**Methow Subbasin Summary**

APPENDIX B - HATCHERY AND GENETICS MANAGEMENT PLAN MID-COLUMBIA COHO REINTRODUCTION PROGRAM

# HATCHERY AND GENETICS MANAGEMENT PLAN

# MID-COLUMBIA COHO REINTRODUCTION PROGRAM

**DECEMBER 1999**

**Yakama Nation** **Washington Department of Fish & Wildlife** **Bonneville Power Administration**

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# SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of Program: Mid-Columbia Coho Reintroduction Feasibility Project (Project #9604000)

1.2) Population (or stock) and species: Coho Salmon *(Oncorhynchus kisutch),* currently extirpated in mid-Columbia basins.

1.3) Responsible organizations and individuals

**Co-managers:**

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**Other organizations involved, and extent of involvement in the program:**

**Technical Team Members:**

- Bonneville Power Administration (BPA) (also is primary funding agency)
- Confederated Tribes of the Colville Indian Reservation
- National Marine Fisheries Service (NMFS) (also has decision responsibilities for listed species)
- Northwest Power Planning Council (NWPPC) (also makes Fish and Wildlife Program decisions under the Northwest Power Act)
- U.S. Fish and Wildlife Service (USFWS) (also has decision responsibilities for listed species)
- U.S. Forest Service (USFS) (also has decision responsibilities for facilities located on USFS land)

1.4) Location(s) of hatchery and associated facilities:

**Location of program**: Feasibility phase (see section 1.6.2): Washington State in the Wenatchee and Methow river basins. Releases or studies could be proposed in the Entiat basin during the feasibility phase, depending on results of ongoing studies. However, currently studies in the Entiat are not expected, and any that would be proposed would be subject to review and approval by the Technical Team and other entities before they were implemented. See Figure 1.

**Facilities that would be used:**

**1. Brood stock collection:** Tumwater, Dryden, or Wells dams; and/or Winthrop NFH or Leavenworth NFH (at dam on the side channel). See section 6 for details.

**2. Adult holding/spawning:** Winthrop NFH will be used for adults returning to the Methow basin. A site for adults returning to the Wenatchee basin has not been identified; one possibility is the Dryden summer chinook acclimation pond.

**3. Incubation/Early Rearing:** For initial smolts from Lower River brood stock: Eagle Creek NFH, Cascade Hatchery (ODFW), and Willard NFH in the lower Columbia River area. For fish reared from brood stock collected from returning adults: Winthrop hatchery will be used for up to 250,000 smolts of each brood year. An additional hatchery with available space needs to be found for the remainder of the production; possibilities include Entiat NFH, Turtle Rock Hatchery (WDFW), Prosser Hatchery (US Bureau of Reclamation and YN), Pasco Springs Hatchery (NMFS), or the Yakima Trout Hatchery (WDFW).

**4. Acclimation/release**: Figures 2 and 3 show potential locations in the Wenatchee and Methow basins. Only some of these sites are currently proposed for use during the period of this plan (see Table 1, section 1.9). Specific release sites on Chumstick and Brender creeks in the Wenatchee basin have not yet been identified and would be subject to environmental analysis of site-specific impacts. While specific sites in the Entiat basin have not been proposed or identified for this phase of the program, target streams have (the Entiat and Mad rivers and Brennegan Creek [Figure 1]), should the long-term vision be implemented (see section 1.6.1).

**5. Other: Monitoring**. Locations of various types of monitoring activities are identified briefly below. Section 10 describes the activities in detail

> **Wenatchee basin:** Juvenile out-migration and predation monitoring would use rotary traps located near the mouth of Nason Creek (predation on spring chinook) and at the Lake Wenatchee outfall (predation on sockeye). Alternatively, beach seining could also be used to collect coho to analyze predation on sockeye. Juvenile distribution/abundance/residualism monitoring would be done using systematic snorkel surveys at all release sites. Juvenile coho in Lake Wenatchee may be radio-tagged to determine their potential overlap with sockeye. Surveys using hydro-acoustic, beach seining, trawling, and/or purse seining gear may be required to collect information on age-specific sockeye rearing distribution in Lake Wenatchee. Spot electro-shocking and/or snorkeling for the presence of bull trout would be done near release sites at Chumstick and Beaver creeks; and for steelhead and bull trout at Beaver Creek and just below the Two Rivers release site. PIT tag detection of juvenile coho mainstem survival would be done at existing facilities at McNary, John Day, The Dalles, and Bonneville dams.

Figure 1 goes here (Figure 1 from EA)

Figure 2 goes here  (Figure 2 from EA)

Figure 3 goes here (Figure 3 from EA)

Adult monitoring could occur at Priest Rapids and Rock Island dams on the Columbia River, at Tumwater and Dryden dams on the Wenatchee, and at the adult brood stock weir on the Chiwawa River. The potential exists to install remote underwater video camera monitoring systems.

**Methow basin:** PIT tag detection would be done at the same locations as for Wenatchee fish, with the addition of Rocky Reach Dam. Adult monitoring would be done at Wells and Rocky Reach dams to determine conversion rates between dams.

**Entiat basin:** Locations not proposed at this time.

1.5) Type of program: Integrated Recovery

1.6) Purpose (Goal) of program:

The Mid-Columbia Coho Reintroduction Program encompasses a vision of an optimistic future that may take many years to achieve, as well as short-term goals that will provide information to enable decision-makers to assess whether the vision is achievable. This section has been divided into two parts to describe both long- and short-term goals. However, the remainder of this plan focuses on tasks and impacts related to the short-term goals. The long-term vision is provided to help reviewers understand the plan's overall context.

1.6.1 Long-term Vision

The long-term vision for this program is to reestablish naturally reproducing coho salmon populations in mid-Columbia river basins, with numbers at or near carrying capacity that provide opportunities for significant harvest for Tribal and non-Tribal fishers. It is closely tied to the vision for reintroduction of coho to the Yakima basin and to other areas from which the species has been eliminated. Mid-Columbia coho reintroduction is identified as a priority in the *Wy-Kan-Ush-Mi-Wa-Kish-Wit* document (Tribal Restoration Plan) by the four Columbia River Treaty Tribes; and has been affirmed as a priority by the Northwest Power Planning Council (see section 2.1).

Mid-Columbia basins historically occupied by coho include the Wenatchee, Methow, Entiat, and Okanogan basins. Mullan (1983) estimated historical mid-Columbia River adult coho populations as follows:

- Wenatchee—6,000 - 7,000
- Methow—23,000 - 31,000
- Entiat—9,000-13,000
- Okanogan—Numbers were not identified, although their presence was documented

The ideal would be to restore coho populations in these basins to their historical levels. Due to 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.

1.6.2 Goals of Feasibility Phase

This phase has two primary goals:

- to continue existing studies and to initiate new ones (adapting to changing needs, new information, and concerns of project participants) to determine whether a brood stock 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
- to initiate natural reproduction in areas of low risk to sensitive species.

Studies done in this phase will inform future decisions about whether the long-term vision described in 1.6.1 can be achieved.

1.7) Specific performance objective(s) of program

**Specific objective(s) of program (for next 5 years):**

- Determine whether hatchery adults from lower Columbia River brood stock return in increasing numbers to the Wenatchee and Methow basins so that their progeny may be expected to reach replacement, thus significantly limiting the infusion of the Lower River hatchery stock, with the long-term goal of eliminating use of the Lower River stock altogether. Specific numeric goals are shown in Table 1 (section 1.9).
- Begin to develop a locally adapted brood stock, starting with adult returns to Winthrop NFH and Wells Dam in 1999. Specific numeric goals for the Wenatchee and Methow basins are shown in Table 1.
- Begin coho releases in areas of low risk to listed species that will be allowed to return as adults to spawn naturally. These areas currently are expected to be in the Wenatchee basin at as-yet-unidentified sites at Chumstick and Brender creeks. Escapement goals would be as shown in Table 1.
- Study interactions among coho and listed and sensitive species, particularly spring chinook and sockeye salmon, steelhead, and bull trout.
- Minimize potential negative interactions among coho and listed and sensitive species.
- Annually evaluate project performance and expand or adapt studies as data indicate is necessary or appropriate.

1.8) List of Performance Indicators designated by "benefits" and "risks"

Monitoring studies of these performance indicators are described in detail in section 10.

**Benefits to coho**

- Trends in survival of hatchery fish as measured by smolt-to-smolt (PIT tags) and smolt-to-adult (counts at dams/facilities) survival.

- Changes made by out-of-basin stock, using genetic monitoring of neutral allelic frequencies; and physical and behavioral traits such as fecundity, body morphometry, and maturation timing.

**Risks to other listed species**

- Predation on other species by program fish as indicated by stomach content analyses.
- Other potential ecological interactions as indicated by residualism, distribution, and habitat surveys.

1.9) Expected size of program

1.9.1 Program size for the feasibility stage (this plan)

Smolt release numbers, brood stock requirements, and expected production for the feasibility stage of the program are shown in Table 1. Feasibility studies are identifying ecological risks, brood stock requirements, and survival of out-of-basin stocks.

1.9.2 Program size in the long term

Before implementation of the long-term vision described in section 1.6.1 can begin, a variety of decision processes must be completed, using the results of the feasibility studies. These processes most likely would include, at a minimum, an Environmental Impact Statement (EIS) if federal funding is involved, and a Step Two review by the NWPPC. Then, if the decision-making entities agree to continue the project, it is expected that release numbers would be calculated taking into account carrying capacity (see section 2.5), survival estimates of hatchery fish, harvest goals, and any reductions necessary to limit risks to other species. It is possible, however, that future coho releases would be less than the number required to fully seed the habitat due to concerns about interactions with listed species.

1.10) Date program started or is expected to start: Research into feasibility began in 1996.

1.11) Expected duration of program:

Some feasibility studies are expected to continue for at least the duration of this plan. Full-scale implementation could begin only after initial feasibility has been determined, and an Environmental Impact Statement (EIS), the NWPPC Step Two review, and other decision processes are completed.

# Table 1. Summary of Coho Releases and Brood Stock Development

## Methow

Winthrop Releases

| Smolt Release Year | Winthrop Release | Total |
|---|---|---|
| 1998 | 341,000 | 341,000 |
| 1999 | 0 | 0 |
| 2000 | 200,000 | 200,000 |
| 2001 | 250,000 | 250,000 |
| 2002 | 250,000 | 250,000 |
| 2003 | 250,000 | 250,000 |
| 2004 | 250,000 | 250,000 |
| 2005 | 250,000 | 250,000 |

Smolts released in the Methow will be derived as stock transfers from the lower Columbia River coho hatcheries. All smolts will be released from the Winthrop Hatchery. All progeny derived from adults returning to the Methow will be released in natural production areas in the Wenatchee.

| Winthrop Adult Returns | | | Adult Disposition | | Expected Smolt Production from Methow Returns | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Adult Return Year | Adult Return | Prespawn Mortality | Broodstock | Natural Spawning* | Females | Spawning Year | Eggs | Smolts | Outplant Year |
| 1999 | 171 | 26 | 72 | 72 | 36 | 1999 | 204,000 | 173,400 | 2001 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 2000 | 0 | 0 | 2002 |
| 2001 | 100 | 15 | 43 | 43 | 21 | 2001 | 58,438 | 49,672 | 2003 |
| 2002 | 125 | 19 | 53 | 53 | 27 | 2002 | 73,047 | 62,090 | 2004 |
| 2003 | 125 | 19 | 53 | 53 | 27 | 2003 | 73,047 | 62,090 | 2005 |
| 2004 | 125 | 19 | 53 | 53 | 27 | 2004 | 73,047 | 62,090 | 2006 |
| 2005 | 125 | 19 | 53 | 53 | 27 | 2005 | 73,047 | 62,090 | 2007 |

**Methow Assumptions**

| SAR | Fecundity | Egg:Smolt | Female Ratio | Capture Efficiency | Prespawn Mortality |
|---|---|---|---|---|---|
| 0.0005 | 2,750 | 0.85 | 0.5 | 0.5 | 0.15 |

## Wenatchee

Wenatchee Releases**

| Smolt Release Year | Butcher Creek | Beaver Creek | Two Rivers | Chumstick Creek | Brender Creek | Leavenworth | Total |
|---|---|---|---|---|---|---|---|
| 1999 | 75,000 | | | | | 450,000 | 525,000 |
| 2000 | 75,000 | | | | | 925,000 | 1,000,000 |
| 2001 | 173,400 | | | | | 826,600 | 1,000,000 |
| 2002 | 120,000 | 100,000 | | 101,476 | | 678,524 | 1,000,000 |
| 2003 | 120,000 | 171,003 | 171,003 | 100,000 | 100,000 | 337,993 | 1,000,000 |
| 2004 | 120,000 | 177,212 | 177,212 | 100,000 | 100,000 | 325,575 | 1,000,000 |
| 2005 | 120,000 | 168,545 | 168,545 | 100,000 | 55,198 | 387,712 | 1,000,000 |

| Wenatchee Adult Returns | | | Adult Disposition | | Expected Smolt Production from Adult Returns | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Adult Return Year | Adult Return | Prespawn Mortality | Broodstock | Natural Spawning*** | Females | Spawning Year | Eggs | Smolts | Outplant Year |
| 2000 | 539 | 81 | 275 | 183 | 138 | 2000 | 378,207 | 321,476 | 2002 |
| 2001 | 1,027 | 154 | 524 | 349 | 262 | 2001 | 720,394 | 612,335 | 2003 |
| 2002 | 1,027 | 154 | 524 | 349 | 262 | 2002 | 720,394 | 612,335 | 2004 |
| 2003 | 1,027 | 154 | 471 | 402 | 235 | 2003 | 647,291 | 550,198 | 2005 |
| 2004 | 1,027 | 154 | 419 | 454 | 210 | 2004 | 576,315 | 489,868 | 2006 |
| 2005 | 1,027 | 154 | 419 | 454 | 210 | 2005 | 576,315 | 489,868 | 2007 |

**Wenatchee Assumptions**

| SAR | Fecundity | Egg:Smolt | Female Ratio | Capture Efficiency | Prespawn Mortality |
|---|---|---|---|---|---|
| 0.0010273 | 2,750 | 0.85 | 0.50 | 0.6 | 0.15 |

Source of Wenatchee Outplants

| Smolt Release Year | Lower River | Wenatchee Production | Methow Production | Total |
|---|---|---|---|---|
| 1999 | 1,000,000 | 0 | 0 | 1,000,000 |
| 2000 | 1,000,000 | 0 | 0 | 1,000,000 |
| 2001 | 826,600 | 0 | 173,400 | 1,000,000 |
| 2002 | 678,524 | 321,476 | 0 | 1,000,000 |
| 2003 | 337,993 | 612,335 | 49,672 | 1,000,000 |
| 2004 | 325,575 | 612,335 | 62,090 | 1,000,000 |
| 2005 | 387,712 | 550,198 | 62,090 | 1,000,000 |

* This natural spawning is predicted as a result of capture efficiency at Wells and straying.

