks are also based on the 2009 budget (Table 8-10). Adjustments used to estimate costs for future years are based on levels of M&E activity. Costs increase in 2010 when species interaction studies begin and again in 2013 when competition and predation evaluations are added. They decrease after 2017 as some M&E studies are completed. Costs are assumed to inflate at a rate of 2.5% per year to match the BPA MOA funding inflation rate (see Section 8.4).

Table 8-10. Monitoring and evaluation budget (2009)

	2009
COST ELEMENT	
Wages	$ 202,145
Fringe	$ 43,172
Small Contracts (<$5,000)	$ 3,824
Training	$ 953
Office Supplies	$ 4,346
Supplies and Equipment (<$500)	$ 25,980
Repair & Maintenance	$ 5,153
Operating Supplies (consumables)	$ 10,140
Rental vehicles, building	$ 24,238
Land Rental	$ -
Electricity	$ -
Water	$ -
Telephone	$ -
Cell phones	$ -
Insurance	$ 4,692
Travel	$ 7,191
Property Tax Expense	$ -
Indirect (overhead)	$ 55,024
Professional Services (>$5,000)	$ -
Equipment (>$5,000)	$ -
Misc	$ 9,279
TOTAL	**$ 396,100**

M&E costs are shared with WDFW, the HCP Hatchery Compensation Program's M&E plan, and BPA project number 2003-017-00. Smolt traps at Monitor, Chiwawa, White, Upper Wenatchee, Methow, and Twisp, currently funded through alternate sources, are an integral part of the proposed M&E plan; they provide data to monitor natural coho production and NTTOC status. The value of this cost share is estimated to be $774,500 annually and is not shown in Table 8-10.

8.4 Funding

If all approvals are obtained, the MCCRP is directly funded until 2018 by BPA, Grant County PUD, and Chelan County PUD. It is anticipated that funding from 2018 until the program terminates will also be provided by these agencies, although agreements are not yet in place. Douglas County PUD agreed to a single payment of $600,000, made in 2008, and are expected to contribute further compensation after 2018. A regional office in the Methow watershed was purchased with this obligation.

Regional action agencies (BPA, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation) and three Columbia Basin tribes (the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Indian Reservation, and the Confederated Bands and Tribes of the Yakama Nation) are operating under a memorandum of agreement (MOA) titled *3 Treaty Tribes-Action Agency Agreement*, dated April 4, 2008, that funds habitat and hatchery actions in the Columbia River Basin. Support for all programs proposed by the three tribes under the MOA totals $900,000,000 over a 10-year period. The MCCRP portion of this total is $28,827,000 plus inflation at 2.5%.

GCPUD and YN entered into an *Agreement for Professional Services* for the period March 1, 2008 to March 1, 2018 that provides funding for implementation of the MCCRP. This funding commitment totals $7,375,212 over the 10 year period and does not include any correction for inflation.

CCPUD and YN signed the *Agreement to Meet Coho Salmon Hatchery Obligations for the Chelan County PUD Rocky Reach and Rock Island Hydroelectric Projects*. This provides $3,060,000, plus inflation at the Consumer Price Index rate, over a 10-year period. The inflation rate assumed for CCPUD funding is 3% per year, the long-term average value.

These three agreements allow the MCCRP to maintain the flexibility to determine how annual costs are to be shared between the funding sources.

In addition to this direct funding, cost sharing, as discussed in sections 8.3.2.1 and 8.3.3, also provides funding support. Both rearing and M&E costs are partially contributed by other agencies. This cost share totals approximately $1,211,200 per year.

8.5 Total Program Cost Schedule

Table 8-11 shows the yearly cost for all project elements for the expected duration of the project.

Table 8-11. MCCRP total project cost schedule
(in Dollars /1,000,000)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
CAPITAL EXPENSE																				
TOTAL CAPITAL	**0.60**	**0.00**	**0.00**	**0.00**	**6.73**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
OPERATING EXPENSE																				
Plan, Design, Per.	0.12	0.82	0.49	0.55	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rearing	0.63	0.63	0.67	0.69	0.71	0.92	0.62	0.63	0.63	0.65	0.66	0.68	0.70	0.72	0.27	0.28	0.29	0.29	0.30	0.31
Tagging	0.56	0.49	0.61	0.62	0.64	0.89	0.91	0.93	0.71	0.72	0.74	0.76	0.78	0.80	0.48	0.49	0.50	0.51	0.53	0.54
O&M	0.89	0.96	1.16	1.19	1.22	1.65	1.70	1.74	1.35	1.38	1.42	1.45	1.49	1.53	0.98	1.00	1.03	1.05	1.08	1.10
M&E	0.45	0.40	0.41	0.58	0.60	0.74	0.76	0.78	0.80	0.82	0.50	0.25	0.26	0.27	0.27	0.28	0.29	0.29	0.30	0.31
TOTAL OP.	**2.64**	**3.31**	**3.33**	**3.63**	**3.33**	**4.21**	**3.99**	**4.09**	**3.49**	**3.57**	**3.32**	**3.15**	**3.22**	**3.31**	**2.00**	**2.05**	**2.10**	**2.15**	**2.21**	**2.26**
TOTAL EXPENSE	**3.24**	**3.31**	**3.33**	**3.63**	**10.06**	**4.21**	**3.99**	**4.09**	**3.49**	**3.57**	**3.32**	**3.15**	**3.22**	**3.31**	**2.00**	**2.05**	**2.10**	**2.15**	**2.21**	**2.26**
DIRECT FUNDING																				
Douglas PUD	0.60																			
Chelan PUD 10 Year	0.31	0.32	0.33	0.34	0.36	0.37	0.39	0.40	0.42	0.44										
Future Chelan PUD											0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant PUD 10 Year	0.61	0.64	0.66	0.69	0.72	0.75	0.78	0.81	0.84	0.87										
Future Grant PUD											0.45	0.47	0.49	0.51	0.53	0.55	0.58	0.60	0.62	0.65
BPA MOA 10 Year	1.72	2.35	2.33	2.60	8.99	3.09	2.82	2.88	2.23	2.26										
Future BPA											2.86	2.67	2.73	2.79	1.47	1.50	1.52	1.55	1.58	1.61
TOTAL INCOME	**3.24**	**3.31**	**3.33**	**3.63**	**10.06**	**4.21**	**3.99**	**4.09**	**3.49**	**3.57**	**3.32**	**3.15**	**3.22**	**3.31**	**2.00**	**2.05**	**2.10**	**2.15**	**2.21**	**2.26**

Chapter 9.
References

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Allee, B.J. 1974. Spatial requirements and behavioral interactions of juvenile coho salmon and steelhead trout. Doctoral Dissertation, University of Washington, Seattle.

Allee, B.J. 1981. The role of interspecific competition in the distribution of salmonids in streams. Pages 111-122 in E.L. Brannon and E. O. Salo, editors. Proceedings of the salmon and trout migratory behavior symposium. University of Washington Press, Seattle.

Allendorf, F.W. 1995. Genetics: Defining the units of conservation. American Fisheries Society Symposium 17:247-248.

Allendorf, F.W. and S.R. Phelps. 1981. Use of allelic frequencies to describe population structure. Canadian Journal of Fisheries and Aquatic Sciences. 38:1507-1514.

Andonaegui, C. 2001. Salmon, steelhead, and bull trout habitat limiting factors for the Wenatchee subbasin (Water Resource Inventory Area 45) and Portions of WRIA 40 within Chelan County (Squilchuck, Stemilt and Colockum drainages). Final draft report. WSCC.

Baumsteiger, J., D. M. Hand, D. E. Olson, R. Spateholts, G. FitzGerald, and W. R. Ardren. 2008. Use of parentage analysis to determine reproductive success of hatchery-origin spring Chinook salmon outplanted into Shitike Creek, Oregon. North American Journal of Fisheries Management 28:1472-1485.

