Yakima Coho Master Plan

Prepared by

Yakama Nation
In cooperation with
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1. BACKGROUND

1.1 Yakima/Klickitat Fisheries Project

The Yakima Coho Project is a component of the Yakima/Klickitat Fisheries Project (YKFP). Section 1 summarizes overall YKFP goals and management philosophy, which guides projects relating to all target species in the two basins, including Yakima coho. Section 2 discusses goals and history to date of the Yakima Coho Project specifically.

The YKFP is a project designed to use artificial propagation in an attempt to re-establish, supplement, or increase natural production and harvest opportunities of anadromous salmonids while maintaining the long-term fitness of the target population, and while keeping ecological and genetic impacts on non-target species within specified limits. The planning, implementation, and evaluation of this project is guided by the framework developed by the Regional Assessment of Supplementation Project (RASP 1992). The YKFP is also an experiment to resolve uncertainties associated with supplementation. As a "laboratory," the YKFP will help determine the role of supplementation in increasing natural production of anadromous salmonids. Both controlled experiments and basic monitoring contribute information.

Consistent with the Northwest Power and Conservation Council's (formerly Pacific Northwest Power Planning Council [NPPC]) Fish and Wildlife Program (NPPC 1994; NPPC 2000), the objectives of the YKFP are to:

- Enhance existing stocks of anadromous fish in the Yakima and Klickitat river basins, while maintaining genetics and ecological resources.
- Reintroduce stocks formerly present in the basins.
- Apply the knowledge gained through supplementation throughout the Columbia River Basin.

Overall Project objectives are achieved while adhering to all relevant environmental laws and regulations, including National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) requirements.

1.2 Adaptive Management and Project Planning

The YKFP endorses an adaptive management policy, which allows for Project objectives and strategies to change as new information becomes available from Project experiments, monitoring and evaluation, and literature reviews.

The Project initially established an annual process that required, for each target species, preparation and subsequent updates of an overall long-range plan (Planning Status Report [PSR]) and a second plan for resolving uncertainties (Uncertainty Resolution Plan [URP]). Progress and results of uncertainty resolution work were reported in annual project reports and/or in project completion reports, which were peer-reviewed and discussed at an annual meeting (Project

Annual Review [PAR]). Following the PAR, research and monitoring plans were reviewed and revised as necessary, subject to policy review.

Annual preparation of the two plans became difficult to accomplish along with the many other plans, reports, and analyses required by funding and regulatory agencies. Early in 2002, YKFP and BPA managers agreed that master plans for each species targeted by the YKFP would replace the PSRs and URPs. Master plans follow content guidelines from the Northwest Power and Conservation Council (NPCC).

The annual meeting to review study progress and results continues, as does adaptive management in response to this peer review. The difference is that instead of two long-range plans being expected annually, amendments to the master plan will be provided only if substantive changes are made to production, research, or monitoring goals or methods. Annual written reports on study progress and results will continue.

2. YAKIMA COHO PLANS AND CONSISTENCY WITH OTHER PLANS

Wild stocks of coho salmon (*Oncorhynchus kisutch*) were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). However, coho salmon probably became extinct in the Yakima River in the early 1980s (YN 1997). For this reason, efforts to restore coho within the Yakima basin rely largely upon releases of hatchery coho because wild stocks do not exist to supplement. Hatchery coho releases began in the Yakima basin in 1983 with the first release of 324,000 Little White Salmon hatchery smolts. At that time, the program was primarily for harvest augmentation.

The four Columbia River Treaty Tribes (Nez Perce, Umatilla, Warm Springs, and Yakama) identified coho reintroduction in the mid-Columbia region as a priority in the *Wy-Kan-Ush-Mi-Wa-Kish-Wit* document, commonly referred to as the Tribal Restoration Plan (TRP) (CRITFC 1995, updated in 2000). It is a comprehensive plan put forward by the Tribes to restore the Columbia River fisheries (Blodgett and Dunnigan 2001a).

In 1996, Bonneville Power Administration (BPA) completed an environmental impact statement on the proposed Yakima Fisheries Project. The Project proposed to include the Yakima basin's coho program, but to expand its scope to include research into the feasibility of re-establishing a self-sustaining coho population (BPA et al. 1996). A Draft Coho PSR, prepared by the Yakama Nation in 1997 (YN 1997), described the overall long-range plan, as well as objectives, strategies, and assumptions; and it provided a full report of research results on coho to that point. Due to difficulties getting it reviewed outside YN, it was never finalized. An updated version of the draft 1997 coho PSR was prepared in 2001 (YN 2001a), but again, the length of time taken for reviews made it out of date before it could be completed.

In spring of 1999, environmental effects of additional proposed YKFP activities, including those for coho, were reviewed in three separate documents: Biological Assessment on Bull Trout for the Yakima/Klickitat Fisheries Project 1999-2004 (BPA et al. 1999a); Biological Assessment on Mid-Columbia River Steelhead for the Yakima/Klickitat Fisheries Project 1999-2004 (BPA et al. 1999b); and Yakima/Klickitat Fisheries Project Supplement Analysis (BPA 1999). In winter and spring of 2003, use of the Holmes acclimation site described in this master plan was evaluated in a Supplement Analysis to the YFP EIS (BPA 2003) and in consultation with NOAA Fisheries (letter from Patricia R. Smith, BPA, to Allyson Ouzts, NOAA, February 24, 2003).

The YKFP program, including the coho component, has also been the subject of NPPC provincial reviews which include critique by the Independent Scientific Review Panel. Study results have been published in Dunnigan and Hubble 1998; Dunnigan 1999; Dunnigan 2000; Dunnigan and Lamebull 2000; and Dunnigan 2001.

The Yakima Basin Subbasin Summary was prepared in 2001 (Berg and Fast 2001). The YKFP coho program is included in that summary, which also appended a Hatchery and Genetics Management Plan (HGMP) for coho production in the basin. The recently completed Yakima Subbasin Plan (YSPB 2004) also incorporates the YKFP coho program, and the 2001 HGMP (Blodgett and Dunnigan 2001) was recently updated and submitted to NOAA Fisheries (Yakima Coho HGMP 2004 *in draft)*.

This master plan builds on and is consistent with all these previous documents.

The coho master plan was originally written to be consistent with NPPC requirements for master plans, as described in Section 7.4B of the 1994 Fish and Wildlife Program (NPPC 1994). Since the plan was begun, the Council has published an updated and significantly changed Fish and Wildlife Program (NPPC 2000), which includes eight scientific principles that are intended to provide a stable scientific foundation for actions taken to implement the program (Section B, NPPC 2000); biological objectives that the overall program aims to achieve (Section C, NPPC 2000); and strategies to implement the objectives (Section D, NPPC 2000).

The Council's scientific principles recognize that program actions must maintain and promote ecosystem functions by acknowledging and acting in accordance with the holistic nature of ecosystem relationships, the need for biological diversity, the role of each species in maintaining ecological functions, and the need to adapt human actions to minimize adverse impacts on ecosystems. As can be seen in Section 3 of this master plan, the Yakima coho program has been consistent with these principles from its inception by recognizing the need to study the feasibility of habitat in the Yakima basin to sustain a naturally reproducing coho population with minimal impacts to non-target species.

Within the limits of its feasibility studies, the coho program has also been consistent with the Council's Overarching Objectives (Section C1) and Basin Level Biological Objectives related to anadromous fish losses (Section C2). In attempting to determine if extirpated coho can be re-established in the Yakima basin with minimal effects on other species, YN is reaching toward a long-term goal of restoring a healthy, naturally reproducing population of coho at harvestable levels, which would increase diversity and mitigate for effects of the hydro system, while ensuring that populations of other biologically, culturally, or economically sensitive species are maintained or able to recover (see Section 3).

As an artificial production program, albeit in the feasibility phase, the Yakima coho program is using an experimental approach to study the feasibility of restoring coho to the basin, consistent with the Council's artificial production policies, including those discussed in Section D4 (NPPC 2000). The extension of the coho program proposed in this master plan continues the experimental approach, with annual reports, peer reviews, and adaptive management principles (see Section 1.2 and Section 3 of this master plan).

There are no other coho-specific activities in the Yakima basin. However, YN and Washington Department of Fish and Wildlife (WDFW) are conducting a similar coho reintroduction feasibility study in the Wenatchee and Methow basins. Research results are shared among all participants and agency advisors for these projects, and the results inform decisions about further research needs and project directions. In addition, habitat improvements and enhancements being undertaken by various entities in the Yakima basin and on the Columbia mainstem can only improve the potential for success of the coho reintroduction effort (Berg and Fast 2001; YSPB 2004).

3. YAKIMA COHO GOALS, OBJECTIVES, AND STRATEGIES

The Yakima Coho Project is planned in two phases. The first phase is the "feasibility phase" and the second, the "implementation phase."

The goal of Yakima Coho Project feasibility studies is to determine the feasibility of re-establishing a naturally spawning coho population and a significant fall fishery for coho within the Yakima River Basin, while keeping adverse ecological impacts within specified limits.

When warranted by the results of feasibility studies, the YKFP's Policy Group will determine whether to propose an implementation phase and, if so, whether it should consist of supplementation of naturalized populations, harvest augmentation, or some other kind of production program. This proposal would be subject to a number of review processes, including an NPCC step review, as well as NEPA, ESA, and other review and approval processes, depending on the proposal's scope and funding sources. It is expected, however, that any long-term proposal would be consistent with YKFP goals. The decision in the case of *U.S. v. Oregon* and its associated Columbia River Fisheries Management Plan (CRFMP) also provides over-arching guidance to Yakima Coho Project activities.[1]

Although many project activities may be similar in both the feasibility and implementation phases, to detail plans for the implementation phase now would be premature. Therefore, this master plan focuses on the feasibility phase, but includes rough cost estimates (Appendix B) for facilities that might be needed if a long-term program were to be implemented. Appendix C (Coho Rearing Facilities Siting Report) represents an initial attempt to define what a long-term program might look like, for the purposes of estimating long-term costs; however, it is not intended to take the place of the detailed evaluation processes that would be required before a long-term plan could be implemented.

3.1 Feasibility Phase

The feasibility of re-establishing coho in the Yakima Basin may initially rely upon the resolution of two central issues: the adaptability and survival rates of a domesticated lower Columbia River coho stock used in the reintroduction efforts, and the ecological risk to other species associated with coho reintroduction.

[1] Among other things, the CRFMP sets production and release numbers for several salmon species throughout the region, including coho. Its focus is harvest augmentation. The most recent CRFMP expired in 1999. When it is re-negotiated and adopted, the Yakima coho plan will be adjusted, if necessary, to be consistent with the CRFMP.

Initially, project managers expected that feasibility studies would run through 2003 or 2004; they defined a complex set of objectives, with strategies to meet the objectives. While study results show some success in meeting initial objectives, they also indicate that a number of questions remain to be answered before a clear determination can be made that a naturally reproducing population can be established. As a result, the project proposes to continue feasibility studies through approximately 2010 and to revise the goals and objectives to help answer those questions. In effect, the feasibility studies will be divided into **Phase 1A** (ending in 2004 or 2005) and **Phase 1B** (ending in approximately 2010).

The remainder of Section 3 is organized as follows:

- Section 3.2 describes feasibility phase activities in general terms.
- Section 3.3 summarizes project objectives as defined in the 2001 draft PSR. Each objective was refined with an extensive list of strategies, or tasks, that were designed to accomplish those objectives. They guided the feasibility phase activities for what we are now calling **Phase 1A**, which is expected to be completed in December 2004 or 2005. The strategies are not repeated here (see YN 2001a); however, brief results of the studies based on those strategies are reported in Section 5.
- Section 3.4 outlines objectives and strategies proposed for what we are calling **Phase 1B,** currently proposed to begin in 2005. They refine those that guided the initial feasibility studies, based on results to date. It also contains two tables (Tables 1 and 2) which **summarize** activities proposed for this phase. **Phase 1B activities and their risks are fully described in Section 6 of this master plan.**

3.2 Feasibility Phase Activities (General Description)

In general, feasibility activities fall into five categories:

A. Define success
B. Optimize survival/performance of hatchery coho
C. Monitor ecological interactions
D. Identify suitable and critical coho habitat
E. Develop facilities for program activities

A. Define success. The definition of success for the feasibility phase depends on the balance between two major and potentially competing factors: 1) establishing naturalized coho populations while 2) minimizing risks to other species. Factor 1 will be deemed a success if analysis of empirical data indicates that naturalized populations of coho are at or above the replacement level (basin-wide productivity (P) >= 1.0) for a number of generations. Factor 2 will be considered a success if the coho program does not cause impacts on non-target species to exceed specified levels (see Table 8, Section 5).

B. Optimize survival/performance of hatchery coho. Success of the effort to re-introduce coho into the Yakima River relies on the use of hatchery fish to develop naturalized spawning populations. The hatchery coho must return in sufficient numbers as adults to either spawn naturally or to be spawned in a hatchery. Acclimation and release strategies and broodstock collection and mating protocols are key aspects to meeting this objective.

C. Monitor ecological interactions. For the coho program, biologists from YN and WDFW identified Non-Target Taxa of Concern (NTTOC) and impact containment levels for those species (see Table 8, Section 5), similar to those for the spring chinook program. These levels were changed slightly for Phase 1B activities (see Tables 10 - 13, Section 6). Risk containment levels vary with the sensitivity of each species to impact, its importance in the region, and other factors. When monitoring and evaluation suggest that NTTOC populations are declining in areas of coho concentration, studies would be implemented to determine whether coho might be the cause of the decline.

D. Identify suitable and critical coho habitat. A major objective during the feasibility phase is to identify tributaries and mainstem reaches capable of supporting self-sustaining populations of naturalized coho.

E. Develop facilities for program activities. During the feasibility phase, the project will use existing facilities as much as possible for broodstock collection, incubation/rearing, acclimation/release and juvenile and adult monitoring. However, additional acclimation, fish culturing, broodstock collection, or monitoring facilities might be needed or, in some cases, existing facilities might need to be retrofitted. Improvements to existing facilities would be based on the need to fulfill the proposed experimental protocol. Additional facilities proposed for feasibility studies emphasize limited development of sites, and temporary or portable structures wherever possible. Existing facilities and proposed feasibility-phase improvements are described in Section 6.

One aspect of determining overall program feasibility requires evaluating facility needs should a long-term program be implemented. These studies of long-term facility needs are identified as Objective 5 in Phase 1B and are described in Section 6.5. While no formal proposals have been developed for a long-term program, Appendix C is a copy of a report that evaluates potential facilities in order to begin to assess costs of a long-term program. It identifies a preferred alternative for the purpose of these cost estimates (Appendix B). However, before formal proposals are developed, staff would review existing literature on such factors as water quality, quantity and availability for more permanent production and acclimation facilities; and would conduct detailed studies and environmental reviews.

3.3 Objectives of Feasibility Phase 1A

The initial PSR (YN 1997) for this project defined the following objectives for the feasibility phase.

- Determine the feasibility of re-establishing a sustainable, naturally spawning coho population in the Yakima Basin with sufficient productivity to sustain a meaningful in-basin fishery in most years.
- Optimize production of naturalized populations of coho with respect to abundance and distribution.
- Minimize adverse impacts of coho reintroduction on Non-Target Taxa of Concern (NTTOC).
- Limit losses of wild and hatchery coho smolts to native and exotic predators to levels that do not significantly limit coho production potential.

- Establish a Yakima River coho stock with heritable life history traits adapted to the Yakima River Basin.
- Expand harvest opportunities for treaty Indian and sport fisheries inside and outside of the Yakima River Basin while meeting objectives for genetics, experimentation, natural production, and ecological interactions.

As the project progressed, the scope of these objectives was refined to focus on five key questions:

1) Which geographical area is better suited for natural coho production: the upper Yakima basin or the Naches basin?
2) What acclimated smolt release timing (early or late) provides the best smolt-to-smolt and smolt-to-adult survival?
3) Which broodstock (out-of-basin vs. local) has the highest productivity?
4) To which parts of the basin do adult coho return?
5) What is the existence and biological significance of impacts to populations of NTTOC identified as being at demonstrable risk from ecological interactions with coho?