** In the Wenatchee basin, smolts released into natural habitat will be progeny of adults returning to the Wenatchee and Methow rivers. Smolts derived from stock transfers from Lower Columbia River hatcheries that are released in the Wenatchee will be released solely from Leavenworth Side Channel.

*** This natural spawning is predicted in Chumstick and Brender creeks only, due to their location downstream of adult traps.

Explanation of Assumptions in Table 1:

1. Estimated SAR used is the median between Yakima River and Methow River smolt-to-adult survival data.
2. Fecundity is Yakima River broodstock data for 1998 and 1999.
3. Egg-to-smolt survival is based on personal conversations with Lower Columbia River coho hatchery managers. The 1998 brood Yakima River coho experienced high losses due to water quality problems and therefore were not used in the calculations.
4. Female ratio is an average from both the Methow 1999 returns and 1998/1999 Yakima River returns.
5. Straying and trap inefficiency are the main factors in estimating less than 100% capture efficiency.
6. Pre-spawn mortality estimates are from personal communication with Lower Columbia River hatchery managers.

1.12) Watersheds targeted by the program:

**Short-term (this plan)**

Wenatchee: Nason Creek, Wenatchee River, Icicle Creek, Chumstick Creek, Brender Creek, Beaver Creek

Methow: Methow River

**Long-term vision (full implementation)**

Wenatchee: All streams targeted in the feasibility phase, plus Little Wenatchee River, White River, Chiwawa River, Peshastin Creek

Methow: In addition to Methow River, Chewuch River, Wolf Creek, Twisp River, Eight Mile Creek

Entiat: Entiat River, Brennegan Creek, Mad River

Okanogan: Okanogan River and tributaries

# SECTION 2. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

Information in this section includes status of species and potential impacts in the Entiat basin, as well as in the Wenatchee and Methow basins, although the project does not propose feasibility studies in the Entiat at this time. The information is offered to give reviewers a context for the long-term plans and to show similarities and differences among the basins in this region. As well, the information could be useful should adaptive management reviews suggest that studies or other work be undertaken in another basin besides those currently proposed.

2.1) *List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates*

Since the 1990s, various entities in the Pacific Northwest have renewed the region's focus on reintroduction of coho to the mid-Columbia.

The four Columbia River Treaty Tribes (Nez Perce, Umatilla, Warm Springs, and Yakama) identified coho reintroduction in the mid-Columbia as a priority in the *Wy-Kan-Ush-Mi-Wa-Kish-Wit* document, commonly referred to as the Tribal Restoration Plan (TRP) (CRITFC 1995). It is a comprehensive plan put forward by the Tribes to restore the Columbia River fisheries. This project is the initial phase necessary to determine the feasibility of implementing that long-term vision in the mid-Columbia region.

In 1996, the Northwest Power Planning Council (NPPC) recommended the tribal mid-Columbia reintroduction project for funding by BPA, which has responsibilities under the Northwest Electric Power Planning and Conservation Act of 1980 to protect, mitigate, and enhance fish and wildlife that have been affected by the construction and operation of the Federal Columbia River Power System. It was identified as one of fifteen high-priority projects for the Columbia River basin, and was incorporated into the NPPC's Fish and Wildlife Program (program measures 7.1H, 7.4A, 7.4F, and 7.4O). The project will be subject to a Step-Two Review by the Council once the feasibility phase is completed and the time is ripe to consider full implementation of the long-term vision.

The release of coho from lower Columbia hatcheries into mid-Columbia tributaries is also recognized in the Columbia River Fish Management Plan, a court-mandated plan under the jurisdiction of *U.S. v. Oregon*, involving Federal, state and tribal fish managers in the Columbia basin (CTWSR et al. 1988). While this project is not mandated under that court order, fish produced under that plan supply the project.

The *Biological Assessment and Management Plan, Mid-Columbia River Hatchery Program* (NMFS et al. 1998) also recognizes the potential for coho reintroduction in mid-Columbia basins, although coho plans and analyses were recognized as being outside the scope of that document.

Plans for the initial feasibility research phase of this project were outlined, revised, and analyzed in several recent documents, primarily *Mid-Columbia Coho Salmon Study Plan* 11/25/98 (YIN 1998); *Mid-Columbia Coho Reintroduction Feasibility Project Final Environmental Assessment* (USDOE BPA 1999(b)); and *Biological Opinion: 1999 Coho Salmon Releases in the Wenatchee River Basin by the Yakama Indian Nation and the Bonneville Power Administration* (NMFS 1999).

The U.S. District Court ruled on March 22, 1974 that the Yakama Nation and Washington Department of Fish and Wildlife co-manage fish resources in Washington state. This decision is commonly referred to as the Boldt Decision.

A Memorandum of Understanding, dated 12/27/93, stipulates that the Wenatchee National Forest (WNF) and the YN will cooperatively manage fish resources on the Wenatchee National Forest.

2.2) Status of natural populations in target area.

2.2.1) Geographic and temporal spawning distribution.

There are no natural populations of coho in any of the three basins. Table 2 lists sensitive species in the two target basins for this plan and their current status.

**Table 2. Special Status Species in the Wenatchee and Methow Basins**

| Common Name | Endangered Species Act* | Washington Species Criteria** |
|---|---|---|
| Spring chinook salmon | Endangered | Vulnerable/Species of Importance |
| Summer/fall chinook salmon | | Vulnerable/Species of Importance |
| Coho salmon | | Vulnerable/Species of Importance |
| Sockeye salmon | | Vulnerable/Species of Importance |
| Steelhead trout | Endangered | Species of Importance |
| Rainbow trout | | Species of Importance |
| Bull trout | Threatened | Vulnerable/Species of Importance |

*Definitions under the Endangered Species Act include:

Endangered Species: Any species in danger of extinction throughout all or a significant portion of its range.

Threatened Species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

**WDFW species criteria (WDFW 1996) include:

Vulnerable: Species or groups of animals susceptible to significant population declines within a specific area by virtue of their inclination to aggregate, e.g., in fish spawning and rearing areas.

Species of Importance: Native and non-native fish species of recreational, commercial, or Tribal ceremonial and subsistence importance that are vulnerable to habitat loss or degradation.

Table 3 lists spawning areas for certain sensitive species that are within 8 km (5 mi) of potential coho acclimation sites in the Wenatchee and Methow basins. Please see figures 2 and 3 for acclimation site locations. Other known spawning areas in the two basins that are a greater distance from acclimation sites are listed by species and stream below. There are no known spawning areas for listed species in Brender or Chumstick creeks. Specific acclimation/release sites have not yet been identified for the Entiat basin.

**Table 3. Spawning Areas for Sensitive Anadromous Species Near Potential Coho Acclimation/Release Sites***

| Basin/Water Body | Spring chinook | Summer chinook | Sockeye | Steelhead | Bull trout |
|---|---|---|---|---|---|
| **Wenatchee** | | | | | |
| Nason Cr. | **X** | | | **X** | |
| Little Wenatchee R. | **U** | | **U** | **X** | **U** |
| Wenatchee R. mainstem | | **X** | | **X** | |
| White R. | **U** | | **X** | **X** | **U** |
| Chiwawa R. | **U** | | | **U** | |
| Icicle Cr. | | | **X** | **X** | **Uncertain** |
| **Methow** | | | | | |
| Upper Methow R. | **X** | | | | |
| Methow R. mainstem | | | | **X** | |
| Chewuch R. | **X** | **X** | | **X** | |
| Wolf Cr. | | | | | **U** |
| Goat Cr. | | | | **U** | |

*Legend:

X = spawning area overlaps with coho acclimation site

U = spawning area is no further than 8 km (5 mi) upstream of acclimation site

Other known spawning areas for sensitive anadromous species are listed below. The areas are all over 8 km (5 mi) from coho acclimation and release sites evaluated for this project.

- **Spring chinook**: Methow basin—Twisp River, Lost River
- **Steelhead:** Wenatchee basin—Mission Creek, Peshastin Creek;

  Methow basin—Gold Creek, Libby Creek, Beaver Creek, Twisp River, Early Winters Creek, Lost River
- **Bull trout:** Wenatchee basin—Ingalls Creek, Chiwaukum Creek, Nason Creek, Chiwawa River, Chickamin Creek, Rock Creek;

Methow basin—Foggy Dew Creek, Crater Creek, Buttermilk Creek, Reynolds Creek, Twisp River, Blue Buck Creek, Lake Creek, Goat Creek, Early Winters Creek, Cedar Creek, West Fork Methow River, Monument Creek, Lost River

Although potential acclimation and release sites have not been identified in the Entiat basin, streams most likely to be targeted for coho reintroduction (should the long-term vision be implemented) would be the Entiat River, Brennegan Creek, and the Mad River. Sensitive species known to occupy these streams are listed below (USDA 1996).

- **Spring chinook:** Lower Entiat, Lower-Mid Entiat (stronghold*), Upper-Mid Entiat, Lower and Middle Mad rivers.
- **Steelhead:** All of the Entiat except Upper; and Middle Mad rivers.
- **Bull trout:** Lower Entiat, Lower-Mid Entiat, Upper-Mid Entiat (stronghold*), all Mad River (stronghold).
- **Late-run chinook:** Lower Entiat, Lower-Mid Entiat (stronghold*), Upper-Mid Entiat.
- **Sockeye:** Lower Entiat, Lower-Mid Entiat (stronghold*) (most likely wanderers from Okanogan population and considered part of that ESU [NMFS et al. 1998]).

* (as indicated in USDA FS 1996)

In addition, rainbow trout are found throughout the basin (including in Brennegan Creek, the third potential target stream); and cutthroat trout are found in all reaches of the Entiat and Mad rivers.

Table 4 shows the temporal overlap of life-history stages for species in these basins.

2.2.2) Annual spawning abundance for as many years as available: There is no known natural coho spawning in mid-Columbia basins.

2.2.3) Progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for as many brood years as available.

Table 1 (section 1.9) lists assumptions about certain survival and mortality rates observed or expected for this project.

2.2.4) Annual proportions of hatchery and natural fish on natural spawning grounds for as many years as possible: See Table 1 (section 1.9).

2.2.5) Status of natural population relative to critical and viable population thresholds: There is no natural population of coho salmon in these basins.

**Table 4. Life History Timing of Mid-Columbia Salmonids**

Insert Table 4 here (Table 7 from EA)

## 2.3) Relationship to harvest objectives

The long-term vision of the Tribes is to re-establish coho in sufficient numbers to provide significant harvest opportunities for Tribal and non-Tribal fishers in mid-Columbia tributary basins. For the period covered by this plan, however, the numbers of returning coho are not expected to be high enough to justify establishing a fishery in the mid-Columbia basins. Harvest levels of all existing Columbia River and ocean fisheries (Tribal and non-Tribal) could be adjusted once escapement goals for upriver coho are agreed to by all parties.

### 2.3.1) Description of existing fisheries

Upper Columbia River coho are subject to the following fisheries: ocean commercial troll fisheries, ocean recreational fisheries, Buoy 10 recreational fisheries, lower Columbia River commercial fisheries, lower Columbia River recreational fisheries, Zone 6 (Bonneville to McNary) Treaty Indian commercial fisheries, and above Bonneville Dam recreational fisheries.

Ocean fishing seasons and regulations are adopted annually by the Pacific Fisheries Management Council (PFMC). Ocean fisheries for coho are managed on a quota or total allowable catch basis pursuant to objectives in the PFMC's fishery management plan. Because of weak stock constraints, non-Indian commercial troll fisheries targeting coho (especially in areas where Columbia River coho are present) have been very limited since 1994. However, recreational coho fisheries have continued. In 1998, the PFMC adopted the first selective fisheries for coho in recreational fisheries off the mouth of the Columbia River. The states of Washington and Oregon also adopted selective fishery regulations for the popular Buoy 10 fishery in the Columbia River estuary. Washington and Oregon began mass marking (removing adipose fins from) hatchery coho in 1995. Selective fishery regulations required all retained coho to have a healed adipose fin clip. These fisheries generally begin in early August and run through late August to late September.

Mainstem Columbia River sport fisheries typically begin August 1, but generally target chinook and steelhead with minimal harvest of coho. Mainstem commercial fisheries in the lower Columbia River generally occur from mid-September through October. Treaty commercial fisheries in Zone 6 generally occur from late August through early October. Some coho (mostly late stock) are harvested in the later part of this fishery.

Fisheries may also occur in tributary areas. The Yakama Nation regularly conducts fisheries in the Yakima and Klickitat rivers in the late fall (October to December) targeting fall chinook and coho. The state of Washington also reinitiated a late fall fishery in the Yakima River in 1998 which is expected to continue. The Yakama Nation and/or state of Washington may choose to adopt similar late fall fishing seasons in upper Columbia areas once coho populations are reestablished to levels which would support a fishery; however, adult returns are not expected in sufficient numbers in the next 5-6 years to support a coho fishery in the target basins.

### 2.3.2) Expected harvest rates

Upper Columbia River coho adult returns are a sub-component of the Columbia upriver early stock coho return. Average harvest rates in non-Indian ocean and Columbia River fisheries for marked and unmarked Columbia upriver coho can be estimated using data provided in 1999 by the joint staffs of the Oregon and Washington departments of fish and wildlife (ODFW and WDFW). Data include release locations, marking levels, and 1998 selective fishery surveys.

Total harvest rates for upriver early coho average about 20% in ocean fisheries and 15% in mainstem Columbia River fisheries for a total harvest rate of about 35% on upriver early-stock coho. Harvest rates on marked (hatchery-released coho) are estimated to average about 30% in ocean fisheries and 20% in river fisheries for a total harvest rate on marked upriver early-stock coho of 50%. Harvest rates on unmarked (naturally released coho) are estimated to average about 12% in ocean fisheries and 11% in river fisheries for a total harvest rate on unmarked upriver early-stock coho of 23%. Currently non-Indian fisheries are managed to assure that at least 50% of the total upriver coho return (combined early and late stocks) escapes above Bonneville Dam.