Beecher, H.A., B.A. Caldwell, and S.B. DeMond. 2002. Evaluation of depth and velocity preferences of juvenile coho salmon in Washington streams. North American Journal of Fisheries Mgt: 22:785-795.

Berejikian, B. and M. Ford. 2004. Draft: Review of relative fitness of hatchery and natural salmon. National Marine Fisheries Service, Seattle, WA.

Bilby, R.E., P.A. Bisson, J.K. Walter. 1998. Responses of juvenile coho salmon and steelhead to the addition of salmon carcasses to two streams in southwestern Washington. Can. J. Fish. Aquat. Sci. 55:1909-1918.

Bisson, P.A., K. Sullivan, and J.L. Nielsen. 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead and cutthroat trout in streams. Trans. AM. Fish. Soc. 117:262-273.

Bjornn, T.C. 1971. Trout and salmon movements in two Idaho streams as related to temperature, food, stream flow, cover, and population density. Trans. Am. Fish. Soc.: 100:423-438.

Bjornn, T.C. and R.R. Ringe. 1984. Evaluation of conditioning steelhead trout in cold water after rearing at 15 C. Idaho cooperative fishery research unit. University of Idaho, Moscow.

BPA (Bonneville Power Administration). 2012. Mid-Columbia Coho Restoration Program Record of Decision and Mitigation Action Plan. July 19, 2012, Portland, OR.

Bosch, W.J., T.H. Newsome, J.L. Dunnigan., J.D. Hubble, D. Neeley, D.T. Lind, D.E. Fast, L.L Lamebull, and J.W. Blodgett. 2005. Evaluating the Feasibility of Reestablishing a Coho

Salmon Population in the Yakima River, Washington. Yakama Nation Fisheries. Under review.

Bradford, M.J., G.C. Taylor, and J. A. Allan. 1997. Empirical review of coho salmon smolt abundance and production at the regional level. Transactions of the American Fisheries Society, 126:49-64.

Brannon, E.L., D.F. Amend, M.A. Cronin, J.A. Lannan, S. LaPatra, W.J. McNeil, R.E. Noble, C.E. Smith, A.J. Talbot, G.A. Wedemeyer, H. Westers. 2004. The Controversy about Salmon Hatcheries. Fisheries, vol. 29. no. 9. p. 12-31.

Bugert, R.M., and T.C. Bjornn. 1991. Habitat use by steelhead and coho salmon and their responses to predators and cover in laboratory streams. Trans. Am. Fish. Soc. 120(4):486-493.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River salmon. U.S. Fish and Wildlife Service. Fisheries Bulletin 61 Vol. 52. Washington D.C.

Busak, C.A. and K.P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. American Fisheries Society Symposium 15: 71-80.

Busak, C., T. Pearsons, C. Knudsen, S. Phelps, B. Watson, M. Johnston. 1997. Yakima Fisheries Project Spring Chinook Supplementation Monitoring Plan. *Prepared For*: Project Number 1995-064-000 Bonneville Power Administration, Portland, OR.

Bustard, D.R., and D.W. Narver. 1975. Preferences of juvenile coho salmon (Oncorhynchus kisutch) and cutthroat trout (Salmo clarki) relative to simulated alteration of winter habitat. J. Fish. Res. Board Can. 19(6): 1047-1080.

Cannamela, D.A. 1993. Hatchery steelhead smolt predation of wild and natural juvenile Chinook salmon fry in the upper Salmon River, Idaho. Idaho Department of Fish and Game. 36 pp.

Carroll, J., S. O'Neal, and S. Golding. 2006. Wenatchee River Basin Dissolved Oxygen, pH, and Phosphorus Total Maximum Daily Load Study. Publication No. 06-03-018, Watershed Ecology Section, Environmental Assessment Program, Washington State Department of Ecology, Olympia, WA.

Carroll, J. and R. Anderson. 2009. Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load, Water Quality Improvement Report. Publication No. 08-10-062, Water Quality Program, Central Regional Office, Washington Department of Ecology. Yakima, WA.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1999. PIT Tag Marking Procedures Manual. Version 2.0. Columbia Basin Fish and Wildlife Authority, PIT Tag Steering Committee.

CCCD (Chelan County Conservation District). 2004. Entiat Water Resource Inventory Area (WRIA) 46 Management Plan. Prepared for the Entiat WRIA Planning Unit by the Chelan County Conservation District. Wenatchee, WA.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24(10):6-15.

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the Nineteenth Century. Transactions of the American Fisheries Society 115:662-670.

Chapman D., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B. Suzumoto, R. Klinge. 1994a. Status of summer/fall chinook salmon in the mid-Columbia region. Don Chapman Consultants, Inc. Boise, ID.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, F. Utter. 1994b. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc. Boise, ID.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, F. Utter. 1995a. Status of spring chinook salmon in the mid-Columbia River region. Don Chapman Consultants, Inc. Boise, ID.

Chapman, D.W., C. Peven, A. Giorgi, T. Hillman, F. Utter, M. Hill, J. Stevenson, M. Miller. 1995b. Status of sockeye salmon in the mid-Columbia region. Don Chapman, Consultants, Inc. Boise, ID.

Chilcote, M.W., S.A. Leider, and J.J. Loch. 1986. Differential reproductive success of hatchery and wild summer-run steelhead under natural conditions. Transactions of the American Fisheries Society 115:726-735.

Craig, J.A, and A.J. Suomela. 1941. Time of appearance of the runs of salmon and steelhead trout native to the Wenatchee, Entiat, Methow, and Okanogan rivers. Unpubl. MS., 35 pp. Plus 18 affidavits and accompanying letters of corroboration. In: J.W. Mullen, K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. Appendix J of U.S. Fish and Wildlife Service, Monograph I. Leavenworth, WA.

CRITFC (Columbia River Intertribal Fish Commission). 1995. Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes.

CTWSRO (Confederated Tribes of the Warm Springs Reservation of Oregon). 2005. Distribution, Behavior, and Reproductive Success of Outplanted Hatchery Spring Chinook Salmon in Shitke Creek, OR. March 2005.

DCPUD (Douglas County Public Utility District). 2005. Conceptual approach to monitoring and evaluating the Douglas County Public Utility District Hatchery Programs. *Prepared for:* Douglas PUD Habitat Conservation Plan’s Hatchery Committee.

Diamond, J. and H.J. Pribble. 1978. Review of factors affecting seaward migration and survival of juvenile salmon in the Columbia River and ocean. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries. Number 78-7. Portland, OR.

Dickoff, W.D., G.R. Beckman, D.A. Larsen, S. Moriyama. 1995. Endocrine and Growth Control of Salmon Smoltification. Aquaculture 135 (1995) 147.

Dickoff, W.D., C.V. Mahnken, W.S. Zaugg, F.W. Waknitz, M.G. Bernard, C.V. Sullivan. 1989. Effects of Temperature and Feeding on Smolting and Seawater Survival of Atlantic Salmon. Aquaculture, 82, pp 93-102.

Dittman, A.H., T.P. Quinn, G.A. Nevitt. 1996. Timing of imprinting to natural and artificial odors by coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 53: 434–442.

Dolloff, C.A., and G.H. Reeves. 1990. Microhabitat partitioning among stream-dwelling juvenile coho salmon, *Oncorhynchus kisutch*, and Dolly Varden, *Salvelinus malma*. Can. J. Fish. Aquat. Sci 47:2297-2306.

Dunnigan, J. 1999. Feasibility and risks of coho reintroduction in mid-Columbia Tributaries: 1999 annual monitoring and evaluation report, project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Dunnigan, J. and J. Hubble. 1998. Results from YKFP and Mid-Columbia Coho Monitoring and Evaluation Studies. Prepared for the Mid-Columbia Technical Work Group. August 1998.

Ecovista. 2003. Draft Clearwater Subbasin Inventory. Prepared on behalf of the Nez Perce Tribe Watershed Division in cooperation with the Clearwater Policy Advisory Committee for the Northwest Power Planning Council. 851 SW Sixth Avenue, Suite 1100, Portland, OR, 97204. 171 pp.