Study results related to these objectives are briefly summarized in Section 5; full results are described in the cited reports. Section 2 contains a complete list of relevant reports.

3.4 Objectives and Strategies: Feasibility Phase 1B

For this phase, we include objectives we expect to accomplish by approximately 2010, as well as strategies proposed to achieve the objectives. The methods for each strategy, as well as their environmental and project risks, are described in Section 6.

Objective 1. Attempt to establish naturally producing coho populations in the upper and lower Yakima River and tributaries, and in the Naches River and tributaries.

> **Strategy 1a.** Continue acclimated smolt releases in the mainstem of the upper Yakima and Naches rivers, including early-run and late-run stocks.
>
> **Strategy 1b.** Test survival of smolts released in upper Yakima tributaries.
>
> **Strategy 1c**. Test over-winter survival (parr-smolt survival) by releasing coho parr in selected tributaries to the Yakima and Naches rivers.
>
> **Strategy 1d.** Test egg-fry survival, adult productivity, and interactions with NTTOC by releasing adult coho in selected tributaries to the Yakima and Naches rivers.
>
> **Strategy 1e.** Transition from use of hatchery/Lower Columbia origin coho to natural/ Yakima origin coho broodstock as quickly as possible.
>
> **Strategy 1f.** Monitor and evaluate factors that will determine when a self-sustaining and naturally producing population of coho is re-established in each subbasin, including adult productivity, egg-fry survival, over-winter (parr-smolt) survival, smolt-smolt survival, and smolt-adult survival.

Objective 2. Continue to investigate the coho life history in the Yakima basin.

Strategy 2a. Conduct spawner surveys throughout the Yakima basin.

Strategy 2b. Determine, in general terms, where coho currently are found in the basin and their abundance.

Strategy 2c. Determine life history timing (i.e., summer and fall parr and smolt out-migrants).

Objective 3. Assess ecological interactions.

Strategy 3a. Study coho residualism in release locations where steelhead also are found.

Strategy 3b. Study interactions between natural-origin coho or surrogates and other salmonids.

Objective 4. Develop and test use of additional culturing, acclimation and monitoring sites.

Strategy 4a. Develop additional acclimation sites in the upper Yakima River subbasin (Holmes, Boone Pond, and Taneum Creek)[2].

Strategy 4b. Test use of mobile acclimation vessels in several sub-watersheds.

Strategy 4c. Establish additional monitoring sites in the Yakima and Naches subbasins.

Strategy 4d. Test use of a small-scale fish culturing facility (La Salle High School on Ahtanum Creek).

Objective 5. Determine long-term facility needs.

Strategy 5a. Investigate potential permanent rearing sites more suitable than Prosser for coho.

Strategy 5b. Investigate the feasibility/desirability of establishing permanent, fixed acclimation sites in the upper Yakima, Naches, or other subbasins.

Table 1 summarizes the activities proposed to accomplish the objectives and strategies. Further detail on the releases is provided in Table 2. Appendix A provides detail on broodstock collection protocols and projections of numbers to be collected.

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[2] The three sites listed are currently in use or under consideration; however, depending on coho survivals, additional sites, using natural ponds or net pens, might be investigated. See Section 6.4, Strategy 4a, for details.

Table 1. Activities Proposed for Yakima Coho Project (YKFP), Phase 1B

Activity	Location, Numbers, Timing
Hatchery broodstock development - existing	- Prosser Hatchery: 0 - 500,000 smolts - Lower Columbia River hatcheries: 500,000 – 1 million fry/smolts
Small-scale culturing (eyed-summer parr) - new	- Ahtanum: LaSalle High School (RM 2); 30,000; to summer parr
Acclimated volitional smolt releases from mainstem sites (smolt-smolt survival studies)	1,000,000 annually • Early run 400,000 Upper Yakima • Early run 400,000 Naches • Late run 100,000 Upper Yakima • Late run 100,000 Naches
Acclimated volitional smolt releases from new tributary sites (smolt-smolt survival, late-run/early-run survival studies)	Up to 42,000 annually[3] • 40,000 Taneum Cr. • 1,250 Keechelus-Easton Reach Beginning late March
Acclimated volitional smolt releases from new mobile sites	Up to 10,000 annually.[2] Location options include: • Upper Yakima - Wilson Cr. • Ahtanum Cr. • Toppenish/Simcoe creeks
Parr releases – scatter plant (over-winter survival studies)	3,000 each site, 24,000 total annually, in July[4] - Upper and lower Yakima • Crystal Springs/Easton-Keechelus Reach • Big Cr. • Wilson Cr. • Toppenish Cr. • Ahtanum Cr. - Naches • N. Fork Little Naches • Salmon Falls-S. Fork • Nile Cr. • Little Rattlesnake Cr.
Adult releases (egg-fry survival, adult productivity, and NTTOC studies)	20 pairs each site, except Taneum Cr. (see Table 2), in fall - Upper and lower Yakima • Taneum Cr. • Wilson Cr. • Reecer Cr. • Ahtanum Cr. • Toppenish Cr. - Naches • Pileup Cr. • Nile Cr.

[3] Releases would come from the one million coho programmed for the Yakima Basin. Release numbers at other sites would be adjusted as necessary.
[4] All parr releases would be PIT tagged. If numbers prove too small for reliable estimates of survival, releases would be increased, probably to no larger than 5,000 per group. Parr would come from Prosser production, with the exception of parr produced at LaSalle for release in Ahtanum Creek.

Table 1 (continued)

Activity	Location, Numbers, Timing
Acclimation sites – existing	- Upper Yakima: Easton Ponds (RM 201); Clark Flat (RM 164) (use only as alternatives to new upper Yakima mainstem sites) - Naches: Lost Creek Pond (RM 39) and Stiles Pond (RM 9)
Acclimation sites - new mainstem	- Upper Yakima: Holmes site (RM 160) and Boone Pond (RM 180.5) Roza Dam (RM 128) (use as alternate only)[5]
Broodstock collection – existing sites	Prosser, Roza, and Cowiche dams. Collect no more than 50% natural origin, 75% hatchery origin returns. See Appendix A. Oct 1–Dec 15
Radio-telemetry	Tag up to 150 adults and track from jet boats and autos and at fixed dam sites (Prosser: 50; Cowiche: 25; Roza: 25; 2 tributaries: 25). Mid-Sep through Nov
Spawning surveys (foot/boat)	- Mainstem Yakima (Keechelus Dam to Granger) - Mainstem Naches (Little Naches to confluence) - Release tributaries Sep 15–Nov 30
Juvenile collection/rotary trapping - existing traps	- Roza Dam juvenile trap: Up to 3,000 Yakima River naturally produced winter migrants will be PIT tagged (Nov-Mar) - CJMF[6]: Count, measure, PIT tag up to 3,000 coho (Nov 15–Jul 15) - Ahtanum Cr. rotary trap (RM 0.75) Nov 1–Jun 30 - Toppenish Cr. rotary trap (RM 26.5) Nov 1–Jun 30
Juvenile collection/rotary trapping - new traps	- Naches R. (Selah-Naches Diversion Canal, RM 18.4) - Wilson Cr. irrigation dam (RM 2) - Taneum Cr. (RM 4)
Snorkeling – coho distribution, habitat use	Preferred habitat (side channel areas and mainstem pools) in the following streams: - Upper Yakima: systematic sampling (10%) of preferred habitat from Easton to Ellensburg - Naches mainstem: systematic sampling (10%) of preferred habitat from Little Naches R. to confluence - Release tributaries (Taneum, Ahtanum, Toppenish, Pileup, Nile) - systematic sampling of preferred habitat. Specific reach generally will coincide with release reaches. Summer, 3 days for each major subbasin, 1-2 days each for tributaries
Juvenile electro-fishing surveys (boat)	Yakima mainstem: systematic sampling of preferred habitat, 10 half-mile reaches between Roza Dam (RM 128) and Granger (RM 83). One in summer, one in fall/winter
Juvenile electro-fishing surveys (backpack)	**Distribution surveys** Backwater channel areas in the following rivers: - Upper Yakima mainstem (Easton Dam to Wilson Cr.) - Naches mainstem: confluence to the Little Naches R. - Little Naches R.: confluence to North Fork and lower half mile of tributaries (based on presence of redds) - Tributaries near adult and parr release areas Nov-Feb, 5-10 days/month, not every area annually **NTTOC surveys** - Upper Yakima: Taneum Cr. (treatment), Swauk Cr. (control) - Naches: Pileup Cr. (treatment), Quartz Cr. (control)
Snorkeling - residualism	Spot checks downstream of new release site in Taneum Creek. 1 survey in early summer.

[5] The three sites listed are currently in use or under consideration; however, depending on coho survivals, additional sites, using natural ponds or net pens, might be investigated. See Section 6.4, Strategy 4a, for details.
[6] Chandler Juvenile Monitoring Facility

Table 2. Coho Release Plan, Phase 1B

Location	Release #	Life Stage	PIT Tag #	Stock	Purpose	Study Method
Mainstem Sites						
Yakima River						
Easton	Alternate site[1]	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Roza Dam	Alternate site[1]	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Clark Flat	Alternate site[1]	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location. CJMF, McNary
Holmes	215,000 early[2] 100,000 late[3]	Smolt	1,250	L. Columbia origin[4]	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Boone Pond	215,000[2]	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Naches River						
Stiles Pond	250,000 early[2] 100,000 late[3]	Smolt	1,250	L. Columbia origin[4]	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Lost Creek	250,000[2]	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, Selah-Naches diversion, CJMF, McNary
Tributary Sites						
Upper Yakima						
Crystal Springs/Easton-Keechelus Reach	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	PIT detector at Roza, CJMF, McNary
Keechelus-Easton Reach	1,250	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at Roza, CJMF, McNary
Big Creek	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	PIT detector at Roza, CJMF, McNary
Taneum Creek	20,000 early run, 20,000 late run	Smolt	1,250	Yakima/L. Columbia origin	Smolt-smolt survival	PIT detector at Taneum trap, CJMF, McNary,
Taneum Creek	120 females 160 males	Adult	na	L. Columbia origin	Egg-fry survival, adult productivity, NOTTOC study	Electro-fishing surveys, redd capping, new Taneum trap
Swauk Creek	Control for Taneum Cr.	na	na	na	NTTOC study	Electro-fishing surveys
Wilson Creek	20 pairs (40 fish)	Adult	na	L. Columbia origin	Egg-fry survival, adult productivity	Electro-fishing surveys, new trap at RM 2

1. Might be used if bird predation is too high at preferred sites (Holmes and Boone Pond).
2. These numbers are not fixed. If the project succeeds in producing more than 500,000 Yakima-origin smolts, numbers at ponds designated for in-basin fish could be increased to accommodate them. The balance between the two types of smolts in the four ponds will be managed on an annual basis by the WDFW and YN co-managers as the need arises.
3. Late-run fish could be released from upstream ponds if space becomes limited at downstream sites.
4. Eventually, if the project begins to approach the goal of producing up to 1 million smolts from Yakima-origin adults (see Appendix A), Lower Columbia fish could be replaced by Yakima-origin smolts in all ponds.

Table 2 (continued)

Location	Release #	Life Stage	PIT Tag #	Stock	Purpose	Study Method
Wilson Creek	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	Electro-fishing surveys; new trap at RM 4; PIT detectors at diversion trap, CJMF, McNary
Wilson Creek[5]	10,000	Smolts	2,500	Yakima origin	Smolt-adult survival from mobile facility	PIT detectors at CJMF, McNary; redd surveys
Reecer Creek	20 pairs (40 fish)	Adult	na	L. Columbia origin	Egg-fry survival, adult productivity	Electro-fishing surveys
Middle Yakima						
Ahtanum Creek	20 pairs (40 fish)	Adult	na	Yakima origin	Egg-fry survival, adult productivity	Electro-fishing surveys, existing rotary trap
Ahtanum Creek	3,000	Parr	3,000	Yakima origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; existing rotary trap; PIT detection at Ahtanum trap, CJMF, McNary
Ahtanum Creek[5]	30,000	Smolts	2,500	Yakima origin	Smolt-adult survival from mobile facility	PIT detection at CJMF, McNary; redd surveys
Toppenish Creek	20 pairs (40 fish)	Adult	na	L. Columbia origin	Egg-fry survival, adult productivity	Electro-fishing surveys, redd capping
Toppenish Creek	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; existing rotary trap; PIT detection at Toppenish, CJMF, McNary
Toppenish Creek[5]	10,000	Smolts	2,500	Yakima origin	Smolt-adult survival from mobile facility	PIT detection at CJMF, McNary; redd surveys
Naches						
N. Fork Little Naches River	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; PIT detection at Selah-Naches diversion, CJMF, McNary
Pileup Creek	20 pairs (40 fish)	Adult	na	L. Columbia origin	Egg-fry survival, adult productivity, NTTOC studies	Electro-fishing surveys, redd capping
Little Naches (Salmon Falls-South Fork)	3,000	Parr	3,000	Hatchery origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; PIT detection at Selah-Naches diversion, CJMF, McNary
Quartz Creek	Control for Pileup Cr.	na	na	na	NTTOC studies	Electro-fishing surveys
Nile Creek	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; PIT detection at Selah-Naches diversion, CJMF, McNary
Nile Creek	20 pairs (40 fish)	Adults	na	L. Columbia origin	Egg-fry survival, adult productivity	Electro-fishing surveys, redd capping
Little Rattlesnake Creek	3,000	Parr	3,000	L. Columbia origin	Over-winter survival (parr-smolt)	Snorkel, electro-fishing surveys; PIT detection at Selah-Naches diversion, CJMF, McNary

5. Only one portable vessel site would be tested each year through Phase 1B.

4. EXISTING ENVIRONMENT

4.1 The Historical and Current Status of Anadromous and Resident Fish in the Subbasin

4.1.1 Target Species: Coho Salmon (Oncorhynchus kisutch)

Kreeger and McNeil (1993) and the Yakima Subbasin Plan (YIN et al. 1990) estimate the historical coho run at 44,000 and 150,000 respectively (Berg and Fast 2001). The historical distribution of coho salmon in the Yakima subbasin is shown in Figure 1 (Berg and Fast 2001).