Harvest rates of 10% or more on upriver coho stocks in combined Treaty Indian Zone 6 and tributary area fisheries could also occur. Harvest rates for all ocean and Columbia River fisheries (Treaty Indian and non-Indian fisheries) would adjust annually to be consistent with escapement goals for upriver coho once these goals are established and agreed upon by all the parties.

2.4) Relationship to habitat protection and recovery strategies.

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

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

Mid-Columbia coho salmon populations were decimated in the early 1900s by impassable dams 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 and fire management also contributed to destruction of salmon habitat.

Indigenous natural coho salmon no longer occupy 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 has not exceeded 1,300 coho since 1974 (WDFW/ODFW 1998). Since 1988, adult counts at Priest Rapids Dam have averaged only 16 coho, probably a result of releases from Turtle Rock Hatchery, which annually released about 600,000 coho smolts, until the program was terminated in 1994 (WDFW/ODFW 1995).

For several reasons, self sustaining 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 because of the number of dams and reservoirs through which they had to pass, leading to deaths from turbines, 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 PUD. The coho program was terminated because continual disease problems during the summer months required that the fish be constantly medicated. Unhealthy fish were released, which resulted in poor adult returns. 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.

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, mining has ended, and improvements in grazing practices have been made. A few specific examples of projects designed to improve conditions for fish in the target basins include:

Wenatchee Basin:

- improvements in fish passage at Tumwater and Dryden dams
- fish screens at Dryden Dam
- replacement of Chumstick Creek culvert

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. The recent 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.

2.5) Ecological interactions

Because many negative impacts of ecological interactions among species are density-dependent, the estimated carrying capacities of selected Mid-Columbia rivers and streams (if the habitat were to be "fully seeded") are shown in Table 5 as an aid to assessing the near term risks to other species. These estimates should be considered minimum for the basins, because they include only the main tributaries listed. In addition, there will be few, if any, over-wintering coho juveniles in these areas for the period of this plan.

The method used to calculate the carrying capacities is presented below.

## Method for Estimating Carrying Capacities

We compiled and summarized existing physical habitat inventory for the largest tributaries of the Wenatchee (Little Wenatchee, Nason Creek, White and Chiwawa rivers) and Methow (upper Methow, Chewuch and Twisp rivers) sub-basins. We did not develop estimates for smaller tributaries within these watersheds, so these estimates likely underestimate the potential available habitat and therefore the coho smolt carrying capacity within these watersheds. The U.S. Forest Service collected the data using the Hankin and Reeves (1988) methodology. For each tributary of interest, we tabulated the total stream area by habitat type (pool, glide, riffle, side channel, etc.). We used summer stocking densities presented by Reeves et al. (1989) to estimate the total potential summer standing crop of coho parr within each tributary. In order to estimate adult coho escapement required to fully seed the habitat at these levels, we needed estimates of adult coho sex ratio (D. Dysart, personal communication), life-stage-specific survival rates, and coho fecundity (Yakama Nation, unpublished data). Life-stage-specific survival rates (L. Lestelle personal communication) were partitioned into the egg-to-emergent fry, emergent fry colonization, and summer and winter parr survival. These survival rates are considered to be near optimal and therefore likely overestimate survival within these watersheds.

Female escapement (FE) and adult coho escapement (AE) required to achieve coho smolt carrying capacities (CC) were estimated using the following formula:

$$FE = \frac{CC}{F \times EFS \times FCS \times SPS \times WPS}$$

$$AE = \frac{FE}{SR}$$

Where F = average fecundity (2750 eggs/female)
EFS = egg-to-emergent fry survival (60%),
FCS = emergent fry colonization survival (80%),
SPS = summer parr survival (75%),
WPS = winter parr survival to spring smolt (50%), and
SR = female sex ratio (percent females: 50%)

**Assumptions**

- Methodology presented by Reeves et al. (1989) accurately estimates potential natural coho summer parr stocking densities within these watersheds.
- Fecundity, sex ratios, and survival rates are realistic.
- Coho survival at life stages earlier than spring smolt will not limit spring smolt production.

**Table 5. Estimated Carrying Capacity of Selected Mid-Columbia Basins**

| **Wenatchee** | **Summer Natural Stocking Capacity** | **Spring Smolt Natural Stocking Capacity** | **Female Escapement** | **Adult Escapement** |
|---|---|---|---|---|
| **Nason Creek** | 845,676 | 422,838 | 427 | 854 |
| **White River** | 681,656 | 340,828 | 344 | 689 |
| **Chiwawa River** | 887,348 | 443,674 | 448 | 896 |
| **Little Wenatchee** | 157,592 | 78,796 | 80 | 159 |
| **Total** | 2,572,272 | 1,286,136 | 1,299 | 2,598 |

| **Methow** | **Summer Natural Stocking Capacity** | **Spring Smolt Natural Stocking Capacity** | **Female Escapement** | **Adult Escapement** |
|---|---|---|---|---|
| **Methow River** | 2,638,180 | 1,319,090 | 1,332 | 2,665 |
| **Chewuch River** | 1,119,008 | 559,504 | 565 | 1,130 |
| **Twisp River** | 709,108 | 354,554 | 358 | 716 |
| | 4,466,296 | 2,233,148 | 2,256 | 4,511 |

**Assumptions**

1 Reeves et al. (1989) accurately estimates natural coho summer parr stocking densities
2. Fecundity = 2750 eggs/female
3. Egg to fry survival = 60%
4. Fry dispersal survival = 80%
5. Fry to summer parr survival = 75%
6. Over-winter survival = 50%
7. Adult sex ratio (female) = 50%
8. Estimates are minimum because they include only the mainstem tributaries listed

**Sources**

1. Physical habitat inventory for each tributary Hankin and Reeves (1988) collected by USFS
2. Sex ratio (Doug Dysart, personal communication)
3. Survival rates (Larry Lestelle, personal communication)
4. Fecundity estimates (Yakama Nation, unpublished information)
5. Coho summer stocking density estimates (Reeves et al. 1989)

2.5.1) Species that could negatively impact the success of the program:

Historically, bull trout and northern pikeminnow (*Ptychocheilus oregonensis*) were probably the most significant fish predators within the Methow, Wenatchee, and Entiat sub-basins. Today bull trout abundance within these three basins is low and would not be expected to limit project success. Although little information exists about the abundance of northern pikeminnow for the mainstem Methow, Wenatchee or Entiat sub-basins, the abundance of this species is expected to be relatively low and probably accounts for a small portion of juvenile mortality occurring in freshwater. Several non-endemic centrarchid and ictalurid species are present in the mainstem Columbia River, but the potential impact of these species on project success is unknown.

Project activities are not expected to appreciably change the functional or numeric response or the long-term abundance of predators within the Methow, Wenatchee, or Entiat sub-basin, or in the mainstem Columbia River. This is due to the relatively large number of all species of hatchery fish that currently rear and/or migrate within these areas.

2.5.2) Species that could be negatively impacted by this program:

Ecological interaction risks include direct predation by coho on other species of concern, indirect predation effects, competition between coho and other species, and transfer of disease.

In this section, examination of ecological interactions focuses on those that could occur within the Wenatchee and Methow river basins, as these basins are where releases are most likely during the time period of this plan. However, the nature of the impacts in the Entiat sub-basin, should coho be released there, would, for the most part, be similar to those expected in the Methow and Wenatchee. The species that could potentially be adversely affected by the project would be the same for $F_2$ and hatchery fish.

Species of concern within each basin are listed in section 2.2.1.

### *Predation*

Predation effects can be direct or indirect and are related to the release of hatchery smolts into the natural environment. For this analysis, direct predation refers to coho consumption of another species. Indirect predation—either “chumming” or “shielding”—refers to either the increased or reduced levels of predation on other species as a result of the release of large numbers of coho smolts. “Chumming” refers to the response of predators attracted by the release of a group of hatchery smolts, which reduces the survival of co-mingling wild smolts. “Shielding” occurs when the predator base is overwhelmed by the presence of large numbers of hatchery smolts, thus increasing the survival rate of wild smolts.

Although the impact of predation on an individual prey animal is unambiguous, the impact on a population of prey is not. Depending on the abundance and productivity of the prey population, the impact of predation on the persistence and productivity of the prey population may range from negligible to serious. The relative impacts of predation on a prey population are determined by partitioning the sources of freshwater mortality and comparing the relative magnitude of each source. Size of hatchery fish appears to be relevant to whether or not the supplemented species will prey significantly on other fish species (Hillman and Mullan 1989).

Coho salmon have been shown to prey on several species of salmonids including sockeye salmon (*O. nerka)* fry (Ricker 1941; Foerster and Ricker 1953; Ruggerone and Rogers 1992); pink (*O. gorbuscha*) and chum (*O. keta*) salmon fry (Hunter 1959); spring chinook fry (Dunnigan and Hubble 1998); and fall chinook salmon (Thompson 1966; Dunnigan and Hubble 1998).

In the mid-Columbia basins, the species most at risk for direct predation is spring chinook; sockeye salmon could be at risk in certain parts of the Wenatchee basin, especially downstream of the Two Rivers acclimation site in Lake Wenatchee. Spring chinook spawn in higher reaches of the watershed and emerge from the gravel later than summer/fall chinook, due to the colder water; and young-of-the-year spring chinook are smaller than coho when coho begin migrating. Sockeye emerge at about the same time as coho and rear in habitat proposed for coho acclimation in the Wenatchee basin. Summer/fall chinook spawn lower in the watershed, and emerge sooner than coho. They are smaller than coho, and there has been concern that summer/fall chinook would be prey for coho. However, studies in the Yakima basin, as discussed below, have shown that coho predation on fall chinook is very low. Most resident trout and steelhead are not considered to be at risk because these species generally emerge from the gravel after coho have migrated downstream, or spawn in upper reaches of tributaries (i.e., bull trout). See section 2.2.1.

The potential for impact to each listed or sensitive species is discussed in more detail below.

**Coho Salmon Predation on Fall Chinook**

Studies of coho predation on fall chinook were conducted in the Yakima basin at the Chandler Juvenile Monitoring Facility (CJMF) in 1997 and 1998. They indicate that coho predation on fall chinook was 0.1% of all fall chinook smolts produced above Prosser, or the equivalent of 3.7 fall chinook adults. However, researchers believe that the artificial conditions associated with CJMF create abnormal opportunities for predation (the fish are at unnaturally high densities in unnatural habitat with no cover against predators, and fish are potentially held several hours in the livebox before being examined) (Dunnigan and Hubble 1998).

Coho predation studies were also conducted in 1997 and 1998 in the open Yakima River (Dunnigan and Hubble 1998). There the observed rate of coho predation on fall chinook was zero: none of the coho sampled in either year contained remains of fall chinook. Calculations were then made, using two different methods, to estimate what total coho predation on fall chinook in the Yakima River might have been. Because the 1997 sample size was small, calculations made from it were not precise and the estimates ranged to absurd numbers. However, despite the small sample size, it seems likely that sampling reflected actual consumption rates in the river during the 1997 coho outmigration (Dunnigan and Hubble 1998). Conditions were not conducive for sight-feeding predators such as coho to be highly successful. Flows were extremely high and the water was turbid. Coho salmon migrated rapidly during this period (averaging 160 kilometers [100 miles] in 3 days) so the potential time for predation was limited. Predation rates on fall chinook by other sight-feeding predators such as smallmouth bass and northern pikeminnow were also relatively low during this period in 1997. It also seems highly unlikely that impacts in the river during 1997 would have been high given that coho predation at CJMF in 1997 was low and CJMF is perhaps the worst-case scenario for fall chinook predation (see above) (Dunnigan and Hubble 1998).

Sample sizes in 1998 allowed for more precise estimates of the total number of fall chinook consumed in the open river. They show that, given an observed predation rate of 0% and sample size of 462 coho, there was a 5% chance of observing a predation rate equivalent to the consumption of a total of no more than 349 smolts (or approximately 3.5 adult fall chinook) (Dunnigan and Hubble 1998).

**Coho Salmon Predation on Spring Chinook**

In 1998, the YN studied coho predation on spring chinook, analyzing the stomach contents of coho sampled at a rotary trap in the Easton reach of the upper Yakima River. Of an estimated 803,880 spring chinook fry in the study reach, researchers estimated coho consumed between 93 and 324 spring chinook fry, depending on which analysis model was used (Dunnigan and Hubble 1998). Using what appeared to be the more reliable model of gut evacuation rates presented by He and Wurtsbaugh (1993), researchers estimated that the total number of adult spring chinook equivalents consumed was no higher than approximately 7 adults (or 0.38% of the potential number of returning adults to the study reach) (Dunnigan and Hubble 1998). Researchers believe that this experiment represented the worst-case scenario to test for direct coho predation on spring chinook fry for the proposed release time because the Easton reach has the highest density of spring chinook redds in the upper Yakima basin; and during the period of the experiment, spring chinook fry were abundant and available as potential prey items for the coho smolts. The predation rate might have been higher if the coho had been released earlier, when the newly emergent spring chinook were smaller and probably more vulnerable to predation. However, the test accurately represented the time period during which future coho releases would be made (Dunnigan and Hubble 1998).

A similar study was repeated in 1999, with the exception that two separate releases of 24,850 coho smolts were made on May 17 and May 27. Investigators estimated that approximately 140,000 spring chinook fry were present during the study. Observed predation rates of spring chinook fry by coho smolts was zero (YN, unpublished data). Given an observed predation rate of 0% and sample size of 1757 coho, there was a 5% chance of observing a predation rate equivalent to the consumption of between 201 and 702 spring chinook fry, depending on which analysis model was used. The density of spring chinook fry in the study reach in 1999 was more similar to densities of spring chinook fry in the mid-Columbia tributaries. Results from 1999 are therefore potentially more likely to represent ecological conditions in these tributaries than the results from the study conducted in the upper Yakima in 1998.

In 1997, YN snorkeling surveys in the Methow basin generally found emergent spring chinook fry in association with shallow (less than 12 inches), low-velocity backwater and spring brook channels, or close to large woody debris along shallow stream margins (Dunnigan and Hubble 1998). Wild coho juveniles progress through a series of preferred habitat types beginning with back eddies, then moving to log jams, undercut banks, open bank areas, and finally to fast water habitat (Lister and Genoe 1970). Dunnigan and Hubble's observations generally agree with Lister and Genoe's (1970), in that coho prefer deeper and faster water conditions than do spring chinook fry, so there is minimal spatial overlap and therefore limited opportunity for direct predation or competition. Overall, based on data collected to date by the YN, direct predation has not been shown to be a significant risk to spring or fall chinook. There is, however, some uncertainty because the results are limited and because the results are being applied to potential effects in a different basin. Because of this uncertainty, coho releases in mid-Columbia basins would be sized, based on the Yakima data initially, to minimize impacts to spring chinook.