Everest, F.W. and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile chinook salmon and steelhead trout in two Idaho streams. J. Fish. Res. Board Can. 29:91-100.

Fish, F.F. and M.G. Hanavan. 1948. A report on the Grand Coulee Fish Maintenance Project 1939-1947. U.S. Fish & Wildlife Service Spec. Sci. Rep. 55.

Flagg, T.A., and C.E. Nash (editors). 1999. A conceptual framework for conservation hatchery strategies for Pacific salmonids. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-38. 46 pp.

Ford, M.J., H. Fuss, J.J. Hard, and E. Lahood. Unpublished ms. Estimating selection gradients in a salmon population using molecular markers. Available from M.J. Ford, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Blvd E., Seattle, WA 98112.

Fraley, J.J, and B. Shepard. 1989. Life history, ecology and population status of migratory bull trout in the Flathead Lake and river system, Montana. Northwest Science Vol. 63, No. 4: 133-142.

Fraser, F.J. 1969. Population density effects on survival and growth of juvenile coho salmon and steelhead trout in experimental stream channels. Pages 253-266 *in* T. G. Northcote (ed.), Symposium on Salmon and Trout in Streams. H.R. MacMillan Lectures in Fisheries. Univ. British Columbia, Institute of Fisheries, Vancouver, BC.

Fresh, K.L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. Pages 245-275 in D.J. Stouder, P.A. Bisson, and R.J. Naiman editors, Pacific salmon and their ecosystems: Status and future options. Chapman and Hall, New York, NY.

GCPUD (Grant County Public Utility District). 2009. Draft monitoring and evaluation plan for Grant County PUD Salmon and Steelhead Supplementation Programs. *Prepared for:* The Priest Rapids Coordinating Committee.

Glova, G.J. 1986. Interaction for food and space between experimental populations of juvenile coho salmon (*Oncorhynchus kisutch*) and coastal cutthroat trout (*Salmon clarki*) in a laboratory stream. Hydrobiologa 132, 155-168.

Glova, G.J. 1987. Comparison of allopatric cutthroat trout stocks with those sympatric with coho salmon and sculpins in small streams. Environmental Biology of Fishes, 20(4):275-2.

Ham, K.D. and T.N. Pearsons. 2001. A practical approach for containing ecological risks associated with fish stocking programs. Fisheries Vol. 26, no. 4, pgs 15-23.

Hartman, G.F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon and steelhead trout. Journal of the Fisheries Research Board of Canada 22:1035-1081.

Hawkins, S. 2002. Residual hatchery smolt impact study: Wild fall chinook mortality 1998. Columbia River Progress Report 02-10. Washington Department of Fish and Wildlife, Vancouver, WA.

Hawkins, S., and J. Tipping. 1999. Predation by juvenile hatchery salmonids on wild fall chinook salmon fry in the Lewis River, Washington. California Fish and Game 85(3): 124-129.

HCP. 2002. Mid-Columbia River Habitat Conservation Plan. Chelan Public Utility District. 2002. Anadromous fish agreement and habitat conservation plan: Rock Island Hydroelectric Project, FERC license No. 943. Chelan PUD. Wenatchee, Washington <u>and</u> Douglas Public Utility District (Public Utility District No. 1 of Douglas County). 2002. Anadromous fish agreement and habitat conservation plan: Wells Hydroelectric Project, FERC license No. 2149. Douglas PUD. East Wenatchee, WA.

He, E., and W.A. Wurtsbaugh. 1993. An empirical model of gastric evacuation rates for fish and an analysis of digestions in piscivorous brown trout. Transactions of the American Fisheries Society 122:717-730.

Hendry, A.P. 2001. Adaptive Divergence and the Evolution of Reproductive Isolation in the Wild: an Empirical Demonstration Using Introduced Sockeye Salmon. *Genetica* 112–113: 515–534.

Hicks, B. J., and J.D. Hall. 2003. Rock type and channel gradient structure salmonid population in the Oregon coast range. Trans. Am. Fish Soc. 132:468-482.

Hillman, T.W. 2004. Monitoring strategy for the Upper Columbia Basin: Draft Report February 1, 2004. Prepared for Upper Columbia Regional Technical Team, Wenatchee, WA.

Hillman, T.W. 2006. Monitoring strategy for the Upper Columbia Basin. *Prepared for:* Upper Columbia Salmon Recovery Board. Wenatchee, WA.

Hillman, T., T. Kahler, G. Mackey, J. Maurauskas, A. Murdoch, K. Murdoch, T. Pearsons, and M. Tonseth. 2013. Monitoring and Evaluation Plan for PUD Hatchery Programs: 2013 Update. *Prepared for:* HCP and PRCC Hatchery Committees.

HSRG (Hatchery Scientific Review Group). 2008. Draft Columbia River Coho Salmon Hatchery Analysis, Vol. 2. May 2008. http://www.hatcheryreform.us/prod/Portals/_default/Documents/Vol%202%20Master%20Columbia%20Coho%20Reports%205-30-08.pdf

Hubble, J., T. Newsome, and J. Woodward. 2004. Yakima Coho Master Plan. Prepared by the Yakama Nation in cooperation with the Washington Department of Fish and Wildlife. Toppenish, WA.

IDFG (Idaho Department of Fish and Game). 1999. Spawning Distribution of Outplanted Adult Summer Chinook Salmon in the South Fork Salmon River, 1992-1994; Project Progress Report. Report #99-04, March 1999.

IEAB (Independent Economic Analysis Board). 2005. Economic Effects From Columbia River Basin Anadromous Salmonid Fish Production. Document IEAB 2005-1.

Integrated Hatchery Operations Team (IHOT). 1997. Hatchery Evaluation Report, Willard Hatchery – Coho. February 1997.

IHOT. 1998. Hatchery Evaluation Report Summary for Winthrop NFH – Spring Chinook, Summer Steelhead. July 1998.

ISRP and ISAB. 2005. Review of the All-H Analyzer (AHA). Document ISRP/ISAB 2005-5. Northwest Power and Conservation Council.

Johnson, S.L. 1996. Factors Influencing Freshwater and Marine Survival of Oregon's Coastal Coho Salmon—What We Know and What We Don't. NOAA Technical Memorandum NMFS-NWFSC-29 Estuarine and Ocean Survival of Northeastern Pacific Salmon.

Johnson, S.L., M.F. Solazzi, and T.E. Nickelson. 1990. Effects on Survival and Homing of Trucking Hatchery Yearling Coho Salmon to Release Sites, North American Journal of Fisheries Management, 10:427-433.

Johnston, J.M. 1967. Food and feeding habits of juvenile coho salmon and steelhead trout in Worth Creek, Washington. Masters of Science Thesis, University of Washington, Seattle.

Kamphaus, C.M., and K.G. Murdoch. 2005. Mid-Columbia Coho Reintroduction Feasibility Study: Draft 2003 Broodstock Development Report, Project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Kamphaus C.M., K.G. Murdoch, C.H. Strickwerda, M.B. Collins. 2008. Mid-Columbia Coho Reintroduction Feasibility Study: **2007 Annual Report,** October 1, 2006 through September 30, 2007. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. March 6, 2008.

Kamphaus, C.M., K.G. Murdoch, G.C. Robison, M.B. Collins, R.F. Alford. 2009. Mid-Columbia Coho Reintroduction Feasibility Study: **2008 Annual Report**, October 1, 2007 through September 30, 2008. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. June 11, 2009.

Kamphaus, Cory M., Keely G. Murdoch, Gregory C. Robison, Mathew B. Collins, Rick F. Alford, Ben Truscott, Kraig E. Mott. 2010. Mid-Columbia Coho Reintroduction Feasibility Study: **2009 Annual Report**, October 1, 2008 through September 30, 2009. Prepared by Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. October 2010.