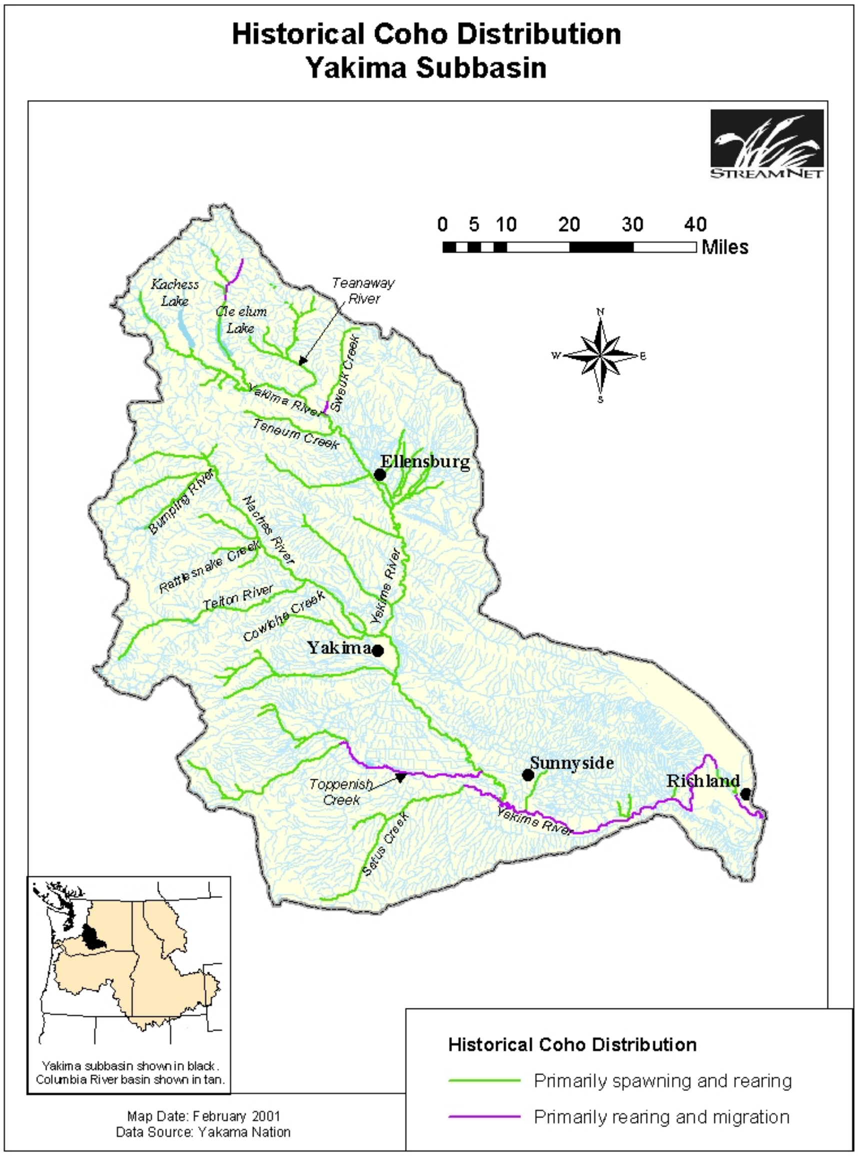


Figure 1. Historical Coho Distribution in the Yakima Subbasin

Fragmentary WDFW records of spawner surveys indicate that the endemic stock spawned in the upper Yakima above the Cle Elum confluence. Bryant and Parkhurst (1950) reported that coho spawned in smaller tributaries of the upper Yakima in the early 20th century, and it is now assumed that coho used virtually every low-gradient, perennial stream in the basin prior to extensive habitat alteration in the late 1800s (Berg and Fast 2001).

Wild coho now are considered extirpated in mid-Columbia basins and are not listed under the Endangered Species Act. However, the State of Washington Species Criteria lists them as Vulnerable, and Species of Importance. Their decline occurred in two major phases. First, between 1850 and 1900, water diversions for irrigation reduced runs of coho and all other anadromous salmonids by 90% (Davidson 1953; Tuck 1995; Lichatowich 1996). In the second phase, from 1900 to 1980, a remnant coho population slowly dwindled to extinction (Tuck 1995; Lichatowich 1996).

Efforts to restore coho within the Yakima basin rely largely upon releases of hatchery coho derived from Lower Columbia River stocks. The Yakama Nation has released between 85,000 and 1.4 million coho smolts in the Yakima basin annually since 1985. However, before 1995, the primary purpose of these releases was harvest augmentation; after 1995, the primary purpose became a test of the feasibility of re-establishing natural production (Berg and Fast 2001). Adult passage data at Roza Dam from 1941 to 1968 indicate that the endemic stock was early-run. The vast majority of the hatchery coho smolts out-planted since 1985 also have been early-run.

Figure 2 shows the estimated coho run size for the years 1984-2003. Coho returns since regular out-planting began in 1985 have increased steadily, climbing from 0 in 1984 to a peak of 6,138 in 2000 (Figure 2). The poor 2002 returns reflect low juvenile survival in their release year—the drought year of 2001. Because few of the out-planted coho smolts were marked until 2000, the proportion of natural-origin recruits in returns before 2001 is unknown (Berg and Fast 2001). Natural-origin adults comprised 30.8% of the 2001 adult return (YN 2001b), and 69% of the 2003 adult return (see Table 15, Section 6.1).

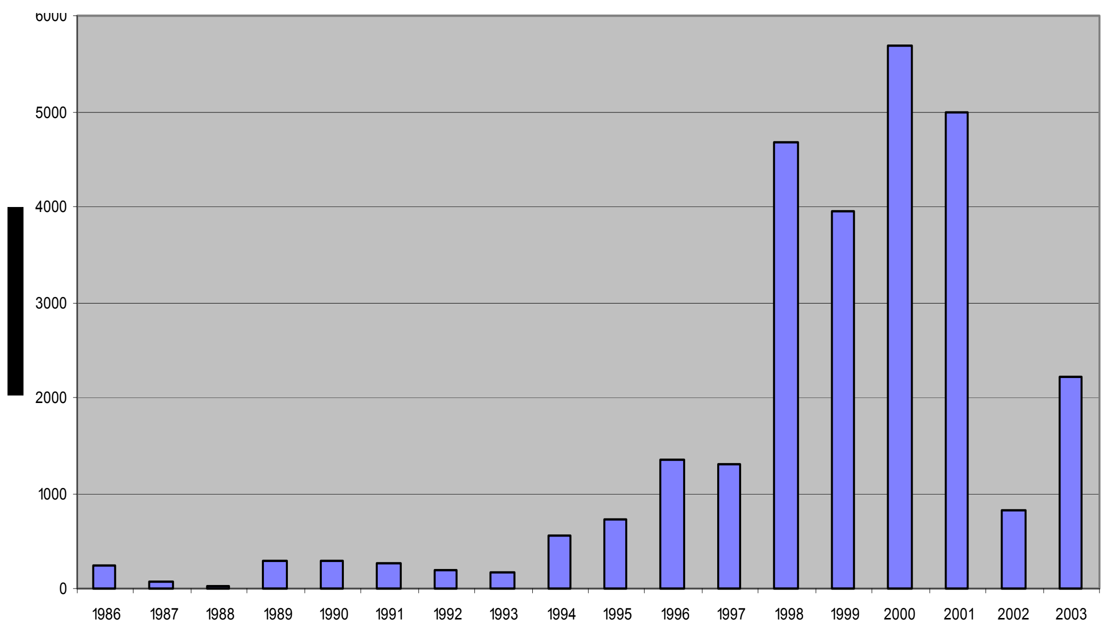


Figure 2. Adult Coho Returns 1986 – 2003 [7]

[7] The coho program changed from harvest augmentation to feasibility studies in 1995.

Hatchery-reared coho, out-planted as smolts, are now reproducing in both the Yakima and Naches Rivers (Figure 3). Natural reproduction is evident from the increasing number of zero-aged coho parr in samples taken at numerous points in the basin (YN, unpublished data, 2000 [in] Berg and Fast 2001). The naturalized run spawns in reaches downstream of the historical areas because, until 1999, the vast majority of hatchery smolts were acclimated and/or released well downstream of historical spawning areas. As was evident from the monitoring of radio-tagged adult coho in the fall of 1999, most coho spawned near their acclimation and release points, primarily in the middle Yakima below Sunnyside Dam (from RM 95 - RM 104) (Dunnigan 2000).

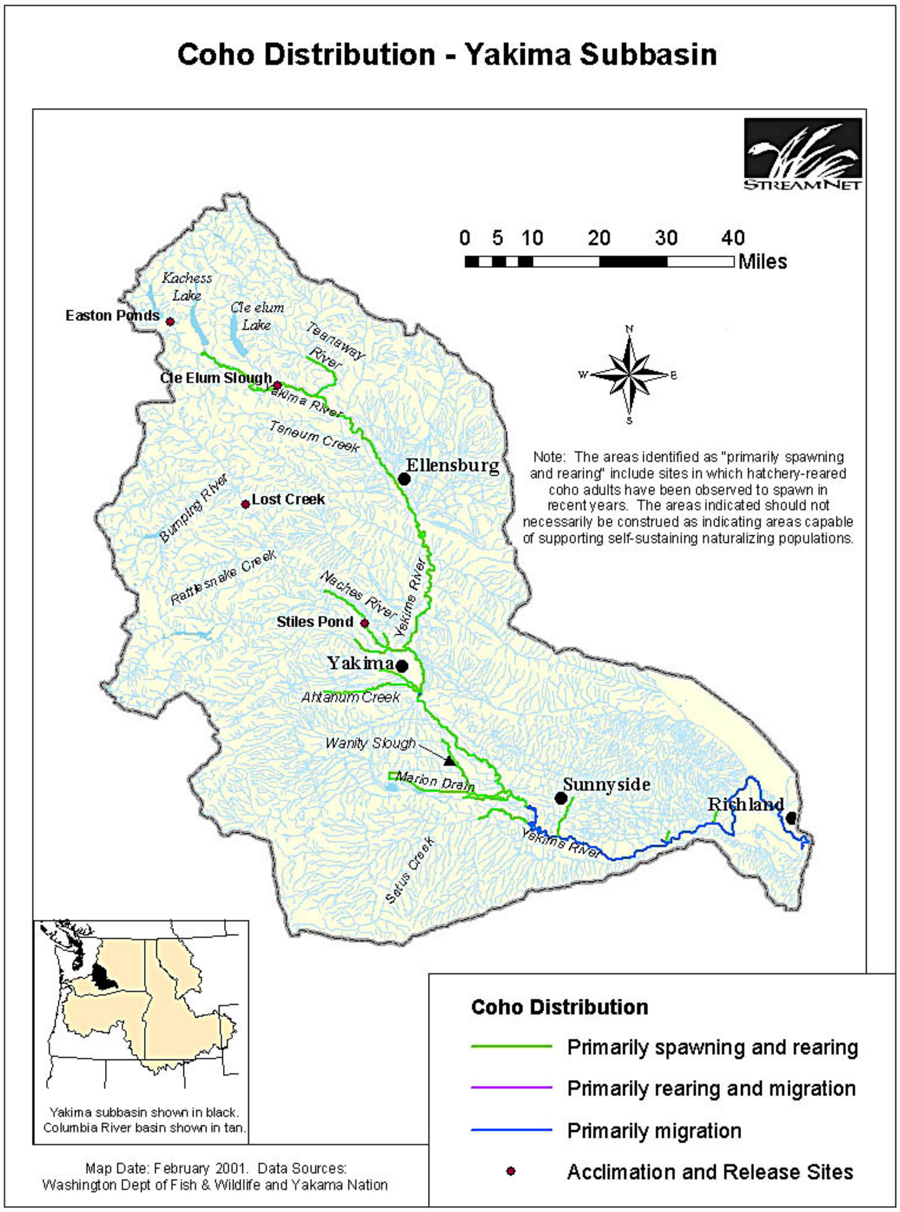


Figure 3. Current Coho Distribution in the Yakima Subbasin

Since 1999, all smolts have been released in the Naches and the upper Yakima rivers, although a portion of the releases began from Lost Creek in the upper Naches River in 1997. Despite this, the majority of spawning appears to occur in the Yakima River downstream of the Naches River confluence. Three factors could be contributing to this:

- lack of stamina (primarily of females) to reach their areas of release located further upstream,
- straying and delay due to false attraction from irrigation return flow, and
- natural production occurring in the Yakima River above Granger.

Nevertheless, the percentage of spawners returning to the Naches River has increased from 8.2% in 1999 to 29% in 2003 (Table 3), though the increase has not been steady. Correspondingly, the percentage of fish spawning in the Granger to Sunnyside Dam reach has decreased from 61.6% in 1999 to 28% in 2003 (with the percentage in 2002 being even lower).

Table 3. Results of 1999-2003 Radio Telemetry Studies for Yakima Basin Coho

	1999	2000	2001	2002	2003
Number radio tagged	86	102	105	48	71
Never seen	3.5%	5.9%	5.7%	4.0%	4%
Mortality/regurgitated tag	3.5%	2.0%	7.6%	6.0%	6%
Fell back at Prosser	4.7%	7.8%	5.7%	4.0%	4%
Prosser Dam to Granger	4.7%	1.0%	6.7%	13.0%	9%
Granger to Sunnyside Dam	61.6%	41.1%	37.1%	19.0%	28%
Sunnyside Dam to Naches confluence	12.8%	16.6%	5.7%	6.0%	9%
Mid-Yakima tributaries	1.2%	14.6%	4.8%	1.0%	11%
Lower Naches	4.7%	2.0%	3.8%	6.0%	0%
Naches above Cowiche Dam	3.5%	1.0%	13.3%	3.0%	29%
Naches confluence to above Roza Dam		7.9%	9.5%	11.0%	9%

Total harvest rates for all upriver, early coho (marked and unmarked) average about 20% in ocean fisheries and 15% in mainstem Columbia River fisheries, for a total of about 35%. Harvest rates on marked coho (hatchery released) are estimated to average 30% in ocean fisheries and 20% in river fisheries, for a total harvest rate of 50%. Harvest rates on unmarked coho (natural-origin or unmarked hatchery smolts) are estimated to average 12% in ocean fisheries and 11% in river fisheries for a total harvest rate of 23%. Currently non-Indian fisheries are managed to assure that at least 50% of the total upriver coho return escapes above Bonneville Dam. (These are combined early and late stocks—late stocks return to the Klickitat River) (Blodgett and Dunnigan 2001a). Harvest in the Yakima basin is minimal. In 2001, no coho were caught in the Tribal fishery, 50 coho in the sport fishery (YN 2001b).

4.1.2 Other Anadromous and Resident Fish in the Basin

Summer Steelhead *(Oncorhynchus mykiss)* ESA-listed as Threatened [8]

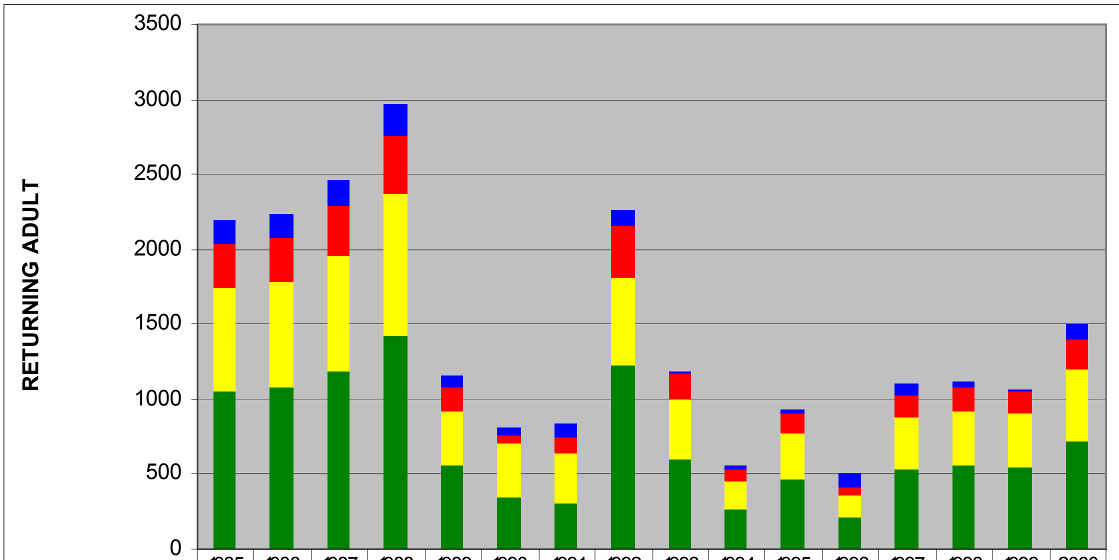
Historically, steelhead were probably found wherever spring chinook were found, and in many other tributaries and reaches as well. Yakima steelhead spawn in intermittent streams (Hubble 1992), side channels of larger rivers (Pearsons et al. [date not cited in original source] [in] Berg and Fast 2001), and in smaller streams and streams with steeper gradients than are suitable for

[8] Information in this section came from Berg and Fast 2001.

spring chinook or coho. Therefore it is probable that the historical spawning distribution of summer steelhead included nearly all accessible portions of the Yakima basin, with highest spawning densities occurring in complex, multi-channel reaches of the mainstem Yakima and Naches rivers, and in third- and fourth-order tributaries with moderate (1-4%) gradients. Estimates of the size of the historical steelhead run range from 20,800[9] (Kreeger and McNeil 1993) to 100,000 (Smoker 1956) [in] Berg and Fast 2001).