Other factors will further limit the risk of coho predation on spring chinook. In the Wenatchee basin,

1) coho smolt releases would be below 70% of spring chinook redds;

2) most returning coho adults will be captured for brood stock; and

3) planned natural coho spawning will be below 100% of spring chinook redds.

In the Methow,

1) a large proportion of adult spring chinook are being collected for an adult-based supplementation program;
2) most coho adults would be collected for brood stock; and
3) experience has shown that coho adults that are not captured consistently return to their release site, which in the Methow will be at Winthrop Hatchery only (J. Dunnigan, YN, personal communication).

Consequently, the opportunities for predation by naturally spawning progeny of these released fish would be minimal.

Finally, as a further precaution, and to guide adaptive strategies, coho predation on spring chinook juveniles in the Wenatchee basin will be monitored to assess the relative level of risk to spring chinook. (See section 10.4.4). This study, though limited in its statistical power, is expected to signal the potential for risk to spring chinook. It would be undertaken in consultation with NMFS to ensure that there would be no jeopardy to the endangered spring chinook ESU (Evolutionarily Significant Unit).

**Coho Salmon Predation on Sockeye Salmon**

The risks of coho predation on sockeye salmon could be similar to spring chinook. Sockeye spawn upstream of most of the proposed release areas in the Wenatchee basin, but a significant number rear in Lake Wenatchee and would be there, at prey sizes, and at times when coho would be released from the Two Rivers acclimation site immediately upstream of the lake (see figure 2). Although not listed under ESA, sockeye in this area are considered a vulnerable species because they are one of only two populations remaining in the Columbia River system (the other is in Lake Osoyoos [Okanogan River]) (Ken MacDonald, USFS, personal communication, 1999). Coho released from the Two Rivers site (and the White River Side Channels, if used), could pose a risk to sockeye. Prior to release of coho from either of these two sites, YN would attempt to investigate the spatial and temporal distribution of juvenile sockeye within Lake Wenatchee, in order to assess the potential for spatial and temporal overlap of hatchery coho smolts during the hatchery coho smolt outmigration (see section 10.4.4). This work would likely be accomplished by beach seining and/or trawling in Lake Wenatchee. If coho releases go ahead, the risk would be monitored by implementing a predation study similar to that proposed for spring chinook, possibly using a WDFW screw trap at the Lake Wenatchee outfall, or beach seining or trawling in Lake Wenatchee. In addition, approximately 100 juvenile coho could be radio-tagged to determine their distribution in Lake Wenatchee and their potential overlap with sockeye (section 10.4.4).

Sockeye are considered to be introduced in the Entiat basin (USDA 1996), most likely wanderers from the Okanogan (NMFS et al. 1998).

**Coho Salmon Predation on Bull Trout**

Potential for coho predation on young-of-the-year bull trout would be limited due to the lack of geographic overlap between bull trout spawning and rearing areas in the Wenatchee and Methow basins and proposed coho acclimation and release sites (Table 3). All proposed acclimation sites in the Wenatchee and Methow are lacustrine-type habitats that generally are not used by juvenile bull trout.

One alternative coho acclimation site in the Wenatchee (White River Side Channels—Figure 2) is only 2.4 km (1.5 mi) downstream of bull trout spawning habitat, but it is not proposed for use during the period of this plan. In any event, bull trout tend to stay on the spawning grounds until they are large enough not to be a prey-sized item for coho smolts. Significant spatial overlap between the two species may occur in the long term if this site is ever used for coho acclimation and if coho return to spawn upstream of the acclimation site in significant numbers. Conversely, coho might also benefit bull trout in the long run as coho juveniles probably would become prey for adult bull trout.

Specific coho release sites have not been identified in the Entiat basin and studies are not proposed under this plan. If coho reintroduction is eventually initiated in the Entiat basin, two of the three target rivers (Entiat and Mad) contain bull trout (see section 2.2.1). In particular, the Mad River is considered a stronghold for bull trout by the USFS (USDA 1996). In the Entiat, the presumed spawning area for bull trout is within a mile of Entiat Falls (WDFW 1998). Downstream of the falls, which is a barrier to fish, lower gradients, higher temperatures and the presence of rainbow trout and chinook salmon suggest that the habitat may be unsuitable for bull trout spawning and initial rearing. In the Mad River, known spawning occurs in the upper middle reach, most above Cougar Creek (WDFW 1998). At this time, the potential for coho predation on bull trout in the Entiat basin is unknown but expected to be minimal, due to limited micro-habitat overlap and late emergence timing of juvenile bull trout.

In sum, predation of coho smolts on other species is expected to be low either because coho would be actively migrating downstream and therefore be moving quickly away from other species' rearing areas; because habitat overlap is minimal; because fish densities in the habitat are low; or because coho would be too small to prey on other species. While some risk to spring chinook needs to be imposed in order to study the potential for long-term risk to sensitive species, implementing the following mitigation measures as appropriate would minimize that risk:

- working with other fish managers to determine release sites and numbers that minimize risk but that also meet research objectives;
- releasing coho smolts in low densities;
- avoiding or delaying releases in habitat for sensitive species (except when the point of the research is to test coho predation on a specific species);
- releasing fish that more closely resemble sizes of wild coho, which tend to be smaller than hatchery fish[1];
- waiting until smolts are ready to actively migrate before releasing them; and
- monitoring predation and adapting feasibility studies and activities as necessary to minimize risks.

**Indirect Predation**

An indirect predation study was initiated in 1998 in the Yakima basin, but the results were inconclusive; the study results and experimental design were compromised due to river conditions. The impacts of indirect predation on wild salmonid smolt survival are being investigated in the Yakima basin in 1999 because the known avian and fish predators are very abundant in the lower Yakima River (below Prosser

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[1] Throughout the geographic range of coho salmon, length at smoltification is relatively consistent. Groot and Margolis (1991) reported that mean smolt size in yearling smolts ranged from 75 (Andersen and Narver 1975) to 122 mm fork length (McHenry 1981), and smolt size in Minter Creek, Washington ranged from 95-106 mm (Salo and Bayliff 1958).

Dam). Therefore, any impacts or benefits to wild smolts are most likely to be detected in an experiment conducted in the Yakima Basin. In other words, the Yakima probably presents a worst-case scenario for a potential impact (negative or positive) on wild salmonid survival. Fewer such predators are expected in the Wenatchee, Methow, or Entiat rivers.

The annual production of all state and Federal anadromous salmonid hatchery programs in the mid-Columbia region is approximately 10.2 million fish. The largest number of coho released during the period of this plan would represent an approximate 10% increase in the number of migrating salmonids in the region. This increase in production is unlikely to cause an increase in the functional or numeric response of either avian or fish predators in the area, and therefore impacts would be negligible.

### *Competition*

By definition, competition is a situation where the use of a common and limited environmental resource by two individuals or species causes the growth or survival of one individual or species to be reduced due to the shortage of this resource (Whittaker 1975). Direct competition for food and space between hatchery coho and other species can result in displacement of other fish into less preferred areas, which can potentially affect their growth and survival. For competition to have an adverse effect, the same limited resource must be used by more than one species. However, in some instances, competition for space and food may clearly alter patterns of microhabitat utilization while having no effect on productivity or viability (Spaulding et. al 1989). Indeed, the small-scale shifts in use of habitat niches may represent a significant benefit at the community level because environmental resources are used more efficiently (Nilsson 1966).

Juvenile coho salmon are known to be highly aggressive compared to other juvenile salmonids; thus they may compete with hatchery or naturally produced spring and summer/fall chinook, steelhead or rainbow trout, and resident fishes under certain conditions. For example, in a study conducted by Stein et al. (1972) in an artificial stream, coho socially dominated **fall chinook**, and fall chinook grew faster alone than with coho present. However, Lister and Genoe (1970) suggested that coho and fall chinook do not interact in the natural environment because of size-related differences in microhabitat selection. Coho salmon displaced **spring chinook** from preferred microhabitats in the Wenatchee River drainage but did not measurably affect their growth or survival (Spaulding et al. 1989). YN snorkeling surveys, as discussed under “Predation” above, showed that spring chinook and coho use different microhabitats (Dunnigan and Hubble 1998). Groot and Margolis (1991) also suggest that there is little habitat overlap between chinook and other salmonids including coho and sockeye, and that this habitat segregation provides a possible mechanism for reducing ecological interactions between the species.

Coho salmon have been shown to displace **cutthroat trout** from pool habitat into riffle habitat (Glova 1984; 1986; 1987; Bisson et al. 1988), even though both species preferred pool habitat in the absence of the other species. Tripp and McCart (1983) observed increasing negative impacts on cutthroat trout growth and survival as coho stocking densities increased.

Coho salmon and **rainbow/steelhead trout** are reported to share habitat along the western coast of North America from California to British Columbia (Frasier 1969; Hartman 1965; Johnston 1967; Burns 1971), with both species residing in freshwater for extended periods (Groot and Margolis 1991). However, the reported impacts of the presence of coho salmon on rainbow/steelhead trout are conflicting. Frasier (1969) observed that the survival rate of steelhead living sympatrically with coho salmon declined slightly as coho salmon densities increased. Coho were shown not to affect steelhead growth or habitat use in the Wenatchee River (steelhead occupied different microhabitats than salmon)

(Spaulding et al. 1989), and coho affected steelhead habitat use only to a small extent in another Washington stream (Allee 1974, 1981). However, Hartman (1965) concluded that strong habitat selection occurred in the spring and summer as a result of aggressive behaviors which were differentially directed by coho against steelhead in pools and by steelhead against coho in riffle habitats.

Coho salmon may have a competitive advantage over steelhead when they coexist. Juvenile coho salmon tend to emerge from the gravel earlier than steelhead, which allows them to establish territories and reach larger sizes than steelhead of the same age class (Berejikian 1995). Both laboratory and stream studies indicate that these species use different stream microhabitats. In the absence of coho salmon, steelhead use more of the water column and more pool habitat than when coho salmon are present (Hartman 1965, Allee 1974, Bugert and Bjorn 1991). In the presence of coho salmon, age-0 steelhead generally occupy the shallower, faster water of riffles and pool slopes, while coho salmon occupy the deeper water of pools (Bugert et al. 1991).

The segregation of these species appears to be both actively maintained and adaptive (Nilsson 1967). Their habitat segregation is consistent with inter-specific morphological variation: juvenile steelhead are more fusiform in shape than coho salmon and therefore better able to cope with higher water velocities (Bisson et al. 1988). These differences may reduce competition and facilitate partitioning of stream resources during low summer flows in streams when competition is most intense (Hard 1996). Because of their different morphology and habitat use, it is expected that stream characteristics will be primary determinants of interactions between these species: steelhead are expected to thrive better in the presence of coho salmon in streams with higher gradients and velocities, while steelhead are likely to diminish in streams with lower gradients and velocities (Hard 1996), Stelle 1996).

In 1998, the YN conducted field experiments to address the impacts of coho on the growth, abundance, and broad-scale geographical displacement of cutthroat and rainbow/steelhead trout. Researchers found no evidence that coho salmon influenced the abundance of cutthroat or rainbow trout when they compared the abundance of each species at sites where coho were stocked as well as where coho were not stocked. Coho abundance was largely related to stocking location. In addition, they found no evidence that coho affected the growth of cutthroat or rainbow trout when they compared the condition factor of each species in areas with and without coho (Dunnigan and Hubble 1998). These streams were generally characterized as relatively high gradient (2-5%), and ranged from second- to third-order streams.

Researchers were unable to locate any studies that investigated competitive interactions between **bull trout** and coho salmon. However, Underwood et al. (1992) investigated competitive interactions between hatchery steelhead and spring chinook juveniles and juvenile bull trout and concluded that competition between these species of hatchery fish and bull trout was not affecting abundance of bull trout or their use of microhabitats.

Little competitive interaction is expected between bull trout and coho smolts released in the mid-Columbia tributaries. Bull trout typically spawn in tributaries to the Wenatchee and Methow Rivers, or in the middle to upper reaches of the Entiat and Mad rivers. Spawn timing in these tributaries is most likely similar to general patterns observed for the species, is related to water temperature and generally occurs from September to October (Pratt 1992). Spawning and rearing of bull trout is thought to be primarily restricted to relatively pristine and cold streams, often within the headwater reaches (Rieman and McIntyre 1993). The geographic overlap of the juvenile bull trout rearing habitat and the coho migratory path would be minimal for coho releases because the majority of juvenile bull trout rearing habitat is believed to occur upstream of proposed (or likely, in the case of the Entiat River) coho acclimation sites. Sites proposed in the future for the Mad River would take into account known bull trout spawning locations. Any opportunity for interaction with bull trout juveniles would be further limited due to the migratory behavior of coho smolts.

No published studies were found that demonstrated complete competitive exclusion (species extirpation) by coho of any species.

Rapid out-migration of hatchery fish is believed to decrease the risk of ecological interaction to wild fish (Steward and Bjornn 1990). Recent studies in the Yakima basin found that, on average, actively migrating PIT-tagged coho smolts migrated approximately 30.1 km (18.8 miles) per day. The later the fish were released and the higher the volume of water flowing in the river, the faster the fish moved. Migration rates for coho released in the mid-Columbia tributaries are expected to be similar.

Competition that results directly from the release of hatchery coho smolts would likely be negligible due to the fact that coho would be actively migrating downstream and therefore have limited time to interact with individual fish species. Implementing the following mitigation measures (which are similar to those for minimizing predation) as appropriate would minimize the risk further:

- releasing coho smolts in low densities;
- avoiding or delaying releases in habitat for sensitive species (except when the point of the research is to test interactions with a specific species);
- releasing fish that more closely resemble sizes of wild coho, and
- waiting until smolts are ready to actively migrate before releasing them.

Coho will be released at levels consistent with project goals and that will produce naturalized coho at levels consistent with the carrying capacity of the natural habitat (Table 1). From the one million coho smolts proposed to be released into the Wenatchee River basin in the next few years, the expected number of returning adults would be approximately 1,000 coho. Fewer than half of these fish (454) will be allowed to spawn naturally; that number is approximately 7% of the historic population (6,000 - 7,000) in the basin. Current carrying capacity of tributaries in the mid-Columbia is likely lower than historically for all species of salmonids, and therefore, competition between two species might still be severe at densities below the historic carrying capacity of the habitat. However, while estimating current carrying capacity is imprecise at best, estimates provided in Table 5 suggest that the coho escapement proposed under this plan would not threaten other species.