Kamphaus, Cory M., Keely G. Murdoch, Gregory C. Robison, Mathew B. Collins, Rick F. Alford, Kraig E. Mott. 2011. Mid-Columbia Coho Reintroduction Feasibility Study: **2010**

Annual Report, October 1, 2009 through September 30, 2010. Prepared by Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. July 2011.

Kinnison, M.T., M.J. Unwin, N. Boustead, and T.P. Quinn. 1998a. Population specific variation in body dimension of adult chinook salmon (Oncorhynchus tshawytscha) from New Zealand and their source population, 90 years after their introduction. Canadian Journal of Fisheries and Aquatic Science. 55:554-563.

Kinnison, M.T., M.J. Unwin, W.K. Hershberger, and T.P. Quinn. 1998b. Egg size, fecundity and development rate of two New Zealand chinook salmon populations. Canadian Journal of Fisheries and Aquatic Science. 55:1946-1953.

Kinnison, M.T., M.J. Unwin, A.P. Hedry, and T.P. Quinn. 2001. Migratory costs and the evolution of egg size and number in introduced and indigenous salmon populations. Evolution, 55(8): 1656-1667.

Larkin, P.A. 1956. Interspecific Competition and Population Control in Freshwater Fish. Journal of Fisheries Research Board of Canada. Vol. 13, No. 3, pp 327-342.

Lestelle, L.C. 2004. Guidelines for Rating Level 2 Environmental Attributes in Ecosystem Diagnosis and Treatment (EDT). ,Mobrand Biometrics Inc.

Lichatowich, J., L.E. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in freshwater ecosystems. ,Fisheries 20(1): 10-18.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabitating underyearling of chinook and coho salmon in the Big Qualicum River, B. C. J. Fish Res. Board Can. 27:1215-1224.

Mackey, G., T. Pearsons, M. Cooper, K. Murdoch, A. Murdoch, and T. Hillman. 2014. Ecological Risk Assessment of Upper-Columbia Hatchery Programs on Non-Target Taxa of Concern. Report produced by the Hatchery Evaluation Technical Team (HETT) for the HCP Wells Hatchery Committee, HCP Rocky Reach Hatchery Committee, HCP Rock Island Hatchery Committee, and the Priest Rapids Hatchery Sub-Committee. June 2014.

Mahnken, C., E. Prentice, W. Waknitz, G. Monan, C. Sims, and J Williams. 1982. The Application of Recent Smoltification Research to Public Hatchery Releases: An Assessment of Size/Time Requirements for Columbia River Hatchery Coho Salmon. Aquaculture, 28 (1982) 251-268.

Marnell, L.F. 1986. Impacts of hatchery stocks on wild fish populations. Pages 339-347 in R. H. Stroud, editor. Fish culture in fisheries management. American Fisheries Society, Fish Culture Section and Fisheries Management Section, Bethesda, MD.

Maynard, D.J., T.A. Flagg, and C.V.W. Mahnken. 1995. A review of seminatural culture strategies for enhancing the postrelease survival of anadromous salmonids. American Fisheries Society Symposium 15:307-314.

MCCRP (Mid-Columbia Coho Reintroduction Program). 2005. Mid Columbia Coho Budget, Project No.1996-040-00 Intergovernmental Contract No. 00016988, February 1, 2006 to January 31, 2007.

McDowall, R.M. 1994. The origins of New Zealand's chinook salmon, *Oncorhynchus tshawytscha*. Marine Fisheries Review 56:1-7.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA (National Oceanic and Atmospheric Administration), Washington, D.C., Tech. Memo. NMFS-NWFSC-42.

Miller, L.M., and A.R. Kapuscinski. 2003. Genetic guidelines for hatchery supplementation programs. Pages 329-355 *in* E.M Hallerman, editor. Population Genetics: Principles and Applications for Fisheries Scientists. American Fisheries Society, Bethesda, MD.

Miller, T. 2003. 2002 Chiwawa and Upper Wenatchee River Smolt Estimates. Technical Memorandum, May 22, 2003. Washington Department of Fish and Wildlife, Fish Program-Science Division, Supplementation Research Team, Wenatchee, WA.

Mobrand, L., J. Barr, L. Blankenship, D. Campton, T. Evelyn, T. Flagg, C. Mahnken, R. Piper, P. Seidel, L. Seeb and B. Smoker. 2004. Hatchery Reform: Principles and Recommendations of the Hatchery Scientific Review Group. Long Live the Kings.

Mobrand, L.E., L.C. Lestelle, J.A. Lichatowich, and T.S. Vogel. 1997. An approach to describing ecosystem performance "through the eyes of salmon". Canadian Journal of Fisheries and Aquatic Sciences 54:2964-2973.

Mullan, J.W. 1984. Overview of artificial and natural propagation of coho salmon on the mid-Columbia River. Fisheries Assistance Office, US Fish and Wildlife Service, Leavenworth, WA. 37 pp.

Mullan, J.W. 1986. Determinants of sockeye salmon abundance in the Columbia River, 1880s-1982: A review and synthesis. USFWS Biol. Rep. 86(12).

Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish and Wildlife Serv. Monograph I. Leavenworth, WA 489 pp.

Mullan, J.W., A. Rockhold, and C.R. Chrisman. 1992b. Life histories and precocity of chinook salmon in the mid-Columbia River. Progressive Fish Cult. 54:25-28.

Murdoch, A., and C. Peven. 2005. Conceptual approach to monitoring and evaluating the Chelan County Public Utility District Hatchery Programs. *Prepared for:* Chelan PUD Habitat Conservation Plan's Hatchery Committee.

Murdoch, K., and J. Dunnigan. 2002. Feasibility and risks of coho reintroduction in mid-Columbia tributaries: 2000 annual monitoring and evaluation report, project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Murdoch, K.G., C.M. Kamphaus, S. A. Prevatte. 2004. Mid-Columbia coho reintroduction feasibility study: 2002 monitoring and evaluation report, project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Murdoch, K.G., C. M. Kamphaus, S. A. Prevatte. 2005. Mid-Columbia coho reintroduction feasibility study: 2003 draft monitoring and evaluation report, project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Murdoch, K.G., S.A. Prevatte, and C.M. Kamphaus. 2006a. Mid-Columbia coho reintroduction feasibility study: 2005 Monitoring and Evaluation Report, February 1, 2004 through January 31, 2005. *Prepared for:* Bonneville Power Administration, project #1996-040-00. Portland, OR.

Murdoch, K.G., C.M. Kamphaus, S.A. Prevatte, C.H. Strickwerda. 2006b. Mid-Columbia Coho Reintroduction Feasibility Study: 2005 Annual Report February 1, 2005 through January 31, 2006. *Prepared for*: Project # 1996-040-00 Bonneville Power Administration. Toppenish, WA. October 1, 2006.

Murdoch, K. and M. LaRue. 2002. Feasibility and risks of coho reintroduction in mid-Columbia tributaries: 2001 annual monitoring and evaluation report, project No. 1996-040-000. Bonneville Power Administration, Portland, OR.

Murphy, M.L., J. Heifetz, J.F. Thedinga, S.W. Johnson, and K.V. Koski. 1989. Habitat utilization by juvenile Pacific salmon in the glacial Taku River, southeast Alaska. Can. J. Fish. Aquat. Sci. 46:1677-1685.

Neeley, D. 2004. Release-to-McNary Survival Indices of 2004 Releases into the Wenatchee and Methow Basins. *Prepared for*: Yakama Nation Fisheries Resource Management, Toppenish, WA.

Neeley, D. 2007. Release-to-McNary Survival Indices of 2007 Releases into the Wenatchee and Methow Basins. *Prepared for*: Yakama Nation Fisheries Resource Management, Toppenish WA.

Nickelson, T.E. 1986. Influence of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*O. kisutch*) in the Oregon production area. Canadian Journal of Fisheries and Aquatic Sciences. 43:527-535.