Yakima Basin summer steelhead are included in the Middle Columbia River (MCR) Evolutionarily Significant Unit (ESU) (Busby et al. 1996), which was listed under the Endangered Species Act (ESA) as "threatened" on March 25, 1999 (64 FR 14517). The MCR ESU includes all wild populations of summer steelhead in the Columbia River and its tributaries from the Wind River to the Yakima River (Berg and Fast 2001).

The current distribution of Yakima Basin steelhead is much more restricted and spatially variable than it was historically. Well over half of the spawning occurs in Satus and Toppenish Creeks, with a smaller proportion in the Naches drainage and a much smaller proportion in the upper Yakima (the Yakima mainstem and tributaries upstream of the Naches confluence) (Hockersmith et al. 1995). See Figures 4 and 5 (Berg and Fast 2001). Current steelhead abundance is only about 1.3% to 6% of historical estimates, averaging 1,256 fish (range = 505 in 1996 to 2,840 in 1988) over brood years 1985[10] - 2000 ([in] Berg and Fast 2001), with hatchery fish contributing about 10 to 20 percent of the total run, as monitored at Prosser Dam.



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
YAKIMA	157	160	176	212	83	57	83	113	15	28	23	92	79	34	21	105
TOPPENISH	291	297	327	394	154	57	108	340	167	75	129	59	147	154	150	199
NACHES	694	707	780	940	368	350	334	589	398	179	307	141	350	368	357	475
SATUS	1052	1072	1182	1425	557	350	309	1223	604	272	466	213	530	557	542	720

SATUS NACHES TOPPENISH YAKIMA

Figure 4. Steelhead Return Numbers in Four Yakima Subbasins, 1985-2000

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9 Mean of range estimated – 18,200 to 23,400.

10 Prior to the run of 1984-85, it was impossible to use the ladders at Prosser Dam to count adult steelhead, and estimates of run sizes before the 1985 brood are based on estimated catch and an assumed exploitation rate.

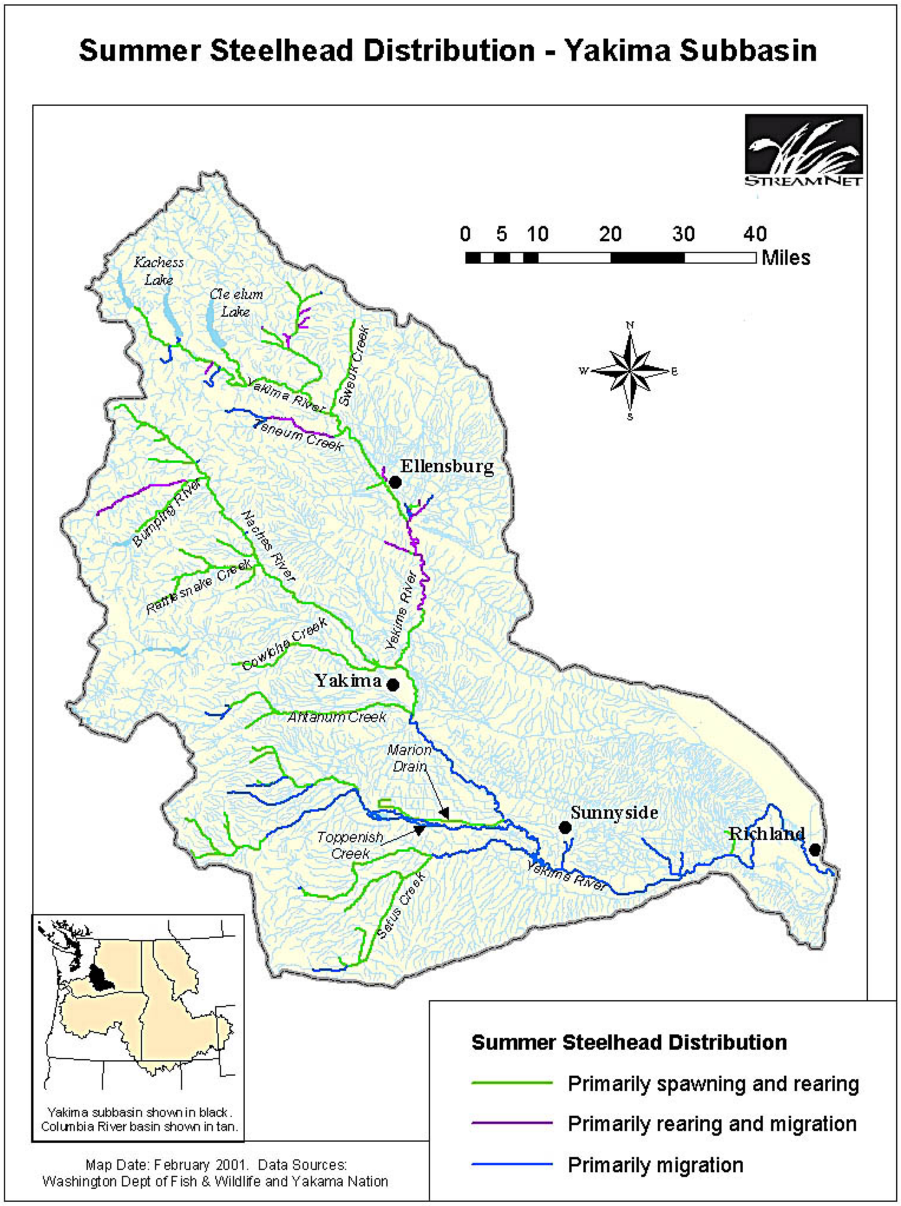

Figure 5. Summer Steelhead Distribution in the Yakima Subbasin

Busack and Phelps (1996) performed a number of electrophoretic analyses on rainbow trout and steelhead of both wild and hatchery origin collected at 14 sites over six years. On the basis of a large number of paired comparisons of allozyme frequencies, they identified four genetically distinct populations of wild steelhead in the basin: an upper Yakima stock, a Naches stock, a Satus Creek stock and a Toppenish Creek stock. They also determined from admixture analyses that wild rainbow and steelhead from a number of locations in the upper Yakima interbreed. Although a comparable analysis of wild Naches trout and steelhead was not performed, it was determined that hatchery trout and Naches steelhead have interbred, as have hatchery trout and wild steelhead in the upper Yakima. Wild Satus and Toppenish Creek steelhead, on the other hand, showed no evidence of interbreeding with hatchery trout or steelhead.

Steelhead adults begin passing Prosser Dam in September, cease movement during the colder parts of December and January, and resume migration from February through June. They hold in the Yakima mainstem and generally are not seen in tributaries until April, May, and June. The run has two peaks, one in late October, and one in late February or early March. The relative numbers of wild fish returning during the fall and winter-spring migration periods varies from year to year, perhaps depending on the duration of a “thermal window” in the fall.

Spring Chinook Salmon (*Oncorhynchus tshawytscha*) [11]

Spring chinook salmon are prized as sport fish and for commercial, ceremonial, and subsistence fishing. Historically, they comprised one of the largest anadromous fish runs in the Yakima River Basin. A substantial portion of the YKFP program is devoted to the study and management of spring chinook.

Based on two years of extensive genetic analysis by WDFW (Busack et al. 1991), there appear to be three genetically distinct substocks of spring chinook salmon in the Yakima River Basin: the American River, Naches River, and upper Yakima stocks.

Adult spring chinook salmon begin migrating upstream past Prosser Dam in late April and have completed passage by late July. Figure 6 shows their current distribution in the basin. They currently spawn in the Yakima River upstream from the city of Ellensburg and immediately downstream to Roza Dam; in the Cle Elum River downstream from Lake Cle Elum; in the mainstem Naches, Bumping, Little Naches, and American rivers; and in Rattlesnake Creek. All populations have completed spawning by mid-October.

[11] Unless otherwise noted, all material in this section came from BPA et al. 1996.

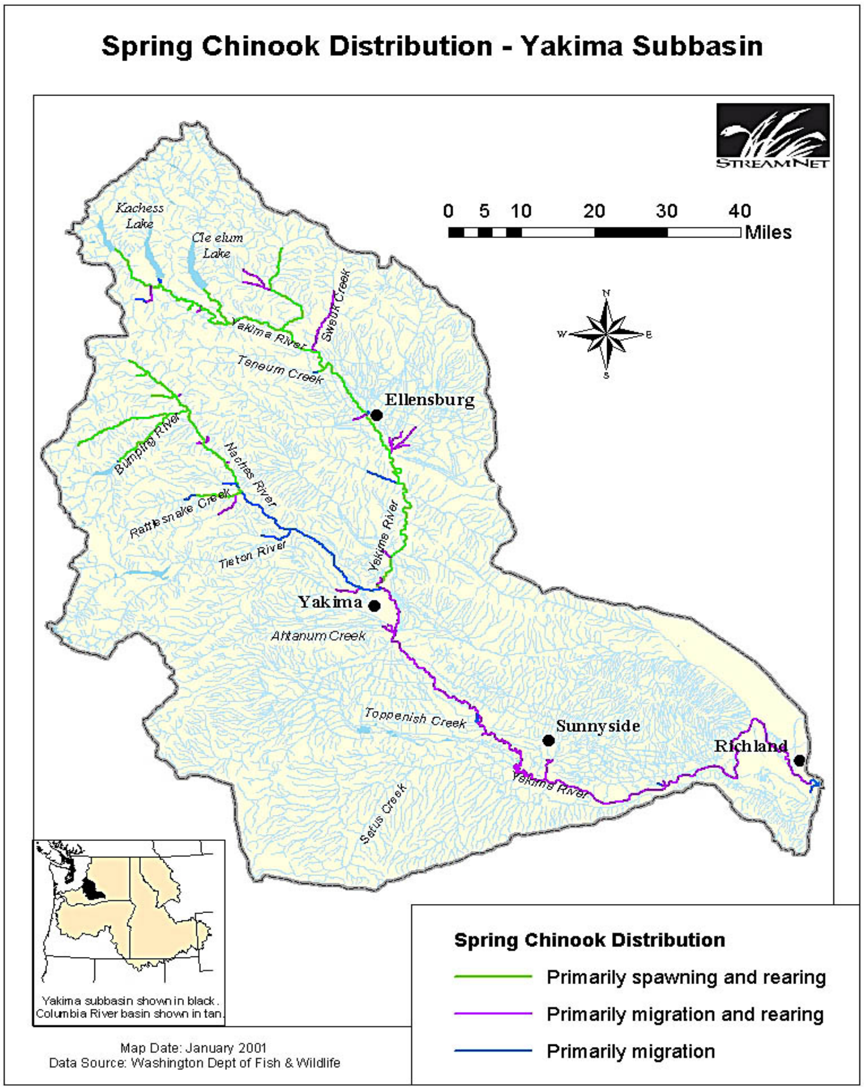

Figure 6. Spring Chinook Distribution in the Yakima Subbasin

Fall Chinook Salmon (*Oncorhynchus tshawytscha*) [12]

Fall chinook salmon once were abundant in the Yakima River Basin. Historical production may have been as high as 250,000 adult fish (YIN et al. 1990). Little is known about their historical distribution within the Yakima River, although their production is believed to have been confined to the area between the Sunnyside Dam and the Columbia River confluence (Fast et al. 1990 [in] BPA et al. 1996). Figure 7 shows recent estimates of adult returns to the Yakima Basin (Blodgett and Dunnigan 2001b).

[12] Unless otherwise noted, all material in this section came from BPA et al. 1996.

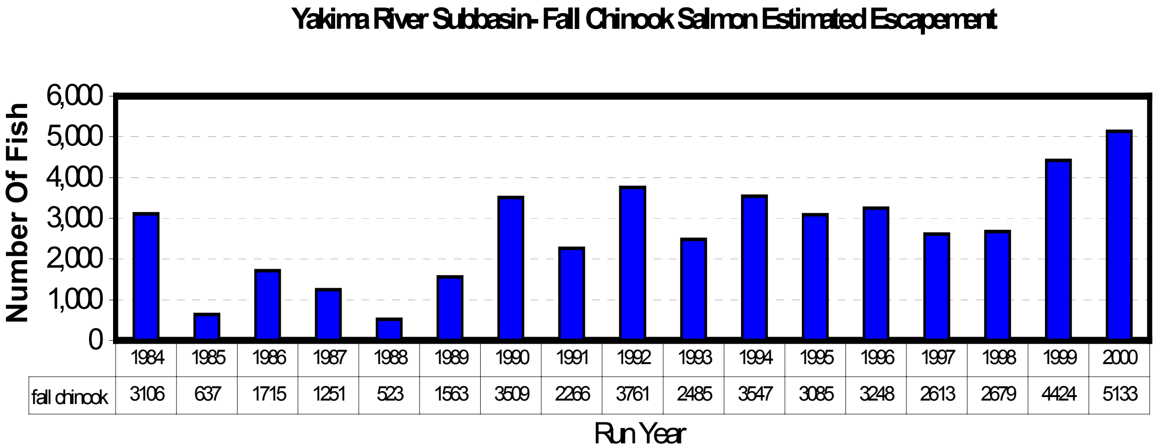

Figure 7. The Estimated Fall Chinook Run to the Yakima Basin (Includes Below Prosser Dam), 1984-2000

There are no data describing the historical run timing, age composition, sex ratio, size-at-age, fecundity, or population structure of Yakima fall chinook salmon. Figure 8 shows their current distribution.

Under the expired Columbia River Fish Management Plan (CRFMP) of *U.S. v. Oregon* (currently being re-negotiated), the YN's fall chinook program in the Yakima River Basin includes the production and release into the Yakima of 1.7 million smolts from the Little White Salmon National Fish Hatchery. Between 1983 and 1994, the smolts were transported and directly released into the Yakima River. With funds provided under the Mitchell Act program, the YN has developed acclimation facilities in the vicinity of Prosser Dam for final rearing and release of these fall chinook smolts; they began operation in 1994.

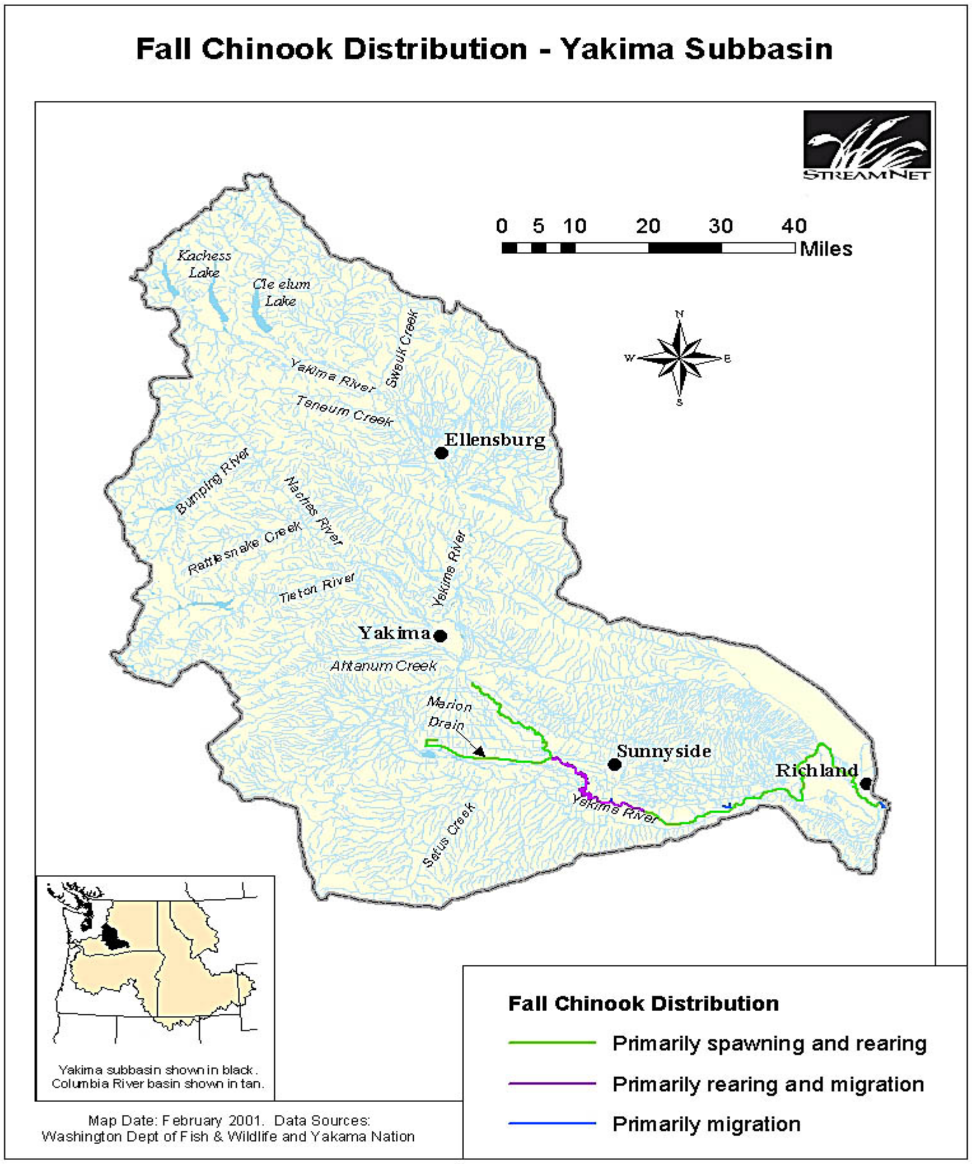

Figure 8. Fall Chinook Distribution in the Yakima Subbasin

Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout that inhabit the mainstem of the upper Yakima basin provide the best naturally produced stream trout fishery in the state of Washington (Krause 1991; Probasco 1994 [in] Berg and Fast 2001).