If the project moves beyond feasibility studies and stocking or natural production significantly increases coho densities, the risk of adverse competition effects could increase. However, this would be unlikely within the timeframe of this plan, particularly because this plan incorporates only two life history cycles for coho; and because most returning coho adults would be collected as brood stock, so little natural production is expected during this period. Project participants expect to implement competition studies when numbers of naturally reproducing fish in the target basins are adequate to make such monitoring possible. It is expected that such studies would inform future decisions on release numbers and escapement goals for the long term. The project will rely on the monitoring program to effectively track abundance of naturally produced coho to determine when such studies will be logistically feasible. However, adults returning to these basins during the period of this plan are not expected in sufficient numbers to perform a meaningful study.

The spatial and annual incidence of residualism—the tendency of hatchery smolts to delay or avoid what otherwise would be normal outmigration in the spring—can be variable. When fish residualize, they become a part of the stream-reared fish community; they could potentially compete with resident fish for resources such as food and space and become potential predators (or prey). Residualism for coho has received little study. Recent experience with mid-Columbia coho releases, however, shows that when researchers remove the barriers at coho acclimation sites, the fish leave quickly. The incidence of coho residualism is expected to be minimized through acclimation and volitional releases and would be monitored in the basins through the proposed snorkeling surveys. Coho residualism is being studied in more detail in the Yakima basin. Whether the expected low residualism would continue with subsequent generations is more open to question and is expected to be the subject of future studies.

Straying of Lower Columbia fish back to their natal hatchery (thus increasing competition with local populations) is not expected to be an issue. Johnston et al. (1990) found that coho smolts acclimated for similar periods used in our study (up to six weeks) strayed back to their natal hatchery at a rate less than 0.001% when released from another river system.

Additionally, those coho that return to the Wenatchee and Methow basins and are not captured for brood stock are not expected to stray. The Yakima radio telemetry study in 1999 found that most hatchery fish returned very close to where they were acclimated and released (YN unpublished data). The same likely will be true for the other basins. So it is likely that returning coho to the Methow and Wenatchee basins that are not captured at the dams or that do not recruit back to the hatcheries will attempt to spawn near the acclimation sites, with minimal straying.

In sum, broad geographical displacement and reduced survival of other salmonid populations is not expected because:

1) coho released during the period covered by this plan are expected to migrate quickly and therefore limit the risk of competition with other species;
2) numbers of naturally spawning and rearing coho are expected to be well below the carrying capacity of the target streams;
3) returning adults are not expected to stray; and
4) the incidence of residualism and the numbers of naturally spawning fish would be monitored as carefully as technology allows, with release numbers modified if necessary to limit effects on sensitive species.

### *Transfer of Disease*

In general, artificially propagated fish are more prone to suffer from infectious diseases and parasites than their wild counterparts because they live under unnaturally crowded conditions where transmission of infectious agents is more efficient. In addition, hatchery rearing conditions and artificial diets may result in stress or nutritional imbalances that affect the physical condition of hatchery fish and their resistance to disease organisms. Among the normal suite of viral, bacterial, fungal and protozoan diseases known to infect salmonids in the Columbia River basin, the most important for coho are bacterial kidney disease (BKD) and coldwater disease. Concerns have been raised in the past that such diseases could be transmitted from hatchery-reared coho to wild fish of other species, thus increasing the incidence of infection among wild stocks.

The presumed risk is from two sources: first from hatchery coho smolts released into these locations and later, from adult fish returning to spawn. Upriver salmonids have been documented holding in the lower reaches of lower Columbia River tributaries where they may become exposed to infectious agents in that sub-basin and later show overt disease when they arrive at their upriver "home." Using genetic "fingerprinting" methods, researchers have documented the movement of strains of infectious agents within the Columbia River basin that are believed to be due to the migration of adult salmonids (Jim Winton, USFS, personal communication, 1999).

Because anadromous fish are already in the subject watersheds and because coho salmon are more resistant than steelhead or chinook salmon to the viral and bacterial pathogens of concern, the added risk from this source seems limited. Virtually all of the infectious diseases affecting hatchery coho salmon in the Columbia River basin are thought to occur in wild fish or in the natural environment. Most Columbia basins have or have had the major diseases of concern. For example, BKD is prevalent in essentially all hatchery and wild stocks of salmonids in the Columbia River basin (Jim Winton, USGS, personal communication, 1999).

A recent literature review by Miller et al. (1990) found that, in spite of the comparatively high incidence of disease among hatchery stocks, there is little evidence that diseases or parasites are routinely transmitted from hatchery to wild fish. This review found a number of studies indicating that bacterial kidney disease was *not* transmitted from infected hatchery outplants.

Coldwater disease is a significant risk to coho, particularly in the higher-elevation tributaries of the mid-Columbia basins. When water temperature in the hatchery falls below about 40° F, potentially lethal bacterial outbreaks can develop. The disease is treated using antibiotics, but it is not always effective. Because coho smolts and adults are less susceptible than other salmonids to this disease, and because the causative bacterium is already free-living in the watershed, other salmonids in the basin would not be placed at significantly greater risk from this disease due to the presence of coho.

Hatchery-reared fish are prone, through proximity, to contract a variety of fungal, protozoan, and helminth parasites that are relatively easy to diagnose, and chemical treatment of the holding water normally is effective. Any potential risk of transmitting most internal and external parasites of salmonid fish from hatchery to wild situations would be confined to the brief period during outmigration and would therefore be limited.

All phases of brood stock development, fish transfers, and smolt releases would follow the fish health policy documented in *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (IHOT 1995). Rigorous sanitation and use of disinfecting procedures combined with optimum husbandry, isolation and quarantine practices and a strong diagnostic and therapeutic program would minimize fish health concerns and reduce any potential for adverse effects from disease transmission by released coho to a low risk.

# SECTION 3. WATER SOURCE

There is no naturally spawning population of coho in mid-Columbia basins. For feasibility studies covered by this plan, existing hatcheries in the basins will be used to begin to establish a locally adapted brood stock. Winthrop National Fish Hatchery on the Methow River will be used for part of the brood stock development, but another hatchery will need to be found in or near the Wenatchee basin to meet brood stock development goals. Potential hatcheries are listed in section 1.4.

Water rights at Winthrop NFH total 29,930 gpm from the Methow River, Spring Branch Spring and two wells. Water use ranges from 8,528 to 27,686 gpm with the Methow River providing the majority of the flow. All rearing facilities are normally supplied with single-pass water; however, some serial re-use occurs in low-flow years (USFWS n.d.). The water supply at Winthrop NFH has frozen in the past. If that were to happen again, any coho at the hatchery would be released into the envirnoment.

# SECTION 4. FACILITIES

*Provide descriptions of the physical plants listed in this section, and three additional sets of information.*

*One, for programs that directly take listed fish for use as brood stock, provide detailed information on catastrophe management, including safeguards against equipment failure, water loss, flooding, disease transmission, or other events that could lead to a high mortality of listed fish.*

This issue does not apply to this project because coho are not listed in these basins.

*Two, describe any instance where construction or operation of the physical plant results in destruction or adverse modification of critical habitat designated for the listed species.*

Section 1.4 describes the locations of physical facilities required for this feasibility study. No new hatchery will be built for this project. Most facilities proposed for use already exist. The exceptions include some acclimation sites proposed in the Wenatchee basin. Impacts of construction and use of most proposed acclimation facilities in that basin are described in *Mid-Columbia Coho Reintroduction Feasibility Project, Final Environmental Assessment and Finding of No Significant Impact* (USDOE/BPA 1999); and in the Biological Assessment for Mid-Columbia Coho Reintroduction Feasibility Project, Chelan and Okanogan Counties, Washington (BPA 1999). The exceptions are the Chumstick Creek and Brender Creek sites. Specific locations for those acclimation and release sites have not been identified. Before those sites are developed, they would be subject to environmental review of site-specific impacts. However, at this point, no listed species are known to occupy those streams (see section 2.2.1).

*Three, describe any inconsistencies with standards and guidelines provided in any ESU-wide hatchery plan approved by the co-managers and NMFS.*

There is no ESU-wide hatchery plan in this area.

# SECTION 5. ORIGIN AND IDENTITY OF BROOD STOCK

5.1) Source

Because coho salmon have been extirpated in the Wenatchee and Methow basins, the research into the feasibility of reintroducing the species relies on development of a coho brood stock from lower Columbia River populations. No wild stock from the mid-Columbia exists to use, and wild stocks from other areas such as British Columbia currently are unavailable. The domesticated Lower Columbia River stock (which originated from the Toutle River stock, with recent infusions of Sandy River stock) will be used as initial brood stock. These fish would come as smolts from Willard, Cascade, and/or Eagle Creek hatcheries. In 2000, 700,000 smolts will come from Cascade and 400,000 from Eagle Creek. The numbers from each hatchery are negotiated annually, but the fish are from essentially the same stock regardless of which of the three lower river hatcheries they come from.

Beginning in 1999, adult coho returning to the mid-Columbia from earlier releases in the Methow basin were collected at Wells Dam and Winthrop NFH for use as brood stock. Other collection points will be added in later years (see section 1.4). Projected numbers of returning adults to be collected are shown in Table 1 (section 1.9). As adult returns increase, the project will rely less on the Lower River stock.

To maximize the potential for genetic variability and naturalization of the returning population, the project would initially use most of the returning fish for brood stock stock, collected throughout the run. Hatchery fish that return to the mid-Columbia will have gone through a substantial selection process to survive the long migration and the variety of obstacles they encounter in the journey, which is expected to enhance the trend toward local adaptation.

Ideally, adults collected at Wells Dam would be used to develop a Methow basin brood stock, and adults collected at Dryden or Tumwater dams would be used to develop a Wenatchee basin brood stock. However, the number of adults returning is likely to constrain the program from meeting the ideal for much longer than the scope of this plan. For this period, Methow returns are spawned at WNFH and their progeny would be released at Butcher Creek, which we consider the best coho habitat available at this point. We want to place as many progeny of returns to the mid-Columbia as possible in the best available natural environment in hopes of strengthening their potential for adaptation to mid-Columbia conditions. We believe that progeny of Methow returns will be the strongest of the mid-Columbia returns because they will have traveled further and passed more obstacles than the Wenatchee returns.

It has been suggested that coho from the Yakima brood stock program could be used to supplement returns to mid-Columbia basins to eliminate use of Lower River stock. The localized brood stock program in the Yakima will not require all returns; however the ability to capture a high proportion of the fish is limited at the current brood stock collection facility (logistically and by ESA concerns). In order to increase capture efficiency at Prosser right bank, we would be required to shut down either or both of the other ladders. This could displace fall chinook spawning below the dam since they are not likely to use the steep pass denil. Additionally, shutting ladders may also increase the incidental take of listed steelhead passing the dam at that time. Neither of these two scenarios is generally favorable. The Yakima program intends to eventually transition the brood stock collection facilities to Roza and Cowiche dams, which will allow for 100% capture efficiency of fish passing those locations. However, given the current spawning distribution, the workability of these two locations is unknown at this time, and will be evaluated in the future (potentially as soon as 2002). If it is logistically possible, given collection rates and adult returns, the program will strongly consider collecting brood stock in the Yakima for the mid-Columbia coho program.

5.2) Supporting information

5.2.1) History

The Lower Columbia River stock has been essentially a hatchery stock since the 1960s and is considered domesticated. The original source of the Lower River stock was the Toutle River stock. The LCR stock also has had recent infusions of Sandy River stock.

*Ninety Years of Salmon Culture at Little White Salmon National Fish Hatchery* (Nelson and Bodle, 1990, pp. 12-18), describes the early history of the Lower River stock. Tables 6 and 7 show more recent history.

> *Initial attempts to rear coho salmon with the native, late-running stock were made in 1919 and 1922. Attempts in 1930 and in the 1950s involved early-running stocks native to the Quinault, Quilcene, and Dungeness rivers of Puget Sound, Washington, as well as a native Toutle River stock. The Toutle River stock was considered responsible for establishing a successful run in 1956. In 1957 and 1958, eggs from Little White Salmon NFH were shipped to Willard NFH for incubation, after which the fry were returned for rearing. Additional eggs of the Toutle River stock were received from Eagle Creek NFH in 1962 and Bonneville State Fish Hatchery (SFH) in 1963.*
>
> *Initially, these fish were released in their first summer; later, they were usually released as yearlings in February or March. Fish reared at Little White Salmon NFH were also shipped to Spring Creek, Eagle Creek, Carson, and Willard NFHs for finishing and distribution; others were released in the Columbia, Snake, Klickitat, and John Day rivers…*
>
> *By 1965, a dependable run of Toutle River coho salmon stock was established… Increasingly larger numbers of eggs were moved to Willard NFH, until finally the Little White Salmon facility began serving its present function as an egg-taking station for Willard NFH. Eggs were also shipped to Entiat, Winthrop, Leavenworth, Carson, and Coleman NFHs; Washougal SFH; and [to other states and countries].*

**Table 6. Coho Genetic History at Eagle Creek Hatchery**

| | |
|---|---|
| Originally at hatchery beginning: | |
| BY '57 | 400,000 from Sandy River<br>200,000 from Little White Salmon NFH (Toutle) |
| BY '58 | 600,000 from Sandy River<br>467,000 from Big Creek |
| Since 1987 (released from ECNFH): | |
| BY '88 | 325,000 from Sandy River, released April '90 |
| BY '90 | 292,000 from Sandy River, released April '92 |
| BY '91 | 196,000 from Sandy River, released April '93 |
| BY '93 | 579,000 from Toutle River, released May '95 |

**Table 7. Willard NFH Coho Salmon Fish/Eggs Received From Other Hatcheries 1985-1999**

| Date | Number | Received From |
|---|---|---|
| 01/28/94 | 187,556 | Speelyai SFH, WA |
| 12/04/94 | 589,433 | Lower Kalama SFH, WA |
| 12/24/96 | 883,000 | Cascade SFH, OR |
| 02/19/97 | 886,413 | Bonneville SFH, OR |
| 03/17/97 | 948,592 | Klaskanine SFH, OR |
| 06/12/97 | 268,002 | Eagle Creek NFH, OR |

5.2.2) Annual size

Brood stock collection of mid-Columbia adults began in 1999 at Wells Dam and Winthrop NFH. Table 1 (section 1.9) shows numbers of fish collected from adult returns in 1999 and to be collected in future years in each basin. If, during the first few years of the project, too few adults return to maintain an effective population size, their numbers would be supplemented either by adding Lower River adults to the breeding pairs, by supplementing the next year's releases with Lower River smolts, or a combination of both.