Nickelson, T.E., J.D. Rodgers, S.L. Johnson, and M.F. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Can. J. fish. Aquat. Sci., 49:783-789.

NMFS (National Marine Fisheries Service). 1999. *Biological Opinion: 1999 Coho Salmon Releases in the Wenatchee River Basin by the Yakama Indian Nation and the Bonneville Power Administration*. U.S. Department of Commerce, NMFS, Northwest Region, April 27, 1999.

NMFS. 2004. Anadramous Salmonid Passage Facility Guidelines and Criteria. National Marine Fisheries Service, Northwest Region. January 31, 2004.

NMFS. 2014. Endangered Species Act (ESA) Section 7 (a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation, Consultation No. 2011/05645. National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division, and Interior Columbia Basin Area Office. June 27, 2014.

NPCC (Northwest Power and Conservation Council). 2004a. Wenatchee Subbasin Plan. Prepared for the Northwest Power and Conservation Council. May 2004. 427 pgs.

NPCC. 2004b. Methow Subbasin Plan. Prepared for the Northwest Power and Conservation Council. November 2004.

NPPC (Northwest Power Planning Council). 1994. Columbia River Basin Fish and Wildlife Program. NPPC 94-55, Portland, OR.

NPPC. 2000. Columbia River Fish and Wildlife Program. Council Document 2000-19.

NPPC (Northwest Power Planning Council). 2001. Three-Step Review Process as approved by Northwest Power Planning Council on October 18, 2001.

Parties to *U.S. v. Oregon*. 1987. Columbia River Fish Management Plan. Columbia River Inter-Tribal Fish Commission. Portland, OR.

Pearsons, T., and C. Hopley. 1999. A practical approach for assessing ecological risks associated with fish stocking programs. Fisheries 24(9):16-23.

Pearsons, T., A. Fritts, G. Temple, C. Johnson, T. Webster, and N. Pitts. 2004. Yakima River Species Interactions Studies; Yakima Klickitat Fisheries Project Monitoring and Evaluation Report 7 of 7: 2003-2004 Annual Report, Project No. 199506325. Bonneville Power Administration, Portland, OR. BPA report DOE/BP-00013756-7.

Petts, G.E. 1980. Long-term consequences of upstream impoundment. Environmental conservation. Volume 7. Pages 325-332.

Peven, C.M. 2003. Population structure, status and life histories of upper Columbia steelhead, spring and late-run chinook, sockeye, coho salmon, bull trout, westslope cutthroat trout, non-migratory rainbow trout, pacific lamprey, and sturgeon. Peven Consulting Inc. Wenatchee, WA.

Piper, R., I. McElwain, L. Orme, J. McCraren, L. Fowler, J. Leonard. 1982. Fish Hatchery Management. U.S. Dept. of the Interior, Fish and Wildlife Service.

PFMC (Pacific Fisheries Management Council). 1999. Review of 1998 Ocean Salmon Fisheries. Pacific Fishery Management Council. Portland, OR. February 1999.

Prevatte, S.A., and K.G. Murdoch. 2004. Integrated status & effectiveness monitoring program, expansion of existing smolt trapping program in Nason Creek: 2004 Draft Annual Report. *Prepared for* Bonneville Power Administration, Portland OR. Project No. 2003-017-00.

Purdom, C. 1994. Book Review: Genetic Conservation of Salmonid Fishes. Journal of Experimental Marine Biology and Ecology. 182:141-142.

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. American Fisheries Society, Bethesda Maryland, *in association with* University of Washington Press, Seattle and London. 320 pages.

Quinn, T.P., and N.P. Peterson. 1996. The influence of habitat complexity and fish size on over-winter survival and growth of individually marked juvenile coho salmon in Big Beef Creek, Washington. Can. J. Fish. Aquat. Sci. 53:155-1564.

Ratliff, D.E., S.L. Thiesfeld. W.G. Weber, A.M. Stuart, M.D. Riehle, and D.V. Buchanan. 1996. Distribution Life History, Abundance, Harvest, Habitat, and Limiting Factors of Bull Trout in the Metolius and Lake Billy Chinook, Oregon, 1983-94 .Oregon Department of Fish and Wildlife, Portland, OR.

Reisenbichler, R.R. 1988. Relation Between Distance Transferred from Natal Stream and Recovery Rate for Hatchery Coho Salmon. North American Journal of Fish Management, 8:172-174.

Reisenbichler, R.R. and J.D. McIntyre. 1977. Genetic differences in growth and survival of hatchery and wild steelhead trout. Journal of the Fisheries Research Board of Canada 34:123-128.

Rife, D. 1999. Mission creek watershed biological assessment for steelhead, spring chinook, bull trout and western cutthroat trout. USFS, Leavenworth Ranger District, Wenatchee-Okanogan NF, Wenatchee, WA.

Riley, S.C., H.J. Fuss, L.L. LeClair. 2004. Ecological effects of hatchery-reared juvenile chinook and coho salmon on wild juvenile salmonids in two Washington streams. North American Journal of Fisheries Management 24: 506-517.

Sabo, J.L., and G.B. Pauley. 1997. Competition between stream-dwelling cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*): effects of relative size and population origin. Can. J. Fish. Aquat. Sci. (54)2609-2617.

Sandercock, F.K. 1998. Life History of coho salmon. *In:* Pacific Salmon Life Histories. C. Groot and L. Margolis, editors. University of British Columbia Press, Vancouver, BC.

Seiler, D., G. Voldkhardt, S. Neuhause, P. Hanratty, L. Kishimoto, P. Topping, M. Ackley, L. Peterson, and L. Fleisher. 2004. 2004 Wild Coho Forecasts for Puget Sound and Washington Coastal Systems. Washington Department of Fish and Wildlife, Science Division. Olympia, WA

Smith, C.T., R.J. Nelson, C.C. Wood, B.F. Koop. 2001. Glacial biogeography of North American coho salmon. Molecular Ecology (2001) 10, 2775 -2785.

Smith, D.L., E.L. Brannon, T.W. Bumstead, D.L. Mayer, D.M Rodgers, B.F. Russell. 2004. An Engineered Natural Channel for Coho Salmon Habitat Development and Rearing. In Review, Fisheries Bioengineering Symposium IV.

Stein, R.A., P.E. Reimers, J.D. Hall. 1972. Social Interaction Between Juvenile Coho and Fall Chinook Salmon in Sixes River, Oregon. Journal Fisheries Research Board of Canada, Vol. 29, No. 12.

Swain, D.P., and B. E.Riddell. 1990. Variation in agonistic behavior between newly emerged juveniles from hatchery and wild populations of coho salmon, *Oncorhynchus kisutch*. Canadian Journal of Fisheries and Aquatic Sciences 47:566-571.

TAC. 1997. All Species Review Columbia River Fish Management Plan. U.S. v. Oregon Technical Advisory Committee. August, 1997. Portland, OR.

Taylor, E.B. 1991a. Behavioral interaction and habitat use in juvenile chinook, *Oncorhynchus tshawytscha*, and coho, *O. kisutch*, salmon. Anim. Behav. 42: 729-744.

Taylor, E.B. 1991b. A review of local adaptation in Salmonidae, with particular reference to Pacific and Atlantic salmon. Aquaculture 98:185-207.

Temple, G.M, and T.N. Pearsons. 2004. Comparison of Single vs. Multiple Pass Electrofishing Effort to Monitor Fish Populations in Wadeable Streams. Pages 32-54 *in* Yakima/Klickitat

Fisheries Project Monitoring and Evaluation Report 7 of 7: Annual Report 2003-2004. Project No. 199506325 Bonneville Power Administration, Portland, OR. BPA Report DOE/BP-00013756-7.

Thurow, R.F. 1994. Underwater Methods for Study of Salmonids in the Intermountain West. United States Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Report INT-GTR-307. 28pgs.