Preliminary genetic analyses of resident rainbow trout in the upper Yakima River have discerned five genetic groups (Pearsons et al. 1993 [in] BPA et al. 1996). Using electrophoretic methods, the analysis found that rainbow trout and steelhead were genetically similar where they occurred together. Genetic as well as ecological evidence indicates that rainbow trout and steelhead interbreed. Rainbow trout were genetically indistinguishable from sympatric steelhead collected in the North Fork of the Teanaway River (Pearsons et al. 1998 [in] Berg and Fast 2001).

Rainbow trout spawn throughout the entire upper Yakima basin, with the possible exception of some high-elevation portions of a few tributaries (Pearsons et al. 1993; Pearsons et al. 1994 [in] BPA et al. 1996).

Bull Trout *(Salvelinus confluentus)* ESA-listed as Threatened [13]

In the past, bull trout were found throughout the Yakima River subbasin. In all streams where bull trout are noted in the historical catch records, relatively few fish were recorded compared to other game fish. Whether this is a reflection of historically low population abundance is difficult to tell.

In June 1998, the U.S. Fish and Wildlife Service (USFWS) listed bull trout in the Columbia River basin as threatened under the Endangered Species Act.

Currently, nine bull trout stocks have been identified in the Yakima basin that are native fish sustained by wild production (Table 4). There are no hatchery bull trout stocks in Washington State. According to WDFW, there is no information to indicate that these are genetically distinct stocks; they are treated separately because of the geographical, physical and thermal isolation of the spawning populations.

According to WDFW, of the nine stocks identified, only Rimrock Lake is healthy; Bumping Lake is depressed; Yakima River, Ahtanum Creek, North Fork Teanaway, Kachess Lake and Keechelus Lake are critical and Naches and Cle Elum/Waptus Lakes are unknown (WDFW 1998).

Bull trout are strongly influenced by temperature and are seldom found in streams exceeding summer temperatures of 18º Celsius. Cool water temperatures during early life history result in higher egg survival rates, and faster growth rates in fry and possibly juveniles as well (Pratt 1992). Depending on the life history form, rearing and over-wintering habitat vary, but all require cool clean water with insects, macro-zooplankton, and small fish for larger adults.

Pacific Lamprey (*Lampetra tridentata*)

Pacific lamprey are known to be in the Yakima Basin (BPA et al. 1996), but their historic and present distribution and status are relatively unknown. Occasionally a few adults were counted at Prosser Dam in the spring through the 1990s. In 2001 and 2002, 22 and 82 adults were counted, respectively (M. Davis, YN, 2003, personal communication).

[13] Unless otherwise noted, all information in this section is from Berg and Fast 2001.

Table 4. Historical and Present Distribution of Bull Trout in the Yakima Subbasin

R=Resident, F=Fluvial, F/R=Fluvial/Resident, AD=Adfluvial

Lake or Stream	Last Year Present	Last Year Checked
Yakima River (Benton Co) (F)	1997 [1]	2002
Yakima River (Yakima Co) (F)	2002	2002
Satus Cr.	1953 [2]	1991
Ahtanum Creek (R)	2002	2002
N.F. Ahtanum Cr.	2002	2002
Shellneck Cr.	2002	2002
M.F. Ahtanum Cr.	2002	2002
S.F. Ahtanum Cr.	2002	2002
Naches River (F)	2002	2002
Cowiche Cr.	2002	2002
Tieton R.	2002	2002
Oak Cr.	1999	1999
Rattlesnake Cr.	2002	2002
N.F. Rattlesnake Cr.	1996	1996
Hindoo Cr.	1995	1996
Dog Cr.	1996	1996
Little Wildcat Cr.	2002	2002
Milk Cr.	1996	1996
Bumping R. (Lower)	2002	2002
American R.	2002	2002
Kettle Cr.	2002	2002
Timber Cr.	1993	1993
Union Cr.	2002	2002
Little Naches R.	2002	2002
Crow Cr.	2002	2002
Quartz Cr.	1998	1998
Pileup Cr.	1998	1998
Rimrock Lake (AD)	2002	2002
S.F. Tieton R.	2002	2002
Short and Dirty Cr.	1994	1994
Spruce Cr.	1996	1996
Grey Cr.	1994	1994
Bear Cr.	2002	2002
Indian Cr.	2002	2002
N.F. Tieton R. (Lower)	1997	1994
Clear Lk.	1993	1996
N.F. Tieton R.(Up.)	1996	1990
Dog Lk.	1950 [2]	
Bumping Lake (AD)	2002	2002
Deep Cr.	2002	2002
Bumping River (Upper)	1994	1994

(1) A single fish captured near Benton City by WDFW biologists (extreme rare occurrence).
(2) This record possibly species mis-identification (brook trout).

Table 4 (continued)

Lake or Stream	Last Year Present	Last Year Checked
Yakima River (Kittitas Co.) (F)	2002	2002
Coleman Cr.	1970	1984
Swauk Cr.	1993	1999
Easton Lake	2000	2000
N.F. Teanaway R. (F/R)	2002	2002
Jack Cr.	1997	1997
Jungle Cr.	1997	1997
DeRoux Cr.	2002	2002
Cle Elum Lake (AD)	1993	1993
Cle Elum R. (Upper)	2002	2002
Waptus Lake	1997	1998
Kachess Lake (AD)	2002	2002
Box Canyon Cr.	2002	2002
Kachess R. (Upper)	2002	2002
Mineral Cr.	2002	2002
Keechelus Lake (AD)	2002	2002
Rocky Run Cr.	1983	1983
Gold Cr.	2002	2002

Source: Updated and modified from Goetz 1989 by WDFW (personal communication, Eric Anderson, 2003).

4.1.3 Yakima Subbasin Habitat Condition

The NPCC's 2000 Fish and Wildlife Program asks that Columbia Basin implementation strategies assess the suitability of proposed actions against the habitat conditions in the subbasin (NPPC 2000). The 2000 Program provides the following table of definitions of habitat conditions.

Criteria			Examples of strategies	
Habitat condition	Description	Biological potential of target species	Habitat strategy	Possible artificial production strategy
Intact	Ecological functions and habitat structure largely intact	High	Preserve	No artificial production
		Low	Preserve	Limited supplementation
Restorable	Potentially restorable to intact status through conventional techniques and approaches	High	Restore to intact	Interim supplementation
		Low	Restore to intact	Limited supplementation
Compromised	Ecological function or habitat structure substantially diminished	High	Moderate restore	Limited supplementation
		Low	Moderate restore	Supplementation
Eliminated	Habitat fundamentally altered or blocked without feasible option	High	Substitute	Replacement hatchery
		Low	Substitute	Replacement hatchery

Source: NPPC 2000.

The following paragraphs quoted from the Yakima Subbasin Summary (Berg and Fast 2001) summarize the extensive analysis in that document of overall habitat conditions in the basin. (There are nearly 75 pages on fish habitat alone.)

> "Today, only a few isolated river fragments within the drainage basin can be considered normative with respect to historic conditions (p. 107). … We recognize that, because we are dealing with an ecosystem that has sustained extensive human development for over 150 years, numerous social and biophysical constraints exist for enhancing normative conditions. The challenge before the region is to reach consensus on the extent to which these constraints can be relaxed or removed to achieve Fish and Wildlife Program goals. Nevertheless, we believe strongly that approaching more normative ecosystem conditions is the only way in which Fish and Wildlife Program goals for recovery of salmonids and other fishes can be met ([Independent Scientific Group] 1996:19) (p.111).
>
> "Recently, management expanded to encompass the acquisition of remnant habitats that contain vestiges of structure, function, and ecological integrity-habitats with the potential for preservation and restoration. These are primarily activities initiated by federal, tribal, state, and some county and municipal entities attempting to partner with industry, conservancies, foundations, and citizens. … Unprecedented in the history of the basin, these approaches are driven by culturally meaningful and legally mandated goals for preservation, restoration, and enhancement of the basin's ecological integrity." (p. 111).

The Summary's analysis suggests that overall habitat conditions in the Yakima basin fit the Council's definition of "Compromised" (NPPC 2000, Section D2).[14] Given that coho have only recently begun to return to spawn naturally in the basin, it also seems that, for the short term, the biological potential[15] of the target species is low. As stated in the 2000 Fish and Wildlife Program, under the definition of "Compromised habitat": "Where the target species has low biological potential, the objective will be to restore the habitat up to the point that the sustainable capacity of that habitat is no longer a significant limiting factor for that population. In this instance, a possible policy choice is expanded artificial production that utilizes the natural selection capabilities of the natural habitat to maintain fitness of both natural and artificial production" (NPPC 2000, Section D2).

As can be seen in the program objectives (Section 3) and the summary of results to date (Section 5), the Yakima coho program has been attempting to use artificial production—with acclimation in good quality habitat to which coho are returning already or that they occupied historically—and development of a locally adapted broodstock to improve the fitness of coho in this subbasin, and thereby to improve the long-term chances of reintroducing a sustainable coho population. The coho program is optimistic that its efforts, in combination with the extensive subbasin habitat improvements already planned and accomplished, will contribute to achieving Fish and Wildlife Program goals and objectives, including those described in Section D3 (NPPC 2000).

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[14] Compromised habitat: Where the habitat for a target population is absent or substantially diminished and cannot reasonably be fully restored, then the biological objective for that habitat will depend on the biological potential of the target species (NPPC 2000).

[15] The "biological potential" of a species means the potential capacity, productivity, and life history diversity of a population in its habitat at each life stage (NPPC 2000).

4.2 Current and Planned Management of Anadromous and Resident Fish in the Subbasin

As mentioned in Section 4.1.3, the Yakima Subbasin Summary (Berg and Fast 2001) lists numerous ongoing and completed habitat restoration projects undertaken in the basin by a variety of agencies and groups. The document also outlines a detailed summary of goals, objectives, and strategies for fish and wildlife in the Yakima subbasin. They represent management goals of a number of federal, tribal, state, and local governments and agencies that have jurisdiction over subbasin resources. The recently completed Yakima Subbasin Plan (YSPB 2004) builds on the goals summarized below, including recognition in Section 4.2 of the plan that the YKFP coho reintroduction effort is addressing key uncertainties.

As can be seen from this summary, the YKFP's Yakima Coho Project objectives are consistent with the subbasin-wide goals. As well, if accomplished, the subbasin goals would enhance the potential for success of the Yakima Coho Project.

Overall goal: Protect, restore and enhance fish and wildlife and their habitats in the Yakima subbasin to provide ecological, cultural, economic and recreational benefits.

- **Goal 1: Maintain and protect existing high quality habitat areas and the native populations inhabiting those areas.** Objectives and strategies address habitat purchases for such key habitat components as floodplain and side channel habitat; use of incentives like conservation easements to encourage habitat protection; maintaining and restoring stock distribution of bull trout and their habitat; continued mapping of resource areas; and enforcement of existing laws designed to protect habitat from further damage and encroachment.
- **Goal 2: Restore degraded areas, and return natural ecosystem functions to the subbasin.** Objectives and strategies call for increased flows and reduced water temperatures in specific sections of the basin, especially when anadromous fish are present; restoration of habitat necessary for critical life history stages including spawning, rearing and migration; and restoration of degraded wetland and riparian habitats.
- **Goal 3: Restore, maintain, and enhance fish and wildlife populations to sustainable levels and also, when applicable, harvestable levels.** Objectives and strategies call for supplementation of wild stocks that are declining and in danger of extinction, and reintroduction of salmon and steelhead to areas they once occupied. Objectives list specific strategies related to spring chinook and the existing program at the YKFP Cle Elum Supplementation and Research Facility (CESRF), **coho reintroduction as described in this master plan**, mainstem and Marion Drain populations of fall chinook, use of reconditioned steelhead kelts to rebuild ESA-listed steelhead in the basin, monitoring and evaluation of existing steelhead stocks/runs and habitat, and recovery of bull trout stocks. Other objectives address fisheries. While one calls for rearing hatchery salmon, steelhead, and trout to provide recreational and tribal fishing opportunities, another emphasizes limiting harvest of bull trout to healthy stocks with surplus production. Maintenance of genetic diversity is also emphasized.
- **Goal 4: Increase the information and knowledge needed to restore and manage fish, wildlife and their habitats.** Objectives and strategies address research and monitoring as well as public information and education programs.

5. PHASE 1A STUDY RESULTS SUMMARY

The following brief summaries are included in this master plan only to provide a rationale and context for the Phase 1B studies now proposed. They should not be considered a complete report of study results, which are detailed in the reports cited.

Phase 1A of the coho feasibility study, due to be completed at the end of 2004 or 2005, addressed five basic questions:

1. Which geographical area is better suited for natural coho production: the upper Yakima basin or the Naches basin?
2. What acclimated smolt release timing (early or late) provides the best smolt-to-smolt and smolt-to-adult survival?
3. Which broodstock (out-of-basin vs. local) has the highest productivity?
4. To which parts of the basin do adult coho return?
5. What is the existence and biological significance of impacts to populations of NTTOC identified as being at demonstrable risk from ecological interactions with coho?

The experiments designed to answer the first three questions were conducted between 1999-2002. Results through 2001 were published in detail in project annual reports (Dunnigan 2000; Dunnigan 2001). The release plan is summarized in Table 5.

Table 5. Coho Release Strategies

Upper Yakima 1				Upper Yakima 2				Naches 1				Naches 2			
Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Out-of-basin	Local	Local	Out-of-basin	Out-of-basin	Local	Local	Out-of-basin	Out-of-basin	Local	Local	Out-of-basin	Out-of-basin	Local	Local	Out-of-basin

Each of the 16 groups was uniquely coded wire tagged and PIT tagged. Smolt-to-smolt survival indices were statistically analyzed by Douglas Neeley, the YKFP statistician. A summary of his results is presented in Table 6 for years 1999-2001.

Table 6. Coho Survival-Index Rates to McNary Dam

Time of release			Release location		Stock type	
Release Year	Early	Late	Upper Yakima	Naches	Local	Out-of-basin
1999	0.53*	0.44*	0.46	0.52**	0.54***	0.43***
2000	0.24	0.18	0.15	0.26	NA	NA
2001	0.13	0.12	0.04	0.22	0.19****	0.07****

* statistical difference (P = 0.05)
** Stiles Pond only
*** statistical difference (P = 0.02)
****statistical difference (P < 0.001)

The early release smolt group out-performed the late-released group all three years and was significantly different in 1999. This is attributed to progressively poorer out-migration conditions in the lower Yakima River from April through June. Smolts released from the Naches basin had greater survival to McNary Dam than those released from the upper Yakima subbasin. Better out-migration survival for smolts originating from the Naches basin is attributed to a shorter out-migration distance to McNary Dam and probably less avian predation at the acclimation sites prior to release. Smolts produced from the local broodstock had better survival than those from out-of-basin in 1999 and 2001.