5.2.3) Past and proposed level of natural fish in brood stock.

There is no natural population from which to collect brood stock, and brood stock will not be collected from naturally reproducing coho (in places such as Chumstick and Brender creeks).

5.2.4) Genetic or ecological differences

There are no natural stocks of coho in the target area. Genetic studies will monitor divergence of natural spawners from hatchery brood stock if the project is successful at improving adult returns (see section 10.4.3).

5.2.5) Reasons for choosing

The primary reason for choosing Lower River brood stock to begin with is that it is the closest stock available geographically and it is the only early stock in the Columbia River basin. For at least six years, the brood stock selection process would be entirely random. While the genetics monitoring program would study returning coho for traits associated with survival and adaptability, any proposal to select for certain traits in developing brood stock would be evaluated in future decision-making processes. See also section 5.1.

5.3) Unknowns

How well the Lower River stock will adapt to mid-Columbia basin conditions.

# SECTION 6. BROOD STOCK COLLECTION

6.1) Prioritized goals

- Minimize impacts to ESA species in terms of stress and induced mortality as a result of handling, impeding passage, increased fallback, or displaced spawning
- Collect brood stock randomly throughout the run
- Minimize impacts to returning coho in terms of stress and induced mortality as a result of handling, impeding passage, increased fallback, or displaced spawning
- Collect sufficient adult brood stock to maintain an effective population for each cultured broodyear.

6.2) Supporting information

6.2.1) Proposed number of each sex: See Table 1 (section 1.9).

6.2.2) Life-history stage to be collected (e.g., eggs, adults, etc.): Adults, including jacks.

6.2.3) Collection or sampling design

**Location:** Wells Dam and Winthrop NFH for Methow fish; Leavenworth Hatchery or Tumwater or Dryden dams for Wenatchee fish.

**Time:** September 15 - November 7 at all locations.

**Collection Protocols and Impacts:**

<u>**Methow Basin:**</u>

- <u>Wells Dam:</u> Beginning in fall of 1999, coho adults returning to the Methow basin were trapped at Wells Dam on the Columbia River. The dam is equipped with traps to collect adult fish. The traps are currently being operated by WDFW to collect steelhead adults, which would be returning at the same time as coho. The current steelhead protocol is to operate the trap for 3 days a week. We will request that after 1999, operations be increased to 4 days a week.

Listed species of fish that could be affected during brood stock collection are bull trout and steelhead.

Peak steelhead upmigration occurs in September and October, and extends from August through November (L. Brown, WDFW, personal communication, 1999). Wild steelhead adults destined for the Methow basin overwinter in the Wells pool on the Columbia River and spawn in April and May. There is an overlap in adult steelhead and adult coho migration timing past the upper mainstem projects when coho would be collected for brood stock. This overlap will be most prevalent in late October and extend into November.

The expected take of steelhead at Wells Dam during coho brood stock collection between September 15 and November 7 is based on the 10 year average (1988-1998) passage timing of steelhead (hatchery and wild) at Wells Dam. During that period 45.96% of the steelhead passing Wells Dam for the calendar year passed during the period which the trap will be operated. We expect that the trap will be approximately 29% efficient if it is operated 4 days per week, 24 hours per day, during the period. Thus, we assume that between September 15 and November 7, the trap may encounter 13.13% of the steelhead passing Wells Dam during the period of trap operation. Based upon average steelhead returns for the period 1988-1998, we expect to handle approximately 578 steelhead. If we examine recent returns (1998-1999) of wild steelhead, the incidental handling will equal 108 wild steelhead.

The trap will be operated independently of this project to collect steelhead for brood stock. Thus this project will subject listed fish to only one day per week of additional trap operation during the September 15 – November 7 period. This is an additional take of approximately 3.2 % over the existing level.

Adult bull trout distribution in the mainstem Columbia River near Wells Dam is unknown. However, in recent years, no bull trout have been observed via video monitoring at Wells Dam between September 15 and November 7 (R. Klinge, Douglas County Public Utility District, personal communication), probably due to temperature constraints in the mainstem Columbia River during that period. We do not anticipate handling any bull trout at Wells Dam during coho broodstock collection.

Any listed fish caught in the trap will be released immediately.

- Winthrop NFH: Coho would swim directly into the hatchery, so listed species would not be affected. Because this is the only release site for coho smolts in the Methow basin, the coho are expected to be well-imprinted on the hatchery, resulting in good collection rates.

**Wenatchee Basin:**

- Leavenworth NFH: Coho would be trapped at the base of the old channel just below the hatchery. There is a very low potential to trap bull trout and steelhead while collecting coho brood stock. Steelhead in Icicle Creek are thought to be remnants of an old USFWS program. An average of 15-20 steelhead adults return per spawning season, most during March and April. The odds of catching one in the coho traps in the fall are extremely low (D. Carie, personal communication, 12/10/99). Bull trout spawn in the fall, but earlier than coho. The potential for catching one in a trap during the coho brood stock collection period is greater than for steelhead, but still low. The trap will be checked daily and any listed species released immediately.

- Tumwater Dam: Traps at the dam would be operated 16 hours a day, 7 days a week for the collection period and would be manned full-time. Ladder and trap would be closed 8 hours a day (nighttime) to allow 100% capture.

  Video monitoring at Tumwater Dam up through 1999 ends in September. However, a steelhead radio telemetry study conducted in 1999 by WDFW tagged steelhead at Priest Rapids Dam. A total of 73 of those fish entered the Wenatchee River. A total of 18 steelhead (24.7%) were holding between Tumwater Dam and Lake Wenatchee (R. McDonald, Chelan County PUD, personal communication) by October 26, 1999. If we assume this is the passage rate of Wenatchee River steelhead at Tumwater Dam, then based on the Wenatchee steelhead escapement (Rock Island minus Rocky Reach counts), we could expect to handle approximately 260 steelhead between September 15 and November 7.

  This analysis is supported by data from a trap at Tumwater operated by WDFW from August 1 through November 19. The trap collects steelhead for a broodstock program. The trap is currently operated 3 days a week for 8 hours a day. The trap operators observed most steelhead passing the dam in August. Given their catch rate for September-October (the bulk of the period the coho program proposes to run the trap), then 308 steelhead passed during the period. These numbers are very similar to numbers estimated from the radio telemetry study and also indicate that the coho collection program would result in additional handling of about 260 steelhead each year, or about 36.7% of the steelhead passing Tumwater Dam between August 1 and November 19.

  Very little is currently known about the spatial and temporal distribution of bull trout in the Wenatchee basin. Bull trout typically require cold water, with spawning in the Wenatchee basin generally restricted to tributaries (L. Brown, personal communication). Bull trout are fall spawners, typically in September and October for most populations (Pratt 1992). Operation of the trap during the period of bull trout spawning is therefore not likely to impact seasonal movement of bull trout, since most spawning individuals likely will be spawning in tributaries during this period.

  Any listed fish caught in the traps would be removed and released immediately.

- Dryden Dam: This is the lowest-priority site for collecting brood stock. Because it is a low-head dam, fish can jump over it. In addition, there is a trap only on the right-bank ladder, so the fish could get past the trap in a number of ways. The trap would be operated 16 hours a day, 7 days a week, but would be checked only twice a day. As a result, steelhead and bull trout could be trapped for 4-6 hours, resulting in a higher risk of mortality than at Tumwater Dam, where any listed fish would be removed and released immediately.

**Sources of bias:** The sources of bias are low at the hatchery and at Tumwater, and Wells dams and at Winthrop and Leavenworth hatcheries. The sources of bias at Dryden are unknown. Potential sources of bias may include fish size and ladder efficiency particularly with regard to river discharge.

6.2.4) Identity

The project will begin marking all hatchery fish to distinguish them from any naturally produced fish that may return in future years. Marks will be coded wire tags. See section 10.1.

6.2.5) Holding

Fish will be held until ripe and then spawned. Jacks (2-year-old males) will be randomly collected during brood stock collection in the relative proportion that they occur in the run and incorporated into the mating schemes.

6.2.6) Disposition of carcasses

Carcasses of any returned spawned adult fish would be disposed of seasonally. Most hatcheries make specific disposal arrangements annually. Depending on a particular hatchery's practices, fish carcasses might also be incorporated into local composting programs or used as fertilizer, rather than disposed of by conventional means.

Fish carcasses also could be left in or returned to the river. Adding carcasses can benefit some aquatic species by increasing the nutrient levels in streams, and perhaps bears, which feed on spawned fish. However, fish to be spawned are injected with an anti-bacterium to keep them disease-free, so care would need to be taken to keep injected, diseased carcasses out of any stream.

6.3) Unknowns

Brood stock collection sites in the Wenatchee basin; value/efficiency/impacts of Dryden Dam for brood stock collection; number of returning adults available for collection; disposition of carcasses.

# SECTION 7. MATING

*Use standards and guidelines provided in any ESU-wide hatchery plan, or other regionally accepted protocols (e.g. IHOT) approved by the co-managers and NMFS. Explain and justify any deviations.*

7.1) Selection method: Spawners would be chosen randomly over the whole run.

7.2) Males: Eggs would be fertilized with more than one male whenever possible. Coho are not repeat spawners.

7.3) Fertilization: IHOT policies would be followed (IHOT 1995, p. 69).

7.4) Cryopreserved gametes: Cryopreserved gametes would be used only if out-of-basin stocks are used.

7.5) Unknowns: None.

# SECTION 8. INCUBATION AND REARING

Incubation and rearing of coho to smolts initially is being done in Lower Columbia River hatcheries. The smolts are then trucked to mid-Columbia acclimation sites. This process is expected to continue for several years until the locally adapted brood stock produces enough smolts to maintain an effective population size.

Beginning in 1999, incubation and rearing of eggs and juveniles from adults returning to the mid-Columbia will be done at Winthrop hatchery. As stated in section 1.4, additional capacity will need to be found for incubation and early rearing of part of each brood year's production.

Physical characteristics of the rearing environment and fish growth and health in those environments depend on the hatchery. All hatcheries currently involved in this project use appropriate IHOT protocols and standards, including those for health and disease monitoring.

Information in sections 8.1 - 8.3 comes from the 1995(b) IHOT document: *IHOT – Operations Plans for Anadromous Fish Production Facilities in the Columbia River Basin: Volume III – Washington, Pages 479-489.* Most of the rest comes from the Winthrop Hatchery Plan (USFWS n.d.).

8.1) Number of eggs taken and survival objective to ponding.

The number of eggs taken each year is shown in Table 1 (section 1.9). Expected survival to ponding is 90-95% (egg to fry).

8.2) Loading density

Winthrop NFH uses Marisource stack incubators with 6-8,000 per incubator (IHOT). Table 8 shows incubation and rearing facilities at Winthrop NFH.

**Table 8. Rearing Facilities at Winthrop National Fish Hatchery**

| Unit Type | Unit Length (ft) | Unit Width (ft) | Unit Depth (ft) | Unit Volume (cu ft) | Number Units | Total Volume (cu ft) | Construction Material |
|---|---|---|---|---|---|---|---|
| Brood Ponds | 80 | 40 | 6 | 19,200 | 2 | 38,400 | Concrete |
| Marisource Incubators | | | | | 42 | | Fiberglass |
| Raceways | 80 | 8 | | 1,300 | 30 | 39,000 | Concrete |
| Foster Lucas Raceways | 76 | 17 | | 2,200 | 16 | 35,200 | Concrete |
| Raceways | 102 | 12 | | 2,200 | 16 | 35,200 | Concrete |
| Starter Tanks | 16 | 3 | | 120 | 34 | 4,080 | Fiberglass |
| Troughs | 16 | 1.33 | 1 | 21 | 8 | 168 | Concrete |

Pond management strategies (e.g., density Index and Flow Index) are used to help optimize the quality of the aquatic environment and minimize fish stress which can induce infectious and noninfectious diseases. For example, the Density Index is used to estimate the maximum number of fish (of a given length) that can occupy a rearing unit based on the rearing unit's size. The Flow index is used to estimate the rearing unit's carrying capacity based on water flows.

8.3) Influent and effluent gas concentration

The following parameters are currently monitored at Winthrop NFH:

- *Total Suspended Solids (TSS)* — 1 to 2 times per month on composite effluent, maximum effluent and influent samples. Once per month on pollution abatement pond influent and effluent samples.
- *Settleable solids (SS)* — 1 to 2 times per month on effluent and influent samples. Once per week on pollution abatement influent and effluent samples.
- *In-hatchery Water Temperatures* — maximum and minimum daily.
- *In-hatchery Dissolved Oxygen* — as required by stream flow and weather conditions

8.4) Ponding

Ponding will occur after complete button up (approximately 1375 temperature units). At ponding the coho will be approximately 1100 fish per pound and 4 centimeters in length. Ponding will occur in February (Joe Blodgett, YN, personal communication).

8.5) Fish Health Monitoring

Health monitoring activities that normally take place at Winthrop NFH include the following:

- On at least a monthly basis, both healthy and clinically diseased fish from each fish lot are given a health exam. The sample includes a minimum of 60 fish per lot.
- At spawning, a minimum of 60 ovarian fluids and 60 kidney/spleens are examined for viral pathogens from each species.
- Prior to transfer or release, fish are given a health exam. This exam may be in conjunction with the routine monthly visit. This sample consists of a minimum of 60 fish per lot.
- Whenever abnormal behavior or mortality is observed, the fish health specialist will examine the affected fish, make a diagnosis and recommend the appropriate remedial or preventative measures.
- Reporting and control of specific fish pathogens are conducted in accordance with the Co-Managers Fish Disease Control Policy and the USFWS Fish Health Policy and Implementation Guidelines.

8.6) Unknowns

The specific location of an additional existing hatchery with space for rearing.

# SECTION 9. RELEASE

9.1) Life history stage, size, and age at release.

Yearling smolts, between 75 and 122 mm fork length.

9.2) Life history stage, size and age of natural fish of same species in release area at time of release.

There are no natural fish of the same species in the mid-Columbia region. Monitoring of differences in hatchery bred fish and naturally reproduced fish will begin when sufficient numbers of naturalized fish begin to appear.