Tripp, D., and P. McCart. 1983. Effects of different coho stocking strategies on coho and cutthroat trout production in isolated headwater streams. Can. Tech. Rep. Fish. Aquat. Sci. No. 1212.

Tyus, H.M. 1990. Effects of altered stream flows on fishery resources. Fisheries. Volume 3. Pages 18-20.

UCRTT (Upper Columbia Regional Technical Team). 2007. A biological strategy to protect and restore salmonid habitat in the Upper Columbia region. A report to the Upper Columba Salmon Recovery Board, Wenatchee, WA.

UCSRB (Upper Columbia Salmon Recovery Board). 2005. Draft Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan. December 2005. Prepared for Upper Columbia Salmon Recovery Board.

UCSRB. 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. August 2007. Prepared for Upper Columbia Salmon Recovery Board.

Unwin, M.J., Quinn, T.P., Kinneson, M.T., Boustead, N.C., 2000. Divergence in Juvenile Growth and Life History in Two Recently Colonized and Partially Isolated Chinook Salmon Populations. Journal of Fish Biology 57:943-960.

USDOE (U.S. Department of Energy). 2005. Office of Environment, Safety, and Health. NEPA Quarterly Report. June 1, 2005; Issue No. 43.

USDOE/BPA (U.S. Department of Energy, Bonneville Power Administration). 1999(a). Biological Assessment for Mid-Columbia Coho Reintroduction Feasibility Project, Chelan and Okanogan Counties, Washington. Portland, OR.

______. 1999(b). *Mid-Columbia Coho Reintroduction Feasibility Project Final Environmental Assessment and Finding of No Significant Impact*. USDOE/EA-1282, Portland, OR.

______. 2001(a). Biological Assessment for Mid-Columbia Coho Reintroduction Feasibility Project, Chelan and Okanogan Counties, Washington. Bonneville Power Administration, Portland, OR. February 22, 2001. Includes addendum letter from Nancy Weintraub, BPA, to Gregg Kurz, USFWS, dated March 6, 2001, with supplemental information on bald eagle presence, impacts and mitigation measures.

______. 2001(b). *Mid-Columbia Coho Reintroduction Feasibility Project Supplement Analysis*. USDOE/EA-1282-SA-01, April 23, 2001, Portland, OR.

______. 2001(c). Dredging of Coho Salmon Acclimation Site at Leavenworth National Fish Hatchery: Biological Assessment and Essential Fish Habitat Assessment, Chelan County, Washington. Bonneville Power Administration, Portland, OR. August 7, 2001.

______. 2001(d). *Mid-Columbia Coho Reintroduction Feasibility Project Supplement Analysis*. USDOE/EA-1282-SA-02, October 5, 2001, Portland, OR.

______. 2002. Supplement Analysis for the Mid-Columbia Coho Reintroduction Feasibility Project EA (DOE/EA-1282/SA-03), November 18, 2002, Portland, OR.

______. 2003. Supplement Analysis for the Mid-Columbia Coho Reintroduction Feasibility Project EA (DOE/EA-1282/SA-04), August 5, 2003, Portland, OR.

______. 2012. Mid-Columbia Coho Restoration Program Final Environmental Impact Statement (DOE/EIS-0425), March 2012, Portland, OR.

USFS (United States Forest Service). 1995. Twisp River Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

———. 1998a. White and Little Wenatchee Rivers watershed assessment. Wenatchee National Forest, Leavenworth Ranger District, Leavenworth, WA.

———. 1998b. Upper Methow Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

———. 2000a. Beaver Creek Stream Survey Summary, 08–92 to 09–92. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

———. 2000b. Chewuch River Stream Survey Summary, 09–93 to 10–93. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

———. 2003. Fisheries Biological Assessment for Ongoing Activities in the Wenatchee River. Wenatchee National Forest, Wenatchee, WA.

———. 2004. Fisheries Biological Assessment for Ongoing Activities in Icicle Creek. Wenatchee National Forest, Wenatchee, WA.

USFWS (United States Fish and Wildlife Service). 1998. Klamath River and Columbia River bull trout population segments; status summary and supporting document lists. Prepared by the Bull Trout Listing Team.

USFWS. 2005. Part II 50 CFR Part 17, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Bull Trout; Final Rule. Federal Register Vol. 70, No. 185.

USFWS Columbia River Basin Hatchery Review Team. 2007. Leavenworth, Entiat and Winthrop National Fish Hatcheries Assessments and Recommendations Final Report. April 2007.

Utter, F., R. Waples, and D. Teel. 1992. Genetic isolation of previously indistinguishable chinook salmon population of the Snake and Klamath Rivers: limitations of negative data. Fishery Bulletin. 90:770-777.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. (37)130-137.

Vedan, A. 2002. Traditional Okanagan environmental knowledge and fisheries management. Prepared by Okanagan Nation Alliance, Westbank, BC. 17 pp.

Washington Department of Fish and Wildlife (WDFW). 1998. Washington salmonid stock inventory. Appendix: Bull trout and dolly varden. Washington Department of Fish and Wildlife. Olympia, WA.

WDFW/ODFW. 1995. Status Report, Columbia River Fish Runs & Fisheries, 1938-94. Washington Department of Fish and Wildlife; Oregon Department of Fish and Wildlife. August 1995.

WDFW/ODFW. 1998. Status Report, Columbia River Fish Runs and Fisheries, 1938-97. Washington Department of Fish and Wildlife; Oregon Department of Fish and Wildlife. June, 1998.

Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes. 2002. Washington State Salmonid Stock Inventory. Appendix 3: Columbia River stocks. Washington Department of Fish and Wildlife, Olympia, WA.

Weir, B.S. 1996. Genetic Data Analysis II: Methods for Discrete Population Genetic Data. Sinauer Associates, Sunderland, MA. 445 pp.

Williams, R.N., J.A. Lichatowich, P.R. Mundy, M. Powell, 2003. Integrating artificial production with salmonid life history, genetic, and ecosystem diversity: a landscape perspective. Issue Paper for Trout Unlimited, West Coast Conservation Office, Portland, OR. 4 September 2003.

Willson, M.F., and K.C. Halupka. 1995. Anadromous fish as keystone species in vertebrate communities. Conservation Biology 9:489-497.

YIN (Yakama Indian Nation, Fisheries Resource Management Program). 1998. Mid-Columbia Coho Salmon Study Plan 11/25/98. Prepared for Bonneville Power Administration. Portland, OR.

Yakama Nation (YN). 2004. Draft Conceptual Long-Term Plan for Coho Reintroduction in the Wenatchee and Methow Rivers. November 15, 2004. Unpublished.

YN, WDFW, BPA (Yakama Nation, Washington Department of Fish and Wildlife, Bonneville Power Administration). 1999. Hatchery and Genetics Management Plan: Mid-Columbia Coho Reintroduction Program. December 1999.

YN, WDFW, BPA. 2002. Hatchery and Genetics Management Plan: Mid-Columbia Coho Reintroduction Feasibility Project. December 2002.

Zar, J. 1999. Biostatistical Analysis, fourth edition. Prentice Hall, New Jersey.

Zillges, G. 1977. Methodology for determining Puget Sound coho escapement goals, escapement estimates, 1977 pre-season run size prediction and in-season run assessment. Washington State Department of Fisheries, Technical Report No. 28. 66 pgs.

Chapter 10. Project Documents and Process History

2017 Update: *This history was moved from Chapter 1 in the 2010 Master Plan and updated to include processes and documents completed since the 2010 plan was published.*

10.1 Process History

1995 - 1997

This project was formally established by the Yakama Nation with the adoption of the Tribal Restoration Plan in 1995 (CRITFC 1995) by the four Columbia River treaty tribes (Nez Perce, Umatilla, Warm Springs, and Yakama).