Results were slightly different in 2002, though the general trends observed in past years remain. The major conclusions were summarized by Neeley (2003), and were as follows:

Early Release versus Late Release

- For the Yakima stock, the late-release survival index significantly exceeded that of the early-release, but the time-of-release difference for the Willard stock was not significant.
- For the Stiles release site, the survival index for the late release significantly exceeded that for the early release. The time-of-release difference was not significant for the other two sites (Easton and Lost Creek).

Yakima Stock versus Willard Stock

- The Yakima stock survival index to McNary significantly exceeded that of the Willard stock for late releases. There was no significant difference between the two stocks for early releases; however, this conclusion was less certain due to logistical issues (Neeley 2003).

Table 7. Weighted Coho Release-to-McNary Smolt Survival Indices from Hatchery and Yakima-Return Broodstock for Upper Yakima and Naches Releases 1999 - 2003 *

		Outmigration Year				
Subbasin	**Broodstock**	**1999**	**2000**	**2001**	**2002**	**2003**
Upper Yakima	**Yakima Returns**	0.3866		0.0512	0.1287	0.1155
	Hatchery Source	0.5200	0.1758	0.0286	0.1647	0.0980
Naches	**Yakima Returns**	0.2490		0.3185	0.4283	0.2334
	Hatchery Source	0.3841	0.2930	0.1059	0.2936	0.1633

* Brood-Years 1997 through 2001, respectively (weights are release numbers)
Source: Neeley 2003

Smolt-adult survival rates for the 2001 and 2002 adult returns (brood years 1998 and 1999) were:

- 2001: hatchery 1.8%, wild 3.8%
- 2002: hatchery .04%, wild 0.87% (reduced survival for both groups during out-migration in the 2001 drought year)

Researchers suggest that the lower adult return rate of the out-of-basin fish might be attributable to lack of stamina in progeny of lower Columbia broodstock, which migrate a much shorter distance when returning from the ocean than Yakima basin-bound fish (Dunnigan et al. 2002).

Results of Phase 1A studies addressing question #4 (location of adult returns) are shown in Table 3, Section 4.1.1.

As a way to begin to address the issue of ecological interactions (question #5), during Phase 1A, the coho project adopted the risk containment objectives for Non-Target Taxa of Concern (NTTOC) as identified by the YKFP spring chinook project (Table 8).

Table 8. Risk Containment Objectives for NTTOC in the Yakima Basin

NTTOC	Containment Objective
Rare – rare species or stock, or regionally rare Bull trout (upper Yakima R. and Naches R.) Westslope cutthroat trout (upper Yakima R. and Naches R.) Pacific lamprey Naches steelhead Status steelhead Toppenish steelhead Upper Yakima steelhead	No impact
Rare – in basin Marion Drain fall chinook salmon Mountain sucker Leopard dace Sand roller	Very low impact (≤ 5%)
Native game or food fish – very important Resident rainbow trout in the mainstem Yakima R. and mainstem Naches R. Upper Yakima R. spring chinook salmon Naches spring chinook salmon American River spring chinook salmon	Low impact (≤ 10%)
Native game or food fish – important Mountain whitefish Resident rainbow trout in tributaries	Moderate impact (≤ 40%)
Common Other native species	≤ maximum impact that maintains all native species at sustainable levels

These objectives are target levels of impact; they are **not** rigid limits, which if exceeded, would cause managers to immediately modify, suspend or cancel the project. The objectives define which species to monitor for changes to populations in areas of coho releases. If changes to NTTOC populations are found, the next step is to design studies to determine if the change is caused by the coho program or by other factors. **Note that these objectives were changed slightly for Phase 1B, and subbasin-specific risk assessments were performed based on proposed releases in specific subbasins (Tables 10 – 13).**

In Phase 1A, the project studied the risks of hatchery coho residualism, and of hatchery coho smolt predation on and competition with other fish species. Specifically, the project examined coho smolt predation on spring and fall chinook, and coho fry competition with rainbow/ steelhead and cutthroat trout. The following describes the project's conclusions to date about each of those risks.

Residualism. The following results were reported in more detail in Dunnigan 1999, Dunnigan 2001, and YN 2001b.

An investigation was initiated in 1999 to determine baseline levels of hatchery coho residuals in the upper Yakima subbasin. Prior to this investigation, no estimates of relative abundance of residual fish existed. On May 17, 1999, approximately 24,850 and 125,000 yearling coho smolts were volitionally released after a period of approximately 5 weeks of acclimation at the Easton and Jack Creek spring chinook acclimation facilities respectively. Identical volitional releases were made from each location on May 27, for a season total release of 49,700 Easton and 250,000 Jack Creek smolts. Snorkel surveys were conducted in the Yakima and Teanaway rivers downstream of the acclimation sites from July 8-20, 1999 to detect the presence of hatchery coho smolts that did not migrate during the May smolt releases.

Analysis suggests that there may have been up to 8,580 (1.7%) hatchery coho residuals between the Cle Elum River confluence and Roza Dam from the 500,000 coho released in the upper Yakima subbasin in 1999. These estimates likely represent the worst case scenario, based on two factors. First, the estimates were calculated using early July snorkel observations, which were higher than late July estimates. Many of the coho present in the early July sample might have migrated downstream and therefore were not detected during the late July surveys. Second, the Easton reach contains probably the highest quality rearing habitat within the entire Yakima basin, which likely maximized the potential for coho to inhabit this area and to be observed in the surveys. Furthermore, hatchery coho residual rates observed in the Teanaway River were much lower than the Easton reach, even though it is likely that Teanaway surveys had higher snorkel efficiency due the narrower stream width. Therefore, expansions based on observations within the Easton reach are likely over-estimates of hatchery coho residual rates for areas of lower quality rearing habitat located downstream. WDFW snorkel and electro-fishing surveys in the upper Yakima subbasin in the summer and fall of 1999 corroborate YN's findings that hatchery coho smolt residual rates were low (T. Pearsons, personal communication).

Residualism surveys near release sites in the Yakima and Naches subbasins were conducted again in 2000 and 2001. Estimates of the average number of residual coho in the upper Yakima and Naches subbasins were relatively low in 2000 (Dunnigan 2001). YN estimated that more coho were present in the Naches subbasin than in the upper Yakima in 2000 (67.8 and 14.7 coho per kilometer respectively). The higher estimated number in the Naches is attributed to natural coho production in that reach. (Hatchery coho had no external mark to distinguish them from naturally produced coho.) Estimates of the number of coho residuals per kilometer in 1999 and 2000 were similar when expressed as a per capita of coho released (Dunnigan 2001). Again, WDFW snorkel and electro-fishing surveys in the upper Yakima subbasin in summer and fall of 2000 corroborate YN's findings that hatchery coho smolt residual rates were low (T. Pearsons, personal communication [in] Dunnigan 2001).

In 2001, surveys for residual coho smolts on the upper Yakima River (Easton reach) were conducted from the Easton acclimation site (Rkm 325.4) to the confluence of Cle Elum River (Rkm 294.6). The Naches River (Lost Creek reach) surveys were done from the Lost Creek acclimation site (Rkm 61.8) to the confluence with Rock Creek (Rkm 53.9). In 2001, residual coho were generally absent from all snorkel surveys. Two residual coho were seen in the Lost Creek reach, which equated to 0.25 fish per river kilometer. No residuals were observed in the upper Yakima River reach. Sub-yearling coho were observed in low numbers (upper Yakima: 55 fish or 1.8 fish per km; Naches: 33 fish or 4.2 fish per km), an indication of natural production. Results in 2001 are consistent with those in 1999 and 2000, where relatively low densities of residuals and sub-yearlings were observed in both subbasins.

A high degree of residualism could negatively impact the coho program strictly from the aspect of production. Based on the low estimated number of residual hatchery coho observed in the Yakima subbasin, it is unlikely that residualism significantly affected smolt survival estimates or future smolt-to-adult survival estimates (Dunnigan 2001).

High numbers of residual coho also could increase the potential for negative ecological interactions with other species. Based on the low estimated number of residual coho found during the study years, the potential probably was minimal for such negative ecological interactions (Dunnigan 2001).

Due to the low numbers of residual coho found at smolt release sites, **Phase 1B residualism studies** will be limited to areas near a new release site (see Section 6.3, Strategy 3a).

Coho Predation on Fall Chinook. As reported in Dunnigan and Hubble 1998, hatchery coho smolt predation on fall chinook was studied in 1992, 1997, and 1998. Because results from 1992 are considered inconclusive, only results from 1997 and 1998 are summarized here. For detail on data collection and analysis methods, please see the original report.

<u>1997</u>

A total of 6,523 coho samples were collected from the Yakima Basin during 1997 for stomach analysis. YN collected 5,234 coho from Chandler Juvenile Monitoring Facility (CJMF) and 1,126 coho from Sunnyside Dam. Five coho (0.4% of the sample) had consumed fish at Sunnyside Dam. Two of the five fish were identified as *Oncorhynchus* spp. Although 837 coho salmon (16% of the sample) collected at CJMF contained fish, only 11 of these prey fish were identified as *Oncorhynchus* spp. The two most abundant fish species found in coho stomachs in 1997 were carp (*Cyprinus carpio*) and sucker (*Catastomus* spp) (92% and 5% respectively, of all fish-containing samples). Coho at CJMF consumed virtually no fish until June 1st, which also coincided with an increase in the abundance of non-salmonid species moving through the facility.

Flows during the 1997 coho out-migration were unusually high and protracted, which greatly reduced coho catchability in the open river, and resulted in the collection of only 173 coho. High flow conditions in the Yakima River began on March 20, and peaked at 19,024 cubic feet per second on May 15th, which coincided with the release date of coho. None of the coho captured in the open river had consumed fish, although most coho (55%) had consumed insects. The small sample size of coho collected in the Yakima River contributed to low precision in the 95% confidence interval for estimates of the incidence of predation.

<u>1998</u>

YN collected a total of 1,693 coho salmon for stomach analysis, of which 1,231 (72.7%) were collected at CJMF and 462 (27.3%) were collected by electro-fishing in the Yakima River. Coho salmon rarely consumed fish in 1998. Researchers found fish remains in 5 (0.29%) coho collected at all locations in 1998, and none of these prey items were identified as chinook. Invertebrates were the most common item found in coho stomachs in 1998. The downstream movement of high numbers of non-salmonid species at CJMF observed during 1997 was not observed in 1998.

Although no fall chinook remains were found in any of the sampled fish in 1998, the results were statistically analyzed to help assess the level of confidence in the observations. Coho predation rates on the estimated total number of fall chinook smolts above and below Prosser were calculated. They ranged between 0.63% of fall chinook smolts above Prosser and 2.17% of fall chinook smolts below Prosser.

Based on the sampling conducted in 1997 and 1998 associated with CJMF, researchers estimated that the impact of coho predation on fall chinook smolts produced above Prosser was no higher than 0.1% and was likely much lower. These levels equate to approximately 3.7 adults, based on a 1% smolt-to-adult survival rate for Yakima River fall chinook (Bruce Watson, YN, personal communication). In addition, predation associated with CJMF is probably the worst-case scenario for coho predation on fall chinook. Fish in the CJMF are at unnaturally high densities in unnatural habitat with no escape cover from predators, and fish are potentially held several hours in the livebox before they are examined and released.

Sample sizes in 1998 provided precise estimates of the total number of fall chinook consumed in the open river. Researchers estimate that coho consumed a maximum of 349 fall chinook smolts in the entire Yakima River, which equates to approximately 3.5 adult fall chinook (Bruce Watson, personal communication). This level of potential impact seems small when compared to predation by smallmouth bass, which consumed an estimated 1 million fall chinook juveniles in the lower Yakima River in 1998 (McMichael et al. 1998), or the equivalent of 10,000 adult fall chinook.

Coho Predation on Spring Chinook. YN released 26,809 non-acclimated coho smolts in the upper Yakima River near Easton, Washington (RM 203) on May 26 and 27, 1998. In 1999, YN released approximately 49,700 acclimated coho smolts, half on May 17 and the other half on May 27. Each year YN operated two 5-foot-diameter rotary traps continuously over a period of 10 days from the release date; the traps were approximately 6 miles downstream of the release point. The trap usually was checked continuously, but time between fish removal from the trap never exceeded 60 minutes, in order to minimize coho predation on chinook fry in the trap.

YN collected 1,097 coho salmon at the rotary trap in 1998. Most coho were captured during the night. Five coho within the sample (0.45%) had consumed fish. Researchers identified two coho prey items as *Oncorhynchus* spp., both of which were consumed by a single coho.

During the 1999 field season, YN collected 993 coho during the early release (May 17 – 22), and 764 coho during the late release (May 27 – June 9). Mean coho and spring chinook fry fork lengths were lower in 1999 than in 1998. However, coho movement was generally similar between years, with most coho moving during the night and passing the trap within a few days after release. The fish weighted mean residence time within the Easton study reach was 2.5 and 3.2 days respectively for the early and late release in 1999, compared to approximately 4 days in 1998. Coho predation on juvenile fish was less common in the 1999 samples than in the 1998 samples. Two coho in the sample had consumed fish (0.11%): a single fish each from the early and late sample periods in 1999 consumed fish. Neither of these prey items was identified as *Oncorhynchus* spp.

It is likely that the smaller chinook fry in 1999 were potentially more vulnerable to predation than the larger fry in 1998; however, several factors offset the higher prey vulnerability in 1999 and resulted in a lower overall predation rate. These factors included lower abundance of fry in 1999, lower water temperatures which resulted in lower coho metabolic rate, and an extended acclimation period which resulted in reduced coho residence time within the study area.

Similar studies of predation by hatchery coho smolts on summer chinook and spring chinook were conducted in the Wenatchee basin in 2000 and 2001, with similar results, indicating that predation by hatchery smolts on these species is low (Murdoch and Dunnigan 2001; Murdoch and LaRue 2002).

Coho Competition with Rainbow/Steelhead and Cutthroat Trout. As reported in Dunnigan 1999, YN scatter-planted a total of 404,340 non-acclimated coho fry into the Naches River basin between June 17 and June 24, 1998. YN estimated stocking densities by estimating available habitat within each stream/reach from existing habitat information (U.S. Forest Service [USFS]), unpublished data; YN, unpublished data); and then estimated coho carrying capacity for the amount of each habitat type (i.e., riffle, pool, glide, side channel, etc.) (Reeves et al. 1989). Coho were released in four broad geographical areas within the basin:

- lower mainstem Naches River (RM 2–16: 121,600 fish),
- mainstem Bumping River (RM 0–17: 132,000 fish),
- upper Naches tributaries (RM 28–42: 67,400 fish), and
- the Little Naches River mainstem and tributaries (RM 45 [RM 3.2-13.2]: 83,431 fish).

The primary focus of the study was to estimate post-release survival of hatchery coho fry; thus, the competition data collected was ancillary to the research.

YN installed traps near the confluence of the Little Naches River and in Quartz and Pileup creeks to monitor fish movement, and conducted electro-fishing surveys in Quartz and Pileup creeks to assess the distribution and abundance of hatchery coho and resident fish.

Cutthroat trout abundance increased with elevation, and rainbow trout density decreased with elevation. Although rainbow trout were more abundant than cutthroat trout in the lower sections of Pileup and Quartz creeks, cutthroat trout were overall more abundant in each stream. Coho salmon abundance was largely an artifact of stocking location, and was not correlated with elevation. Researchers found no evidence that coho salmon influenced the abundance of cutthroat or rainbow trout when they compared the abundance of each species in allopatry and sympatry with coho salmon. They repeated each test after removing the effects of elevation on cutthroat and rainbow trout abundance, and found no difference between allopatric and sympatric mean densities of resident trout. Similarly, they found no evidence that coho salmon affected the growth of cutthroat or rainbow trout when they compared the condition factor of each species in allopatry and sympatry with coho salmon.