For this plan, a diminishing portion of all smolt releases would include Lower River coho smolts. It is expected that the numbers of adults returning to mid-Columbia basins will limit the numbers of their progeny, so that smolt releases in the Methow basin will continue to rely on Lower River smolts for the period of this plan. (See Table 1, section 1.9 and section 5.)

9.3) Dates of release and release protocols: Volitional releases, April 25 – May 30.

9.4) Location(s) of release: See Table 1, section 1.9.

9.5) Acclimation procedures.

Coho smolts would be acclimated away from the hatchery whenever possible, exposed to a semi-natural rearing environment to condition them for the natural environment. Juvenile coho are typically acclimated for 4-6 weeks prior to liberation, but depending on experimental objectives, could be acclimated from 2 to 8 weeks. During that period, fish culturists periodically feed the pre-smolts a predetermined amount of fish food pellets. This amount is calculated based on number and size of fish, and on water temperature. Typical fish culture activities include net maintenance, pond cleaning (if applicable), mortality assessments, and growth and fish health measurements.

9.6) Number of fish released

See Table 1, section 1.9.

9.7) Marks used to identify hatchery adults.

During the initial period of the feasibility phase of the program, adult returns of naturalized fish are expected to be low. As the program progresses and the abundance of naturalized coho increases, the program will mark hatchery fish with coded wire tags. See section 10.1.

9.8) Unknowns

Continued monitoring and evaluation of risks to other species (particularly listed species), survival, and brood stock requirements, could result in modification of currently proposed release numbers or locations.

# SECTION 10. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

Funding for this feasibility project is being provided by Bonneville Power Administration. The research is being implemented by the Yakama Nation, with assistance from other project participants.

10.1) Marking

The marking protocol to estimate the smolt-to-adult survival rate for coho juveniles released in the Wenatchee system is outlined in Table 9. Three mark groups will be identified: lower Columbia River transfers, Wenatchee progeny and Methow returning progeny. Each mark group will receive a differential CWT mark. All CWT marks will be snout tags and potentially alternate body tag locations (for example dorsal, anterior fins, cheek, etc.). Adipose fin clips will not accompany CWT marks. In 2001-2002, an unmarked group (Lower River returns) will be identified by subtraction (total returns collected minus marked returns). Beginning in 2003, all three mark groups of juvenile coho released in the Wenatchee will be marked with CWT. If it is determined that selective mating of in-basin vs. Lower River progeny will occur, then body tag locations will be added in order to non-lethally differentiate mark groups. All marks will be retrieved from spawned brood stock in order to estimate survival by group. Release locations are summarized in Table 1 of section 1.9.

The project will use PIT-tagged juveniles in order to parse out that portion of the smolt-to-adult mortality that is occurring in the freshwater migrant lifestage. Mark groups identified are lower Columbia River transfers, Wenatchee progeny and Methow returning progeny. Releases of PIT-tagged juvenile coho will occur in the Methow in 2000 (Table 10). This will give us two consecutive years of juvenile survival from the Methow for Lower River smolts. PIT tag releases from that point will occur approximately every third year (Table 10), unless mainstem passage conditions change, or other conditions occur to make us suspect survival rates may have changed.

PIT-tagged juveniles will be released in the Wenatchee River every year until at least 2005 (Table 11). The project will PIT tag and release 8,000 in 2001 in order to establish a baseline juvenile survival rate for Lower River coho smolts. Beginning in 2002-2003, the project will continue to release 8,000 coho juveniles from the Leavenworth side channel, in addition to 8,000 Wenatchee progeny from the natural production areas, in order to assess differences in juvenile survival between the two groups. During the period 2004-2005, the project will release 8,000 PIT-tagged Wenatchee progeny in the natural production areas to monitor changes in juvenile survival potentially related to the local adaptation process.

# Marking Protocol for the Mid-Columbia Coho Releases

**Table 9. CWT Marking Scheme for Mid-Columbia Coho Smolt Releases**

| Year | Lower River Transfers | Wenatchee Progeny | Methow Progeny |
|---|---|---|---|
| **2000** | 0% | N/A | N/A |
| **2001** | 0% | N/A | 100% (173,400) |
| **2002** | 0% | 100% (321,476) | N/A |
| **2003** | 100% (337,993) | 100% (612,335) | 100% (49,672) |
| **2004** | 100% (325,575) | 100% (612,335) | 100% (62,090) |
| **2005** | 100% (387,712) | 100% (550,198) | 100% (62,090) |

*Marks will be differential CWT (snout and potentially cheek) with no adipose fin clip.

**Table 10. PIT Tag Releases of Juvenile Coho from the Methow Basin**

| Smolt Year | Lower River Transfers |
|---|---|
| **2000** | 9000 |
| **2001** | 9000 |
| **2002** | 0 |
| **2003** | 0 |
| **2004** | 9000 |
| **2005** | 0 |

**Table 11. PIT Tag Releases of Juvenile Coho from the Wenatchee Basin**

| Smolt Year | Lower River Transfers | Wenatchee Progeny | Methow Progeny |
|---|---|---|---|
| **2000** | 8000 | N/A | N/A |
| **2001** | 8000 | N/A | 0 |
| **2002** | 8000 | 8000 | 0 |
| **2003** | 8000 | 8000 | 0 |
| **2004** | 0 | 8000 | 0 |
| **2005** | 0 | 8000 | 0 |

10.2) Genetic data: See section 5.2.

10.3) Survival and fecundity

10.3.1) Average fecundity.

It is expected that selective pressure will change many of the demographic characteristics of the Lower River coho stocks used as original brood stock for this program. Mean fecundity is one characteristic that may change due to selective pressure. We expect mean fecundity to increase for fish returning to the Wenatchee and Methow basins. Mean fecundity for the Yakima coho for the 1997 and 1998 brood years was approximately 2800 eggs/female. Mean fecundity for Eagle Creek returns average approximately 2400 eggs/female (D. Dysart, personal communication).

10.3.2) Survival

| | |
|---|---|
| a) Collection to spawning | 80% |
| b) Green eggs to eyed eggs | 50% |
| c) Eyed eggs to release | 85% |
| d) Release to adult, to include contribution to: | |
| (I) harvest | none in basin |
| (ii) hatchery brood stock | 50% |
| (iii) natural spawning | 50% |

10.4) Monitoring of performance indicators in Section 1.8

The studies listed below would be conducted in the Wenatchee, Methow and Yakima basins. Current proposals are that direct predation studies to assist in feasibility decisions will be conducted only in the Wenatchee basin, although some likely would be needed in the future in other basins. In addition, for the period of this plan, much of the genetics and adaptation program would be done in the Yakima basin. The monitoring capability in the Yakima is stronger. In addition, the Yakima program is ongoing and getting adult returns, which indicates that if lower Columbia River hatchery coho smolts can return in sufficient numbers to begin to develop a locally adapted brood stock in the Yakima basin, the same may be true in other mid-Columbia basins.

This plan also does not propose to study all potential ecological interactions between coho and other species in the Wenatchee, Methow, and Entiat basins. The Technical Team agreed that results of some studies being conducted in the Yakima basin would be applicable in other basins as well.

The following subsections describe the studies that will monitor feasibility project objectives and performance indicators described in sections 1.7 and 1.8.

10.4.1 Trends in survival of hatchery fish as measured by smolt-to-smolt (PIT tags) and smolt-to-adult (counts at dams/facilities) survival.

The smolt-to-smolt and smolt-to-adult survival rates for hatchery coho released in the Wenatchee and Methow basins would be studied in two ways.

- To estimate smolt-to-smolt survival to McNary Dam and other lower Columbia River mainstem projects, a portion of each release group (approximately 8,000 fish annually in the Wenatchee, 9,000 in the Methow) would be PIT-tagged (see section 10.1).

- Smolt-to-adult survival would be monitored based on Rock Island minus Rocky Reach and/or Tumwater Dam adult fish passage counts for the Wenatchee basin, and based on Wells Dam counts for the Methow basin.

10.4.2 Spatial distribution of returning adults in potential natural spawning areas.

These studies would help determine where and how many adults return to spawn with respect to the juvenile release sites. A key feasibility issue is if coho adults are spawning in areas considered suitable for coho.

Foot/boat redd surveys would be conducted in Chumstick and Brender creeks in the Wenatchee basin (where adults will be allowed to return to spawn naturally). Surveys would be conducted initially in stream reaches close to the smolt release sites, and would branch out from these release sites if redds are not located. Physical data would be recorded from a random sample of redds in each sub-basin. Researchers intend only to get a general sense of the spatial distribution of naturally spawning coho; they do not intend to try to count every redd.

10.4.3) Changes made by out-of-basin stock, using genetic monitoring of neutral allelic frequencies; and recording of such traits as fecundity, body morphometry, and maturation timing.

The genetics sampling and adaptation program would study:

- the naturalization of a hatchery fish stock (Lower Columbia River stock);
- allelic frequencies to determine the amount and rate of divergence of the mid-Columbia brood stock from the Lower River stock;
- physical traits and demographic information for introduced coho juveniles and adults and the contribution of those traits and other characteristics to survival.

The main goal driving the genetic and adaptation monitoring and evaluation is to determine the best implementation strategies that result in enhancing the natural production of coho salmon in mid-Columbia rivers. The genetic and adaptation M&E plan focuses on three major categories: 1) are there changes in the frequencies of neutral alleles in the population over time as the program and brood stock develop; 2) is there phenotypic divergence of localized coho and Lower River hatchery coho; and 3) are the introduced fish successful at producing progeny?

The following subsections describe the specific program for each of the genetic and adaptation monitoring studies listed above. As stated in the introduction to section 10.4, a few of these studies whose results would be considered transferable would be focused in the Yakima basin for the period of this plan.

*10.4.3.1 Assess changes in out-of-basin stock using genetic monitoring of allelic frequencies.*

The main opportunity of the genetics M&E program is to determine the rate and direction of divergence in neutral allele frequencies of the coho stocks that are used for reintroduction in mid-Columbia rivers.

A sound understanding of the genetic structure of the species of interest is a prerequisite to 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 actions. This can be done by measuring the frequencies of alleles at specific loci through time and in a series of populations (Allendorf and Phelps 1981; Utter 1991; Allendorf 1995). Such a database permits the determination of temporal (and mostly stochastic) and geographic (degree of isolation) variance components. A series of samples will be taken of naturalized coho spawning in the wild (Naches and Upper Yakima Rivers), as well as from the Yakima, Wenatchee, and Methow hatchery brood stocks. An additional number of samples will be used to scale the level of variability within and beyond the Columbia River populations (Umatilla, Clearwater, Klickitat, Lower Columbia, and the Thompson River on the Fraser River system). Microsatellite DNA techniques will be the primary tool. Protein electrophoresis and mtDNA may also be used.

*10.4.3.2 Monitor traits such fecundity, body morphometry, and maturation timing.*

Because conditions in the mid-Columbia and Yakima are likely to be different than in the coastal streams and lower Columbia where the coho originate, life history characteristics of the introduced brood stock are likely to change. For one, the migration distance is very much greater into the mid-Columbia than, for example, to Eagle Creek. Optimal maturation rates and 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 brood stock must be monitored over the length of the program.

An important link to environmental condition is the water temperature profiles in the streams or hatchery setting. The coho stock will be exposed to a water temperature profile that may deviate from the ancestral stream. Although this does not represent a particular problem for controlled conditions (there is generally very little variation in development rate of the eggs, and the genetic variance is additive), it is necessary to determine if the brood stock used has sufficient variance in maturation schedules to match local conditions. A longer-term goal is to select the brood stock from successful wild-spawning fish, thereby enabling the brood stock to progress towards local maturation optima.

For this plan, we will monitor fitness-related phenotypic traits such as fecundity, body morphometry, and maturation timing.

*10.4.3.3 Gene flow from program fish into natural populations.*

Monitoring done on mid-Columbia coho will contribute to answering broader questions about the rate of genetic drift when a brood stock is established in a subbasin. A regional sampling effort will collect samples of coho from all reintroduced populations (programs with the intent of establishing wild-spawning, self-recruiting populations) above Bonneville Dam. These samples will be used to extract alleles at a number of nuclear DNA loci. These will be used to estimate parameters of gene flow, diversity, and genetic differentiation.

10.4.4 Predation on other species by program fish as measured by stomach content analyses.

A rotary trap would be placed near two coho acclimation/release sites in the Wenatchee basin to monitor the level of predation on spring chinook and sockeye fry by coho smolts. The stomach contents of up to 3,000 coho would be examined for each of two studies (one of coho predation on spring chinook, the other of coho predation on sockeye) (6,000 fish total). Predation studies would not be done in the Methow basin primarily because the opportunities don’t exist to study predation on the species of concern—spring chinook, sockeye, and steelhead. All returning spring chinook adults in the Methow are collected and taken to the hatchery to be bred under an adult-based supplementation program. Steelhead spawn farther upstream and emerge after coho have migrated.

The rotary trap operated at RM 2 on Nason Creek will likely capture some spring chinook juveniles, although the overall catch is expected to be low. Based on a trap efficiency rate of 5-10%, mean fecundity (4,500 eggs/female), redd counts for 1998 and estimated survival rates (Fast et al. 1991), we expect to handle between 1275 – 2550 spring chinook juveniles.

A brief literature review of the life history of sockeye salmon indicates that substantial variability of age at out-migration, growth, and rearing habitats occurs throughout their geographic range (Groot and Margolis 1991). Such variation makes species-wide generalization difficult. Prior to attempting to conduct a study of coho predation on sockeye, life history information specific to Lake Wenatchee must be collected, in order to determine periods and locations that sockeye salmon in Lake Wenatchee are most susceptible to hatchery coho smolt predation. Initially, we will collect and summarize existing Lake Wenatchee life history information. Included in this database will be all existing spawning and rearing distribution information and age and growth data. Existing information will be assessed and we will determine if additional Lake Wenatchee sockeye life history information needs to be collected. Specifically, information on age-specific rearing distribution in Lake Wenatchee may be limited. If so, additional surveys using hydro-acoustic, beach seining, trawling, and/or purse seining gear may be required to collect additional information. Concurrently, we will attempt to generalize coho smolt behavior and habitat utilization/distribution in large lake environments (such as Lake Wenatchee) from literature reviews.

At the end of the data gathering period (2002), we will assess the information and determine potential risk to sockeye from coho predation and also the potential for monitoring success.