In April 1996 the project was one of the 15 high priority supplementation projects recommended for funding by the Northwest Power Planning Council (NPPC) [now Northwest Power and Conservation Council] and was incorporated into the Fish and Wildlife Program (program measures 7.1H, 7.4A, 7.4F, and 7.4O) (as documented in NPPC 1994). These high priority supplementation projects were forwarded with strong endorsements from both the *U.S. v. Oregon* Policy Committee and the National Marine Fisheries Service (NMFS).

The coho project was proposed to proceed in two phases. The first phase was experimental, as it evaluated feasibility, ecological interactions, survival through the system and broodstock development. The second phase was to focus on production and restoration activities.

In the FY 1998 Annual Implementation Work Plan (AIWP), the Council recommended funding for completion of the environmental review of the first phase (feasibility studies). Because this phase of the project was initiated prior to the Council's Three-Step Review Process and was experimental in nature, no step review was necessary (M. Fritsch, NPPC, memorandum to Council, July 12, 2000).

1998

Spring**:** BPA determined that acclimation and release of coho smolts for research purposes at four sites in the Methow basin was categorically excluded from National Environmental Policy Act (NEPA) analysis.

Summer: Initial research results were reported in Dunnigan and Hubble 1998.

Fall: A comprehensive research program was proposed (YIN 1998).

1999

April: BPA analyzed environmental impacts of the research project in the Mid-Columbia Coho Reintroduction Feasibility Project Final Environmental Assessment (EA) (USDOE/BPA 1999b). The EA analyzed impacts of research to determine the feasibility of reintroducing naturally reproducing coho into the Methow and Wenatchee river basins, from which they had been extirpated. The EA focused on the impacts of construction of coho acclimation facilities, of coho smolt releases, of monitoring their survival and interactions with other species, and of operation and modification of existing production facilities needed to conduct the research. Effects of that plan on species listed under the ESA also were analyzed in Biological Assessments (BAs) submitted to U.S. Fish and Wildlife Service (USFWS) and to NMFS.

***December*:** The project was further refined in the Hatchery and Genetics Management Plan (HGMP) (YN et al. 1999), required by NMFS in its Biological Opinion.

2000

***July*:** A Partial Step 2 Review for NPPC was completed. The review was requested as part of the Fiscal Year 2000 Annual Implementation Work Plan that was triggered by YN's decision to switch the emphasis of this project from the Methow to the Wenatchee basin. It led to requirements that a future plan for the project would need to address (see Section 1.4.2 of the Master Plan).

2001

***April*:** BPA prepared a Supplement Analysis to evaluate additional research activities, temporary incubation and rearing facilities at the Two Rivers acclimation site, and potential additional acclimation sites not evaluated in the EA (USDOE/BPA 2001b).

***October*:** BPA prepared a Supplement Analysis to analyze the effects of using an existing building near Peshastin, Washington for a temporary site to incubate coho eggs for the program (USDOE/BPA 2001d).

2002

***March*:** BPA categorically excluded the dredging of an existing pond behind Dam 5 at Leavenworth National Fish Hatchery (NFH) to improve its effectiveness as an acclimation site.

***November*:** BPA prepared a Supplement Analysis to evaluate the effects of adding several new acclimation sites for the project (USDOE/BPA 2002).

- Leavenworth NFH: The project proposed use of and improvements to existing, unused Foster-Lucas ponds at Leavenworth NFH and construction of an improved water delivery system on hatchery grounds to partially replace the acclimation pond behind Dam 5, which would be unavailable after 2003.
- Nason Creek subbasin: The project proposed three new acclimation sites in the Nason Creek subbasin to help acclimate the remainder of the coho smolts programmed for the Wenatchee basin. The sites were:
    - Coulter Creek: Installation of an outlet pipe, and seasonal installation and removal of nets across a beaver pond located on privately owned land, to allow acclimation and release of up to 100,000 coho smolts.
    - Whitepine Beaver Pond: Seasonal installation and removal of nets across a beaver pond on U.S. Forest Service (USFS) land, and clearing and graveling an overgrown logging road to provide vehicle access to a footpath, which would then allow access to the pond. From 50,000 to 100,000 smolts would be acclimated and released from this site. The site was never used.
    - Mahar Creek Pond (now called Rohlfing): Seasonal installation and removal of nets across an existing pond on privately owned land. From 50,000 to 100,000 smolts would be acclimated and released from this site.
- Little Wenatchee (Two Rivers): Within the previously evaluated area at an existing gravel pit (USDOE/BPA 1999b), the project proposed to use an existing discharge channel as a coho acclimation pond.

- Chumstick Creek: The project proposed a direct stream release of smolts, instead of acclimation as discussed in DOE/BPA 2001b.

December: The HGMP was updated, in consultation with project participants (YN et al. 2002).

2003

July: BPA received concurrences from USFWS (letter dated July 31, 2003 from Mark G. Miller, Supervisor, Central Washington Field Office) and NOAA Fisheries (letter dated June 23, 2003 from D. Robert Lohn, Regional Administrator) on expansion of the Mahar Creek acclimation pond and construction of the Two Rivers acclimation pond.

August: A Supplement Analysis was prepared to examine the impacts of expanding the Mahar Creek acclimation pond (USDOE/BPA 2003).

October: Final Biological Opinion covering the Mid-Columbia Coho Project (plus other upper Columbia artificial production projects) was issued. ESA Section 7 Consultation 1999/01883, issued October 22, 2003.

2006

January: The original Mid-Columbia Coho Restoration Program Master Plan was submitted to the Council. At the Council's request, the ISRP reviewed both the original Master Plan, as part of Step One of the Council's Three Step Review, and the 2007 - 2009 solicitation proposal for this project (#1996-040-00). Although the ISRP recommended partial funding in August of 2006, the Council determined that budget limitations in the Columbia Cascade Province would not allow funding. The project continued to operate using transitional sources of funding until May 2008, when the Yakama Nation signed a Memorandum of Agreement (2008 MOA) with Bonneville Power Administration, the U.S. Army Corps of Engineers, and the Bureau of Reclamation.

September: BPA categorically excluded minor modifications to the acclimation pond on the Rohlfing property (formerly called the Mahar Creek acclimation pond).

2009

March: The Master Plan was substantially revised in response to the 2006 ISRP review and re-submitted for an NPCC Step-One review in March 2009, followed with another review in November 2009.

2010

March: In a letter dated March 10, NPCC recommended that the project begin the Step 2 and 3 process.

2011

June: BPA published the Draft Environmental Impact Statement on the Mid-Columbia Coho Restoration Program (USDOE 0425). The EIS analyzed the impacts of a program based on the one described in the 2009 revised Master Plan, with additional sites and alternatives. Public comment meetings were held in July in Leavenworth and Twisp, Washington, and comments were accepted until August 22, 2011.

2012

March: BPA published the Final Environmental Impact Statement on the Mid-Columbia Coho Restoration Program (USDOE 0425). In response to public comments, the EIS included, among other changes, additional analysis of impacts to water quality in Icicle Creek and the Wenatchee River from rearing coho at the Leavenworth National Fish Hatchery.

June: BPA received concurrences from USFWS (letter dated June 21, 2012 from Ken S. Berg, Manager, Washington Fish and Wildlife Office) and NMFS (letter dated July 5, 2012 from William Stelle, Jr., Regional Administrator, Northwest Region) on excavation of the Gold Creek acclimation ponds in the Methow basin.

July: BPA published its Record of Decision on the Mid-Columbia Coho Restoration Program, indicating it will continue to fund the program through 2028. The ROD acknowledged that, due to the need to replace some facilities evaluated in the EIS that subsequently became unavailable, additional NEPA and ESA evaluations would need to be done as replacement sites were found.

December: A revised BA on sites proposed for use by 2014 was submitted to NMFS.

2013

February: A revised BA on sites proposed for use by 2014 was submitted to USFWS.

July: BPA published Supplement Analysis 1 to the Mid-Columbia Coho Restoration Program Final EIS (DOE/EIS-0425-SA-1) which analyzed the impacts of modifications to the existing Butcher acclimation pond in the Wenatchee basin.