YN found no evidence to suggest coho were having a negative impact on these native fish species in the two streams examined. Researchers attribute these low levels of observed impacts in part to low stocking densities of coho fry. In addition, they believe that spatial segregation (Hartman 1965; Allee 1974), resource partitioning (Ross 1986) and differences in diet (Johnson and Ringler 1980) minimize the potential for competition between coho and steelhead.

The ability to detect small differences (statistical power) in either abundance or condition factor was likely limited by relatively small sample sizes. The report acknowledges this limitation, while noting that competitive interactions were not the primary focus of these field activities.

Due to the consistency of study results that show low rates of predation by hatchery coho smolts on other species, additional **predation studies** are not planned for Phase 1B. However, due to the small sample sizes, the **competition studies** conducted in Phase 1A were limited in their ability to detect small differences in coho effect on other species. Additional studies are proposed for Phase 1B to aid in assessing ecological interactions between naturalized coho or their surrogates and NTTOC (see Section 6.3, Strategy 3b).

6. PHASE 1B STUDY METHODS AND ASSOCIATED RISKS

This section outlines the methods for accomplishing each objective and strategy proposed for Phase 1B, and the environmental risks associated with those methods.

Risks associated with this phase of the feasibility program fall into three categories:

- Physical effects on environmental resources caused by facility development
- Effects on target fish (coho) and non-target taxa (NTT) caused by monitoring and broodstock collection activities (e.g., trapping, marking, handling, etc.)
- Interaction risks to non-target fish from the presence of reintroduced coho.

Site-specific development and monitoring risks are discussed as appropriate for each strategy. However, the kinds of interaction risks, their intensity, and the likelihood of their occurrence are more difficult to predict and are the subject of debate among scientists. As a result, biologists from YN and WDFW prepared a risk assessment for each of four subbasins where coho releases were proposed, using an assessment method as described in Pearsons and Hopley 1999. Table 9 shows the template they used to perform the risk assessment. It includes definitions of the kinds of potential interactions considered, as well as definitions of each factor considered in the assessment.

The biologists identified species of concern for each subbasin (upper Yakima, Naches, Ahtanum and Toppenish) and defined target impact levels which, with one exception (cutthroat trout), correspond to the impact levels defined for spring chinook several years ago as shown in Table 8. Then the amount of overlap between coho and non-target species life stages was identified, as well as the type of interaction that might be expected. The level of risk for each species in each subbasin represents the average of all the participants' estimates; the "Uncertainty" column represents the standard deviation of the group's values. For example, at 9.7, the highest "Uncertainty" number is that for the risk to steelhead from coho releases in the upper Yakima subbasin. This number indicates the large variation in the assessment of risk among the participants, whose risk levels ranged from 9 to 35. However, all the risk levels as shown in Tables 10 - 13 are relatively low and do not warrant additional monitoring beyond what is currently proposed.

Table 9. Template for Assessing Ecological Risks to NTT of Fish Stocking Programs [16]

Proposed Stocking Program: Target taxon_________________________ Size at release _________________
Date of release_________________ Number and location ____

		Overlap[a]		Interaction Strength[b]			
NTT[c]	Status[d]/Impact	Type 1 Life Stage	Type 2 Life Stage	Type 1 Interaction	Type 2 Interaction	Risk[e]	Uncertainty[f]
Example of species or stock	D/10%	Fry	All	C, P, B, D, N	C, P, B, D, N, S	74%	16%

a *Type 1*: spatial and temporal overlap between NTT and released hatchery salmonids, residuals, and returning adults.
Type 2: spatial and temporal overlap between NTT and all life history stages of naturally produced offspring of returning hatchery adults.
Life stage—fry, parr, smolt, adult (salmonids); age 0, juvenile, adults (other species) or all if overlap occurs for all life stages or none if no overlap occurs.

b Ecological interactions that could occur between stocked anadromous salmonids and NTT.

Negative interactions

C (competition)—the presence of hatchery salmonids limiting the availability of resources that NTT would use in the absence of hatchery salmonids. This occurs when stocked salmonids and NTT use common resources, the supply of which is short (i.e., exploitative or indirect competition); or if the resources are not in short supply, competition occurs when hatchery salmonids limit access of NTT that are seeking a desired resource (i.e., interference or direct competition; Birch 1957).

P (predation)—the direct consumption of NTT by hatchery salmonids (direct predation; *Pd*) or the increase in predation by other predator species resulting from the presence of hatchery salmonids (indirect predation; *Pi*). Indirect predation can occur through the following mechanisms: (1) Hatchery salmonids displace NTT from preferred habitat, making NTT more vulnerable to predators; or (2) the increased abundance of hatchery salmonids attracts predators, causes predators to switch prey, or increases population densities of predators, which can increase consumption of NTT, particularly if NTT are preferred.

B (behavioral anomalies)—the presence and behavior of hatchery salmonids alter the natural behavior of NTT. For example, migrating hatchery salmonids may cause premature migration of NTT (e.g., pied-piper effect; Hillman and Mullan 1989) or may cause NTT to become less active (McMichael et al., in press).

D (pathogenic interactions)—the transfer of a pathogen from hatchery salmonids to NTT (direct pathogenic interaction) or the increased susceptibility of NTT to pathogens (indirect pathogenic interaction).

M (nutrient mining)—the carcasses of fish that would normally reproduce naturally are collected for hatchery broodstock and are not distributed back into the natural environment or are distributed inappropriately. This results in a loss of nutrients/food that would ordinarily be available to NTT.

Beneficial interactions

N (nutrient enrichment)—increase in nutrients available to NTT because of an increase in marine-derived nutrients from greater salmonid returns (e.g., salmon carcasses).

F (prey)—increased availability of prey for piscivorous NTT.

S (predator swamping)—the survival of NTT is enhanced due to swamping of predators by hatchery fish.

c *NTT*—highly valued non-target taxa.

d *Status*: H=healthy, D=depressed, T=Threatened (ESA), C=critical (or other status descriptors). Impact—acceptable impact level to the NTT (e.g., 10% impact to abundance, distribution, and size structure).

e *Risk*: probability (0%–100%) of failing to meet an objective for NTT; 0% corresponds to impossibility of failing, and 100% corresponds to surety that an objective will be exceeded.

f *Uncertainty*: scientific uncertainty of risk assessment due to lack of information or variability of ecological interaction outcomes; calculated as the standard deviation of the risks.

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[16] Source: Pearsons and Hopley 1999. The template is slightly edited from the published version to make definitions easier to find and to reflect terms used by participants in this project's risk assessment. The authors provided an example of one NTT relative to a hypothetical stocking program.

Table 10. Risk Assessment for Coho Releases in Upper Yakima Subbasin

NTT	Status/ Impact	Overlap		Interaction Strength		Risk	Uncertainty
		Type 1 Life Stage	Type 2 Life Stage	Type 1 Interaction	Type 2 Interaction		
Spring chinook	D/10%	egg	egg	C[1]	C[1]	5.27	4.93
		fry	fry	Pi, Pd[2], D, N, S	C, Pi, Pd, B, D, N, F, S		
		parr	parr	C, Pi, Pd[3], D, B, N, S	C, Pi, B, D, N, S		
		smolts	smolts	C, Pi, D, B, N, S	C, Pi, D, N, F, S		
		adults	adults	No interactions	No interactions		
Steelhead	T/0%	egg	egg	No interactions	No interactions	17.83	9.68
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pi, Pd, S, D, N, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, S, D, N, F		
		smolts	smolts	C, Pi, B, D, N, S, F	C, Pi, S, D, N, F		
		adults	adults	C	C		
Rainbow (main)	H/10%	egg	egg	No interactions	No interactions	10.33	6.59
		fry	fry	Pd, Pi, B, D, N, S, F	Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, D, N, S, F		
		adults	adults	C	C		
Rainbow (trib.)	H/40%	egg	egg	No interactions	No interactions	4.25	3.13
		fry	fry	C, Pd, Pi, D, N, S, F	C, Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, D, N, S, F		
		adults	adults	C	C		
Bull trout	T/0%	egg	egg	C	C	2.83	2.16
		fry	fry	C, Pd, Pi, D, N, F	C, Pd, Pi, B, D, N, F		
		parr	parr	C, Pi, D, N, F	C, Pi, D, N, F		
		adults	adults	N, F	N, F		
Cutthroat trout	D/5%	egg	egg	No interactions	No interactions	5.33	3.78
		fry	fry	Pd, Pi, D, N, S, F	Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, B, D, N, S, F		
		adults	adults	C	C		
Fall chinook	D/5%	egg	egg	C	C	6.50	4.55
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		parr	parr	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		adults	adults	C	C		
Pacific lamprey	D/0%	egg	egg	C	C	3.50	5.96
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		amocetes	amocetes	C, Pd, N, F	C, Pd, N, F		
		adults	adults	C, N, F	C, N, F		

Assumptions

Assume 100 coho returning above Roza

1 Redd superimposition is expected to be low because of low coho spawner densities (.5 - 1%)

2 Predation estimates from hatchery smolts in Nason Cr. (Wenatchee basin) and Yakima are less than 1%

3 Residualized coho predation

Table 11. Risk Assessment for Coho Releases in Naches Subbasin

		Overlap		Interaction Strength			
NTT	Status/ Impact	Type 1 Life Stage	Type 2 Life Stage	Type 1 Interaction	Type 2 Interaction	Risk	Uncertainty
Spring chinook	D/10%	egg	egg	C[1]	C[1]	2.3	1.1
		fry	fry	Pi, Pd[2], D, N, S	C, Pi, Pd, B, D, N, F, S		
		parr	parr	C, Pi, Pd[3], D, B, N, S	C, Pi, B, D, N, S		
		smolts	smolts	C, Pi, D, B, N, S	C, Pi, D, N, F, S		
		adults	adults	No interactions	No interactions		
Steelhead	T/0%	egg	egg	No interactions	No interactions	12.0	4.2
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pi, Pd, S, D, N, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, S, D, N, F		
		smolts	smolts	C, Pi, D, N, S, F	C, Pi, S, D, N, F		
		adults	adults	C	C		
Rainbow (main)	H/10%	egg	egg	No interactions	No interactions	2.0	1.4
		fry	fry	Pd, Pi, B, D, N, S, F	Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, D, N, S, F		
		adults	adults	C	C		
Rainbow (trib.)	H/40%	egg	egg	No interactions	No interactions	4.5	6.4
		fry	fry	C, Pd, Pi, D, N, S, F	C, Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, D, N, S, F		
		adults	adults	C	C		
Bull trout	T/0%	egg	egg	C	C	5.5	6.4
		fry	fry	C, Pd, Pi, D, N, F	C, Pd, Pi, B, D, N, F		
		parr	parr	C, Pi, D, N, F	C, Pi, D, N, F		
		adults	adults	N, F	N, F		
Cutthroat trout	D/5%	egg	egg	No interactions	No interactions	2.5	0.7
		fry	fry	Pd, Pi, D, N, S, F	Pd, Pi, D, N, S, F		
		parr	parr	C, Pi, B, D, N, S, F	C, Pi, B, D, N, S, F		
		adults	adults	C	C		
Fall chinook	D/5%	egg	egg	C	C	4.0	1.4
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		parr	parr	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		adults	adults	C	C		
Pacific lamprey	D/0%	egg	egg	C	C	0.5	0.7
		fry	fry	C, Pd, Pi, B, D, N, S, F	C, Pd, Pi, B, D, N, S, F		
		amocetes	amocetes	C, Pd, N, F	C, Pd, N, F		
		adults	adults	C, N, F	C, N, F		

<u>Assumptions</u>

Assume 100 coho returning above Roza

1 Redd superimposition is expected to be low because of low coho spawner densities (.5 - 1%)

2 Predation estimates from hatchery smolts in Nason Cr. (Wenatchee basin) and Yakima are less than 1%

3 Residualized coho predation

Table 12. Risk Assessment for Coho Releases in Ahtanum Subbasin

NTT	Impact	Overlap		Interaction Strength		Risk	Uncertainty
		Type 1 Life Stage	Type 2 Life Stage	Type 1 Interaction	Type 2 Interaction		
Spring chinook	10%		fry parr smolts		Pd, C, Pi, N, S C, Pi, N, S C, Pi, N, S	2	2.8
Steelhead	0%		fry parr smolt		Pd, Pi, C, S, N C, Pi, S, N C, Pi, N, S	18	4.2
Bull trout	0%		parr smolts adults		C, Pi, S, N Pi, S, N N	5.5	0.7
Cutthroat trout	5%		fry parr smolt		Pd[3], C, Pi, S C, Pi, S, N C, Pd, Pi, N, S	8.9	1.6

Table 13. Risk Assessment for Coho Releases in Toppenish Subbasin

NTT	Impact	Overlap		Interaction Strength		Risk	Uncertainty
		Type 1 Life Stage	Type 2 Life Stage	Type 1 Interaction	Type 2 Interaction		
Spring chinook	10%		fry parr smolts		Pd, C, Pi, N, S C, Pi, N, S C, Pi, N, S	0	0.0
Steelhead	0%		fry parr smolt		Pd, Pi, C, S, N C, Pi, S, N C, Pi, N, S	20.5	6.4
Bull trout	0%		parr smolts adults		C, Pi, S, N Pi, S, N N	0	0.0
Cutthroat trout	5%		fry parr smolt		Pd[3], C, Pi, S C, Pi, S, N C, Pd, Pi, N, S	2	1.4

3 Residualized coho predation

6.1 Objective 1 Methods and Risks

Objective 1. Attempt to establish naturally producing coho populations in the upper and lower Yakima River and tributaries, and in the Naches River and tributaries.

Strategy 1a. Continue acclimated smolt releases in the mainstem of the upper Yakima and Naches rivers, including early-run and late-run stocks.

Method: Two acclimation/release sites on the mainstem of each river were developed and used in Phase 1A. In the Naches, the project proposes to continue using the existing sites: Lost Creek (RM 39) and Stiles Pond (~RM 8) (Figure 9). However, in the upper Yakima, the coho smolts at the existing sites have been subject to high bird predation. The Cle Elum Slough site (RM 184) was not used in 2002 for that reason—all coho were acclimated at the Easton site. In addition, the acclimation period conflicts with a popular put-and-take fishery at the Easton Ponds site. Phase 1B proposes to use two new sites in the upper Yakima: the "Holmes site" (RM 160)[17] and the Boone Pond site (RM 180.5) (Figure 10). As alternatives, in case bird predation at the new sites is unacceptably high, the project could use the existing Easton Ponds site (RM 201); a portable acclimation raceway at Clark Flat (RM 164); or other existing natural ponds or floating net enclosures at as yet unidentified sites. Minor improvements at Roza Dam (RM 128) could also be made if necessary, or net pens in the forebay could be used. Figure 9 shows existing facilities in the basin. The proposed new upper Yakima sites and alternates are shown in Figure 10. Optional sites and methods are discussed in Section 6.4, Strategies 4a and 4b.

Approximately 500,000 Yakima and 500,000 Cascade stock (Lower Columbia) hatchery smolts from early-run stocks would be released into the Yakima basin each year (Table 14). Each of four sites (two in the Yakima and two in the Naches) would contain approximately 200,000 early-run fish. Yakima-origin fish would be acclimated in the upstream site in each subbasin; the downstream sites would be used for Lower Columbia-origin fish.

Table 14. Mainstem Coho Smolt Release Sites, Phase 1B

Location	Release #	Life Stage	PIT Tag #	Stock	Purpose	Study Method
Yakima River						
Easton	Alternate site	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Roza Dam	Alternate site	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Clark Flat	Alternate site	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location. CJMF, McNary
Holmes	200,000 early 100,000 late	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Boone Pond	200,000	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary
Naches River						
Lost Cr.	200,000	Smolt	1,250	Yakima origin	Smolt-smolt survival	PIT detector at release location, Selah-Naches diversion, CJMF, McNary
Stiles Pond	200,000 early 100,000 late	Smolt	1,250	L. Columbia origin	Smolt-smolt survival	PIT detector at release location, CJMF, McNary

[17] The Holmes site is now in use.