If the managers agree that risk is acceptable and potential monitoring success is high, in the spring of 2003 (the year coho smolts are first proposed to be released from the Two Rivers acclimation site), we will sample those areas that young-of-the-year sockeye salmon are known to inhabit, using the gears described above. When spatial and temporal overlap occurs between the two species, up to 3,000 coho smolts will be collected for stomach analysis. We may also radio tag up to 100 juvenile coho in Lake Wenatchee to determine smolt distribution within the lake to assess potential overlap with sockeye.

10.4.5 Other potential ecological interactions as measured by residualism, distribution, and habitat surveys; and by F2 studies.

*10.4.5.1 Residualism, distribution, and habitat surveys*

Snorkeling surveys would be done near acclimation/release sites to determine whether and how many coho do not migrate downstream after release. Spot electro-shocking and/or snorkeling for the presence of bull trout would be done near release sites at Chumstick and Beaver creeks; and for steelhead and bull trout at Beaver Creek and just below the Two Rivers release site.

*10.4.5.2 F2 studies*

Because adult coho returns are expected to be low for the duration of this plan, coho F2 interaction studies will begin in the Yakima basin and are expected to progress as outlined below. F2 studies will not be proposed for mid-Columbia basins until the Technical Team determines sufficient numbers of adults have returned to make such studies meaningful.

## $F_2$ Coho Interaction Experimental Outline for Yakima Basin Studies

I. Spatial and Temporal Overlap of Naturalized Coho and Species of Concern

1. 1999
   a. Radio telemetry – Yakima spawning distribution
   b. Redd surveys – use radio telemetry to focus efforts, compile past redd surveys to describe spawning distribution
   c. Reproductive success/emergence timing – coho redd caps in selected Yakima tributaries

2. 2000-2003
   a. 100% hatchery smolts marked (quantify naturalized smolt production)
   b. Snorkel surveys in areas of highest spawning distribution
   c. Beach seining/electrofishing in juvenile rearing areas (abundance/growth rate information) with emphasis on areas of the highest abundance for all species
   d. Outmigration timing/smolt size/quality at CJMF
   e. Residual monitoring (snorkel/seining/electro-fishing)

II. Ecological Interactions Monitoring (2001 and beyond)

1. Is there a time/space overlap?
   a. If not – continue monitoring occasionally for overlap and potential interaction
   b. If yes – investigate

2. Predation
   a. Identify spatial/temporal overlap (by life stage) at issue for each species
   b. Collect stomachs in traps/electro-fishing, etc.
      - Focus in areas where abundance for both species is highest (worst case scenario)
      - Limitations: low power, difficult to determine density-dependent effect

3. Competition
   a. Definition – A situation where the use of a common and limited environmental resource by 2 individuals or species causes the growth or survival of one individual or species to be reduced due to the shortage of this resource (Whittaker 1975).
   b. By definition, generally, in many areas where listed species occur, resources are not in limited supply.
   c. Exceptions
      1. Where the ecological release of another species has occurred
      2. If the coho program is extremely successful
   d. Monitoring Approaches
      1. Allopatric/sympatric streams (realistic, but low power)
      2. Test control streams/reaches (good power, but not always realistic).

10.5) Unknowns or uncertainties identified in Sections 5 through 9

See the relevant sections.

10.6) Other relevant monitoring projects

None.

# SECTION 11. RESEARCH

There are no additional studies or descriptions to add to this section beyond what is covered in Section 10.

# SECTION 12. ATTACHMENTS AND CITATIONS

Allee, BJ. 1974. Spatial requirements and behavioral interactions of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). 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. AFS 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.

Andersen, B.C., and D.W. Narver. 1975. Fish populations of Carnation Creek and other Barkley Sound streams – 1974: data record and progress report. Fisheries Resource Board of Canada. MS Rep. Series 1351:73p.

Berejikian, B.A. 1995. The effects of hatchery and wild ancestry on the behavioral development of steelhead trout fry (Oncorhynchus mykiss). Doctoral Dissertation, University of Washington, Seattle.

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. Transactions of the American Fisheries Society 117:262-273.

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. 120:486-483.

Bugert, R.M., T.C. Bjornn, and W.R. Meehan. 1991. Summer habitat use by young salmonids and their response to cover and predators in a small south-east Alaska stream. Trans. Am. Fish. Soc. 120:474-485.

Burns, J.W. 1971. The carrying capacity for juvenile salmonids in some northern California streams. California Fish and Game 57(1):44-57.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1995. *Wy-Kan-Ush-Mi Wa-Kish-Wit: Spirit of the Salmon*. The Columbia River Anadromous Fish Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes.

CTWSR (Confederated Tribes of the Warm Springs Reservation), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Idaho Department of Fish and Game (IDFG), National Marine Fisheries Service (NMFS), Nez Perce Tribe (NPT), Oregon Department of Fish and Wildlife (ODFW), Shoshone-Bannock Tribe (SBT), Washington Department of Fish (WDF), Washington Department of Wildlife, U.S. Fish and Wildlife Service (USFWS) Yakima Indian Nation (YIN). 1988. Columbia River Fish Management Plan. CTWSR et al. 74 pages.

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, Oregon.

Dunnigan, J. and J. Hubble. August 1998. Results From YKFP and Mid-Columbia Coho Monitoring and Evaluation Studies. Prepared for the Mid-Columbia Technical Work Group.

Foerster, R.E. and W.E. Ricker. 1953. The coho salmon of Cultus Lake and Sweltzer Creek. Journal of the Fisheries Research Board of Canada 10:293-319.

Frasier, F.J. 1969. Population density effects on survival and growth of juvenile coho salmon and steelhead trout in experimental stream channels. Pages 253-265 in T.G. Northcote, editor. Symposium on salmon and trout in streams. H.R. MacMillan Lectures in Fisheries, University of British Columbia, Vancouver.

Glova, G.J. 1984. Management implications of the distribution and diet of sympatric populations of juvenile coho salmon and coastal cutthroat trout in small streams in British Columbia, Canada. Progressive Fish Culturist 46:269-277.

Glova, G.J. 1986. Interaction for food and space between experimental populations of juvenile coho salmon (*Oncorhynchus kisutch*) and coastal cutthroat trout (*Salmo clarki*) in a laboratory stream. Hydrobiologia 131:155-168.

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):275-284.

Groot, C. and L. Margolis. 1991. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver.

Hankin, D.G., and Reeves, G.H. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-843.

Hard, J.J. 1996. Summary of coho salmon and steelhead interactions. Memorandum to Michael Delarm, NMFS, from Jeffrey Hard, NMFS, dated October 24, 1996.

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.

He, E. and W.A. Wurtsbaugh. 1993. An empirical model of gastric evacuation rates for fish and an analysis of digestion in piscivorous brown trout. Transactions of the American Fisheries Society 122:717-730.

Hillman, T.W. and J.S. Mullan. 1989. Effect of hatchery releases on the abundance and behavior of wild juvenile salmonids. In: *Summer and Winter Ecology of Juvenile Chinook Salmon and Steelhead Trout in the Wenatchee River, Washington*. Report to Chelan County PUD by D.W. Chapman Consultants, Inc. Boise, ID.

Hunter, J.G. 1959. Survival and production of pink and chum salmon in a coastal stream. Journal of the Fisheries Research Board of Canada 16:835-886.

IHOT (Integrated Hatchery Operations Team). 1995(a). Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries: Annual Report for 1994. Bonneville Power Administration, Portland, OR.

IHOT. 1995(b). Operations Plans for Anadromous Fish Production Facilities in the Columbia River Basin: Volume III – Washington.

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 Worthy Creek, Washington. Master of Science Thesis, University of Washington, Seattle.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon in the Big Qualicum River, British Columbia. Journal of Fisheries Research Board of Canada 27:1215-1224.

McHenry, E.T. 1981. Coho salmon studies in the Resurrection Bay area. Annual progress report. Alaska Department of Fish & Game Aid Fish Restoration 1980-81:1-52.

Miller, W.H., T.C. Coley, H.L. Berge, and T.T. Kisanuki. 1990. *Analysis of Salmon and Steelhead Supplementation: Emphasis on Unpublished Reports and Present Programs.* Project 88-100, U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Mullan, J.W. 1983. Overview of Artificial and Natural Propagation of Coho Salmon (*Onchorhynchus kisutch*) on the Mid-Columbia River. Fisheries Assistance Office, U.S. Fish and Wildlife Service, Leavenworth, Washington. December 1983.

Nelson and Bodle. 1990. *Ninety Years of Salmon Culture at Little White Salmon National Fish Hatchery.* Biological Report 90(17), U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Nilsson, N.A. 1966. Interactive segregation between fishes. In: The biological basis of freshwater fish production. S.D. Gerking editor. Blackwell Scientific Publishing, Oxford, Great Britain.

NMFS, USFWS (U.S. Fish and Wildlife Service), WDFW (Washington Department of Fish and Wildlife), CTYIN (Confederated Tribes of the Yakama Indian Nation), CTCIR (Confederated Tribes of the Colville Indian Reservation), CTUIR (Confederated Tribes of the Umatilla Indian Reservation), Chelan County PUD, Douglas County PUD. 1998. Biological Assessment and Management Plan, Mid Columbia River Hatchery Program. Wenatchee, WA.

NMFS. 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.

NPPC (Northwest Power Planning Council). 1994. Columbia River Basin Fish and Wildlife Program. NPPC 94-55, Portland, OR.

ODFW (Oregon Department of Fish and Wildlife) and WDFW. 1999. Monitoring results from the 1998 Ocean and Buoy 10 recreational selective fisheries. ODFW and WDFW. March 8, 1999.

Parties to *United States versus Oregon*. 1999. 1999 Management agreement for upper Columbia River fall chinook, steelhead, and coho - Attachment C (pending).

Petts, G.E. 1980. Long-term consequences of upstream impoundment. Environmental conservation. Volume 7. Pages 325-332.

PFMC (Pacific Fisheries Management Council). 1999. Review of 1998 Ocean Salmon Fisheries. Pacific Fishery Management Council. 2130 SW Fifth Avenue, Suite 224, Portland, Oregon 97201. February 1999.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 in Howell, P.J. and D.V. Bauchanan, editors. Proceedings of the Gearheart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society.

PRRG (Production and Restoration Research Group). 1999. Salmon Restoration Hatchery Strategies: A Review with Recommendations [Review Draft]. Columbia River Inter-Tribal Fish Commission. Portland, OR.

RASP (Regional Assessment of Supplementation Planning). 1992. Final Report for the Regional Assessment of Supplementation Projects. Bonneville Power Administration. Portland, Oregon.

Reeves, G.H., F.H. Everest, T.E. Nickelson. 1989. Identification of physical habitats limiting the production of coho salmon in western Oregon and Washington. U.S. Forest Service General Technical Report PNW-GTR-245. Corvallis, Oregon

Ricker, W.E. 1941. The consumption of young sockeye salmon by predaceous fish. Journal of the Fisheries Research Board of Canada 5:104-105.

Rieman, Bruce E., and John D. McIntyre. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. In: U.S. Dept. of Agriculture–Forest Service, Intermountain Forest and Range Experiment Station. General Technical Report INT-302.

Ruggerone, G.T., and D.E. Rogers. 1992. Predation on sockeye salmon fry by juvenile coho salmon in the Chignik Lakes, Alaska: Implications for salmon management. North American Journal of Fisheries Management 12:87-102.

Salo, E.O., and W.H. Bayliff. 1958. Artificial and natural production of silver salmon (*Oncorhynchus kisutch*) in Minter Creek, Washington. Resource Bulletin Washington Department of Fisheries 4:76p.

Spaulding, J.S., T.W. Hillman, J.S. Griffith. 1989. Habitat use, growth, and movement of chinook salmon and steelhead in response to introduced coho salmon. Pages 156-208 in Don Chapman Consultants, Incorporated. Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Chelan County Public Utility District, Washington.

Stein, R.A., P.E. Reimers, and J.D. Hall. 1972. Social interaction between juvenile coho salmon (*Oncorhynchus kisutch*) and fall chinook salmon (*O. tshawytscha*) in Sixes River, Oregon. J. Fish. Res. Bd. Can. 29:1737-1748.

Stelle, W. 1996. Letter from W. Stelle, Jr., NMFS, to S. Speaks, BIA, dated December 19, 1996, informal consultation on coho salmon releases proposed by the NPT.

Steward, C.R. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: A synthesis of published literature. In W.H. Miller (editor), Analysis of salmon and steelhead supplementation, Part 2. Report to Bonneville Power Administration (Proj. 88-100), Portland OR.

Thompson, R.B. 1966. Effects of predator avoidance conditioning on the post-survival rate of artificially propagated salmon. Ph.D. dissertation submitted to University of Washington, Seattle.

Tripp, D., and P. McCart. 1983. Effects of different coho stocking strategies on coho and cutthroat trout production in isolated headwater streams. Canadian Technical Report of Fisheries and Aquatic Sciences 1212:175 p.

Tyus, H.M. 1990. Effects of altered stream flows on fishery resources. Fisheries. Volume 3. Pages 18-20.

Underwood, K.D., S.W. Martin, M.L. Schuck and A.T. Scholz. 1992. Investigations of bull trout (*Salvelius confluentus*), steelhead trout (*Oncorhynchus mykiss*), and spring chinook (*O. tshawytscha*) interactions in southeast Washington streams. Bonneville Power Administration. Final report. Project number 90-053.

USDA FS (United States Department of Agriculture, Forest Service). 1990. Land and Resource Management Plan, Wenatchee National Forest. Wenatchee, Washington.

USDA Forest Service. 1996. Watershed Assessment, Entiat Analysis Area Version 2.0, Wenatchee National Forest. Pacific Northwest Region.

USDOE BPA. 1999(a). Biological Assessment for Mid-Columbia Coho Reintroduction Feasibility Project. Portland, OR.

USDOE BPA. 1999(b). *Mid-Columbia Coho Reintroduction Feasibility Project Final Environmental Assessment and Finding of No Significant Impact*. (USDOE/EA-1282, Portland, OR.

USFWS (United States Fish and Wildlife Service). n.d. Winthrop Hatchery Plan. Region One, USFWS.

Utter, F.M. 1991. Biochemical genetics and fishery management: an historical perspective. J. Fish Biology 39 (Suppl. A):1-20

WDFW (Washington Department of Fish and Wildlife). 1996. Species of special concern list. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia, WA.

WDFW. 1998. Washington State salmonid Stock Inventory, Bull Trout/Dolly Varden.

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.

Whittaker, R.H. 1975. Communities and Ecosystems. MacMillan Publishing Company, New York, New York.

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.