October: BPA published Supplement Analysis 2 to the Mid-Columbia Coho Restoration Program Final EIS (DOE/EIS-0425-SA-2) which analyzed the impacts of modifications to the existing Blue Buck acclimation pond in the Methow basin.

2014

March: A Biological Opinion on the revised BA was received from USFWS.

June: A Biological Opinion on the revised BA was received from NMFS.

2015

September: An Addendum to the previous BA discussing additional changes to proposed sites was submitted to USFWS.

October: An Addendum to the previous BA discussing additional changes to proposed sites was submitted to NMFS.

2016

March: A revised HGMP on hatchery operations was submitted to NMFS.

July: BPA, in cooperation with the U.S. Forest Service, published the Final Environmental Assessment for the Eightmile Ranch Coho Acclimation Site (DOE/EA-1959), a new facility in the Methow basin.

July: BPA received a Biological Opinion from USFWS addressing the addendum to the BA.

August: BPA published Supplement Analysis 6 to the Mid-Columbia Coho Restoration Program Final EIS (DOE/EIS-0425-SA-6) which analyzed the impacts of construction and operation of a new acclimation facility in the Methow basin called Early Winters 3.

October: BPA and the U.S. Forest Service each published a Finding of No Significant Impact (FONSI) and their respective decision record/decision notice to proceed with construction and operation of the Eightmile Ranch coho acclimation facility.

10.2 Annual Reports, By Year

Dunnigan, J. 1999. Feasibility and risks of coho reintroduction in mid-Columbia Tributaries: **1999 annual monitoring and evaluation report,** project No. 1996-040-000. Bonneville Power Administration, Portland, OR. [covers 1998 and 1999]

Murdoch, K.G. 2001. Mid-Columbia Coho Reintroduction Feasibility Project: **2000 Acclimation Report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G., and J.L. Dunnigan. 2002. Feasibility and risks of coho reintroduction in mid-Columbia River tributaries: **2000 annual report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G, and M.L. Larue. 2002. Feasibility and risks of coho reintroduction in mid-Columbia River tributaries: **2001 annual report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G. and C.M. Kamphaus. 2003. Mid-Columbia-Coho Reintroduction Feasibility Project: **2001 Annual Broodstock Development Report.** *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Kamphaus, C.M., and K.G. Murdoch. 2004. Mid-Columbia Coho Reintroduction Feasibility Study: **2002 Annual Broodstock Development Report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G., C.M. Kamphaus, and S.A. Prevatte. 2004. Feasibility and risks of coho reintroduction in mid-Columbia tributaries: **2002 Annual Monitoring and Evaluation Report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Kamphaus, C.M. and K.G. Murdoch. 2005. Mid-Columbia Coho Reintroduction Feasibility Study: **2003 Annual Broodstock Development Report.** *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G., C.M. Kamphaus, and S.A. Prevatte. 2005. Mid-Columbia Coho Reintroduction Feasibility Study: **2003 Annual Monitoring and Evaluation Report**. *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Kamphaus, C.M. and K.G. Murdoch. 2006. Mid-Columbia Coho Reintroduction Feasibility Study: **2004 Annual Broodstock Development Report.** *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G., C.M. Kamphaus, and S.A. Prevatte. 2006. Mid-Columbia Coho Reintroduction Feasibility Study: **2004 Annual Monitoring and Evaluation Report.** *Prepared for:* Bonneville Power Administration, Project # 1996-040-00. Portland, OR.

Murdoch, K.G., S.A. Prevatte, and C.M. Kamphaus. 2006. Mid-Columbia coho reintroduction feasibility study: **2005 Monitoring and Evaluation Report**, February 1, 2004 through January 31, 2005. *Prepared for:* Bonneville Power Administration, project #1996-040-00. Portland, OR.

Murdoch, K. G., C. M. Kamphaus, S. A. Prevatte, C. H. Strickwerda. 2006. Mid-Columbia Coho Reintroduction Feasibility Study: **2005 Annual Report** February 1, 2005 through January 31, 2006. *Prepared for*: Project # 1996-040-00 Bonneville Power Administration. Toppenish, WA. October 1, 2006.

Murdoch, K. G., C. M. Kamphaus, S. A. Prevatte, C. H. Strickwerda. 2007. Mid-Columbia Coho Reintroduction Feasibility Study: **2006 Annual Report,** February 1, 2006 through September 30, 2006. *Prepared by* Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Portland, OR. April 10, 2007.

Kamphaus Cory M., K. G. Murdoch, C. H. Strickwerda, M. B. Collins. 2008. Mid-Columbia Coho Reintroduction Feasibility Study: **2007 Annual Report,** October 1, 2006 through September 30, 2007. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. March 6, 2008.

Kamphaus, Cory M., Keely G. Murdoch, Gregory C. Robison, Mathew B. Collins, Rick F. Alford. 2009. Mid-Columbia Coho Reintroduction Feasibility Study: **2008 Annual Report**, October 1, 2007 through September 30, 2008. Prepared by Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. June 11, 2009.

Kamphaus, Cory M., Keely G. Murdoch, Gregory C. Robison, Mathew B. Collins, Rick F. Alford, Ben Truscott, Kraig E. Mott. 2010. Mid-Columbia Coho Reintroduction Feasibility Study: **2009 Annual Report**, October 1, 2008 through September 30, 2009. Prepared by Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. October 2010.

Kamphaus, Cory M., Keely G. Murdoch, Gregory C. Robison, Mathew B. Collins, Rick F. Alford, Kraig E. Mott. 2011. Mid-Columbia Coho Reintroduction Feasibility Study: **2010 Annual Report**, October 1, 2009 through September 30, 2010. Prepared by Yakama Nation Fisheries Resource Management *for* Project # 1996-040-00 Bonneville Power Administration, Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. July 2011.

Kamphaus, Corydon M., Richard F. Alford, Keely G. Murdoch, Mathew B. Collins, Gregory C. Robison. 2013. MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY: **2011** ANNUAL REPORT October 1, 2010 through January 31, 2012. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. December 2013.

Kamphaus, Corydon M., Richard F. Alford, Timothy J. Jeffries, Bryan Ishida, Kraig E. Mott. 2014. MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY: **2012** ANNUAL

REPORT February 1, 2012 through January 31, 2013. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. November 2014.

Kamphaus, Corydon M., Richard F. Alford, Timothy J. Jeffries, Bryan Ishida, Kraig E. Mott. 2016. MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY: **2013** ANNUAL REPORT February 1, 2013 through January 31, 2014. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. January 2016.

Ishida, Bryan R., Richard F. Alford, Timothy J. Jeffries, Corydon M. Kamphaus, Kraig E. Mott, Gregory Wolfe. 2016. MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY: **2014** ANNUAL REPORT February 1, 2014 through January 31, 2015. Prepared by Yakama Nation Fisheries Resource Management for Project # 1996-040-00 Bonneville Power Administration Public Utility District No. 1 of Chelan County, and Public Utility District No. 2 of Grant County. Toppenish, WA. January 2016.

2017 Update: *The lettered appendices were provided as separate documents to the 2010 version of the Master Plan and are not appended to this updated Master Plan, except for the updated HGMP (submitted in March 2016). Some of the information on facilities is now outdated; however, these appendices serve to document the background research and planning done for the original master plan.*

The numbered appendices are new to this 2017 updated Master Plan.

Appendix A Fish Culture Guidelines

Appendix B.1 Rearing Facilities Alternatives

Appendix B.2 Acclimation Facilities Alternatives

Appendix C.1 Rearing and Brood Site Descriptions

Appendix C.2 Wenatchee Acclimation Site Descriptions

Appendix C.3 Methow Acclimation Site Descriptions

Appendix D Hatchery and Genetics Management Plan

Appendix E AHA Calculations

Appendix 1 Tumwater Adult Returns: Monitoring and Evaluation

Appendix 2 Results of NTOCC Risk Assessment