Researchers also propose to test the possibility of establishing late-run stocks of coho. Because low water in the fall due to irrigation withdrawals may reduce adult returns, late-run fish, which could be returning in December, might have better rates of return. YN proposes to release 100,000 late-run smolts, which would be out-of-basin fish, from the downstream acclimation site in each subbasin. However, if space proves too limited in the downstream sites, late-run fish might also be acclimated and released from the upstream sites.

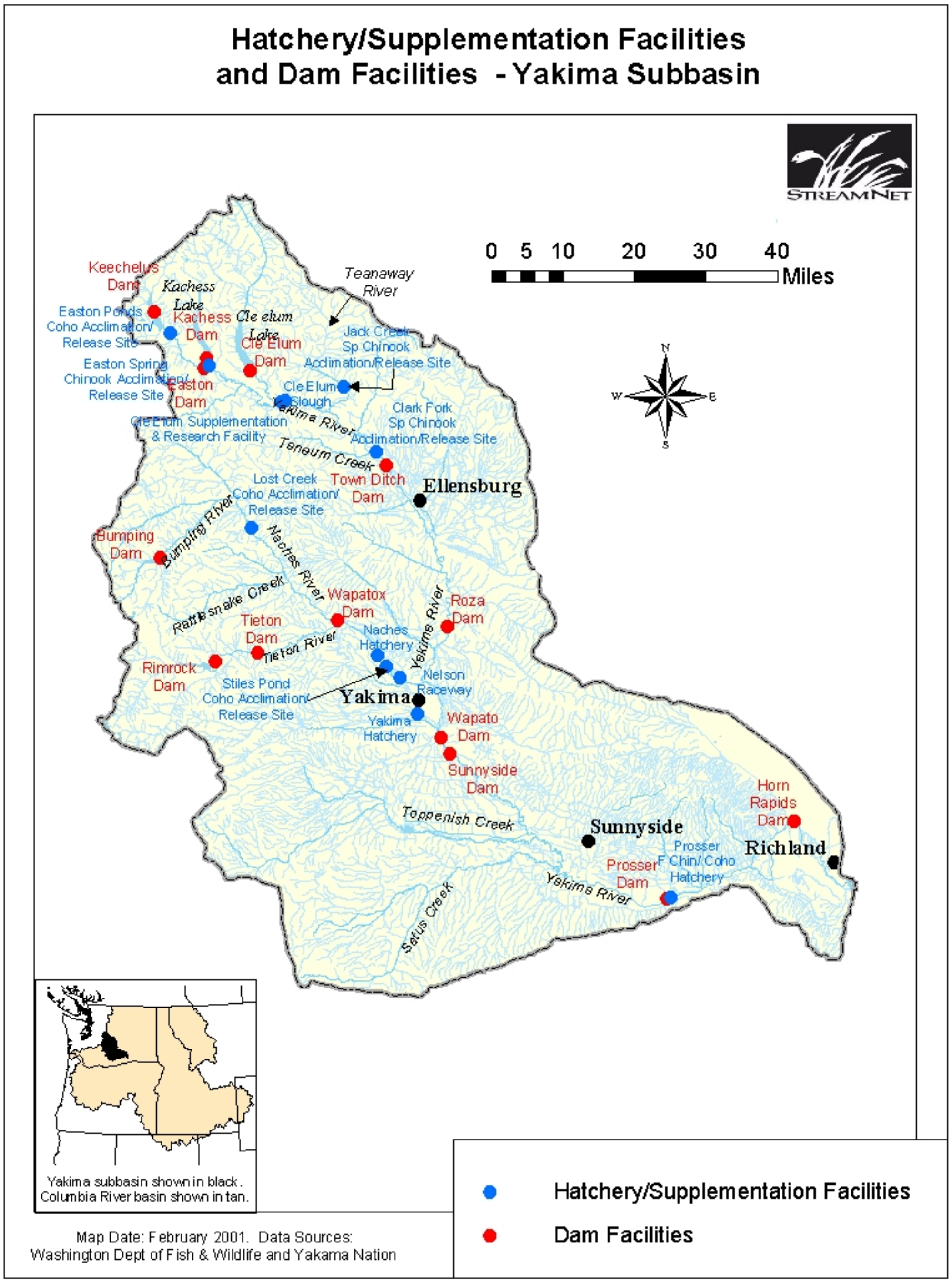

Figure 9. Existing YKFP Facilities

Prosser Hatchery can culture a maximum of 500,000 smolts based on its current water and rearing space constraints. However, should enough local returns be collected to produce more than 500,000 Yakima-origin smolts (see Strategy 1e and Appendix A), some could be reared at lower Columbia River hatcheries. In that case, depending on how many Yakima-origin smolts were produced at hatcheries both in-basin and out-of-basin, more than 200,000 Yakima-origin smolts might be acclimated at the upstream ponds designated for in-basin fish. If the project began to approach its goal of producing all one million smolts from Yakima-origin stock, the Lower Columbia smolts could be replaced in both acclimation ponds in each subbasin.

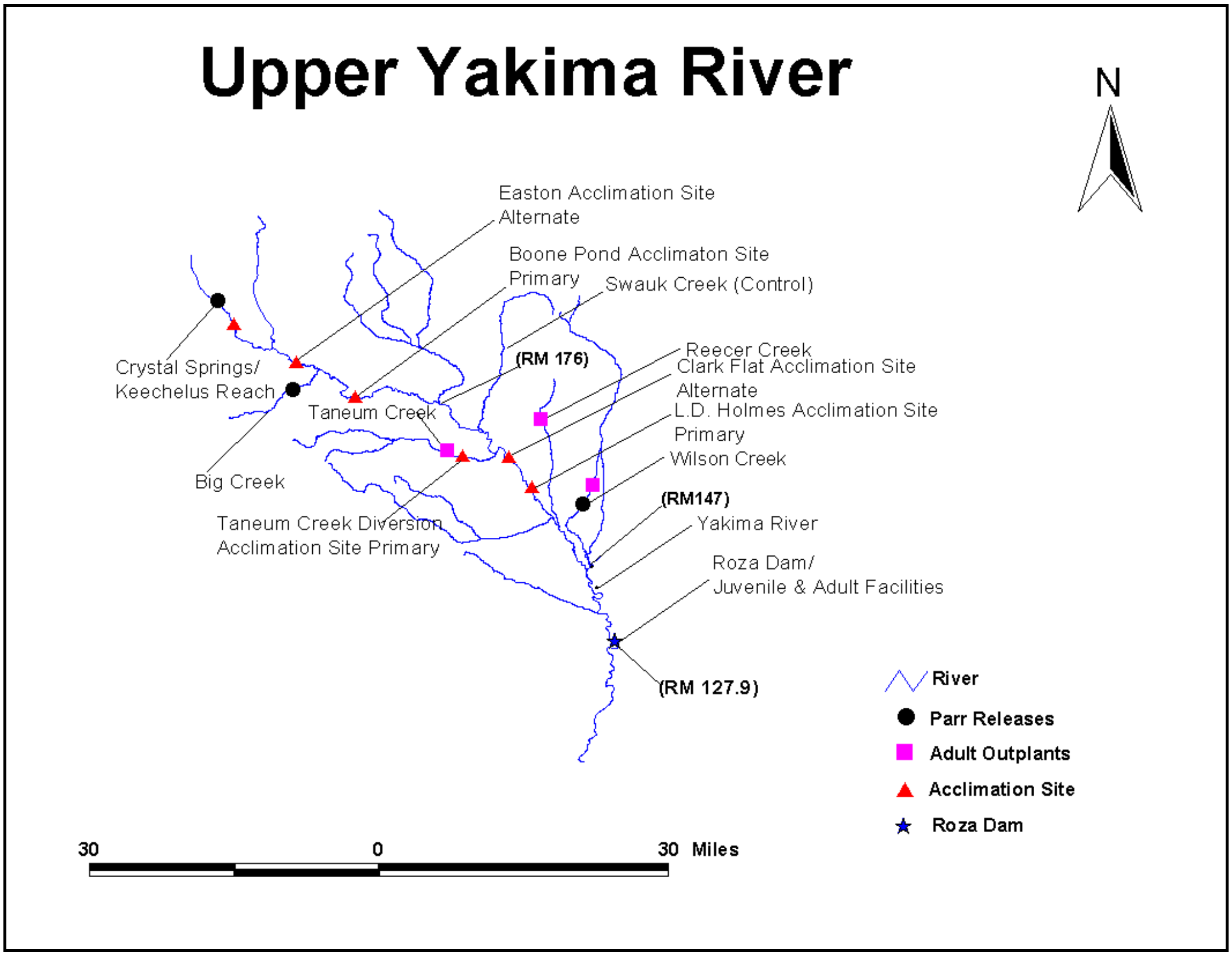

Figure 10. Coho Program Sites in the Upper Yakima Subbasin

Risks: Physical effects caused by development of the proposed new sites are discussed in Section 6.4, Strategy 4a.

The YFP EIS acknowledged potential ecological interactions (competition and predation) between coho and other species in the lower Yakima basin, where coho were expected to be acclimated and released (BPA et al. 1996, section 4.1.2). A Supplement Analysis was prepared in 1999 that assessed environmental effects that might be caused by proposed changes in the YKFP program since the EIS was prepared, including changes to the coho program (BPA 1999).

The Supplement Analysis found that volitional releases of up to one million smolts in May each year from two existing sites in the Naches and upper Yakima basins would pose a low risk of predation on or competition with other fish species, including listed steelhead and bull trout. Steelhead fry emerge from the gravel after the coho have migrated through the Yakima system, and yearling rainbow/steelhead are too large to be readily consumed by coho smolts (BPA 1999). The risk to bull trout is especially low due to the limited spatial overlap between coho smolt emigration corridors and bull trout spawning areas (WDFW 1998). Subsequent studies, including residualism studies and a study of predation on spring chinook in Easton Reach, generally support these conclusions (Dunnigan 1999). See Section 5 of this master plan for a summary of that research.

Despite these studies and previous findings, concerns and questions remain. For that reason, WDFW and YN undertook the interactions risk assessment shown in Tables 10 and 11. As shown in the tables, coho interactions with steelhead are not expected to pose a high risk. For example, the highest risk level projected for coho/steelhead interactions is under 18 (when 100 represents maximum risk) in the upper Yakima basin, and 12 in the Naches. Interaction risks with other non-target species are expected to be even lower.

Of particular concern are the effects of interactions between natural-origin coho and other species. These interactions are expected to be low for at least a few years due to the low number of natural-origin spawners (an estimated 1,526 adults in 2003—Table 15). As stated in Section 4.1.1, adult returns still are concentrated in the lower reaches of the mainstem Yakima River (downstream of Union Gap) (Dunnigan et al. 2002), most of which is not spawning or rearing habitat for listed species or those in the "no impact" section of the NTTOC list (Table 8). Although some life cycle activities of late-run stocks would take place a few weeks later than those of early-run fish (i.e., primarily spawning and fry emergence), the effects on other fish of releasing late-run coho would not be noticeably different from those of early-run coho.

Table 15. Hatchery/Wild Survivals Release Year 2000 - 2003

Brood Year	Release Year	Number Released	Out Migr. Year	Prosser Juvenile Index Total	Hatchery	Wild
1998	2000	1030000	2000	231890	194219	37671
1999	2001	1030000	2001	482854	442249	40605
2000	2002	783,000	2002	49865	30006	19859
Return Year	**Prosser Adult Passage Total**	**Hatchery**	**Wild**	**Prosser Jack Passage Total**	**Hatchery**	**Wild**
2001	4966	3538	1428	68	47	21
2002	541	189	352	270	77	193
2003	2221	695	1526	132	34	85
Production Adults per Release	**Production Total per Release**	**Prosser Adult/Juvenile Survival (%) Total**	**Hatchery**	**Wild**		
0.004821359	0.005272816	0.021415326	0.02	0.04		
0.000525243	0.000591262	0.001120421	0.0004	0.0087		
0.003198657	0.003587507	0.044540259	0.02	0.08		

Source: YN unpublished data

However, the trend has been for the number of coho adult returns to increase since 1985, despite low returns in drought years (Figure 2, Section 4.1.1). The hatchery smolt-to-all adult return rates increased beginning with the 1998 return (0.448%) and averaged 0.456% for 1998-2001. Prior to this period, rates didn't exceed 0.142%. Thus, numbers of possible natural-origin returns

(NORs) comprising the adult run probably began to increase beginning with the 2001 return. Because all smolts released in 2000 were coded wire tagged, 2001 was the first year NORs could be distinguished from hatchery-origin returns (HORs). Table 15 shows hatchery/wild survivals since that time.

If the trend continues, and if coho begin to populate the upper reaches of the basin, density-dependent competition effects might become a concern. To study the potential for such effects in advance of large numbers of naturally produced coho occupying parts of the basin, the project proposes controlled studies in paired streams in the Naches and upper Yakima subbasins (see Section 6.3, Strategy 3b). Habitat use and residualism surveys will help identify general species associations, habitat overlaps with steelhead and other species of concern, and whether coho appear to be displacing these species in areas where they overlap.

Juvenile trapping to monitor out-migration would be done partly at existing facilities, partly at potential new smolt traps (see Strategy 1f in this section).

Strategy 1b. Test survival of smolts released in upper Yakima tributaries.

Method: Smolts would be acclimated and released in two upper Yakima tributaries.

Approximately 1,250 Yakima-origin smolts would be PIT tagged and placed in the Keechelus-Easton Reach at the head of Lake Easton. Their survival would be monitored at Roza, CJMF, and McNary.

A more multi-faceted study would be conducted for smolts acclimated and released at a new site in Taneum Creek. All coho used for the project in Phase 1A were primarily early-run fish. In Phase 1B, the project would compare survival of 20,000 early run Yakima-origin smolts and 20,000 Lower Columbia-origin late-run smolts, all acclimated together in the new Taneum acclimation pond (see Section 6.4, Strategy 4a, for a description of the site). The project would PIT tag 1,250 smolts from each group and monitor their survival to Roza, CJMF, and McNary.

Risks: As shown in Table 10 and discussed under Strategy 1a, the risks of smolt releases in the upper Yakima would be low.

Strategy 1c. Test over-winter survival (smolt-parr survival) by releasing coho parr in selected tributaries to the Yakima and Naches rivers.

Method: In July each year, 24,000 parr would be scatter-planted in designated tributaries, 3,000 parr in each of the following streams (see Figures 10 - 12):

- Upper and lower Yakima subbasins
  - Crystal Springs/Easton-Keechelus Reach: From Kachess River confluence (RM 202.5) to Keechelus Dam (RM 214.5)
  - Big Creek: From Main Canal crossing (RM 1.5) to Jim Creek (RM 6.5)
  - Wilson Creek: From Cherry Creek (RM 1.1) to Bull Ditch (RM 7.8)
  - Toppenish Creek: From Toppenish Lateral Canal (RM 44.2) to North Fork (RM 55.4)
  - Ahtanum Creek: From Goodman Road (RM 2.8) to North Fork/South Fork confluence (RM 23.1)

- Naches subbasin
  - North Fork Little Naches River: From confluence (RM 0) to RM 2
  - Little Naches River: From Salmon Falls (RM 4.5) to South Fork (RM 9.9)
  - Nile Creek: From USFS boundary (RM 3) to Glass Creek confluence (RM 7.5)
  - Little Rattlesnake Creek: From RM 0 to Soda Spring Meadow (RM 6)

All parr would be coded wire tagged and PIT tagged. The tags allow researchers to monitor their survival as smolts to various PIT detectors on the Yakima mainstem and tributaries or the Naches River, and to CJMF and McNary, as well as to monitor out-migration timing. If 3,000 proves to be too small a number for reliable estimates of survival, releases would be increased, probably to no more than 5,000 per group. Habitat use and distribution surveys would also be conducted (see Section 6.2, Strategy 2b).

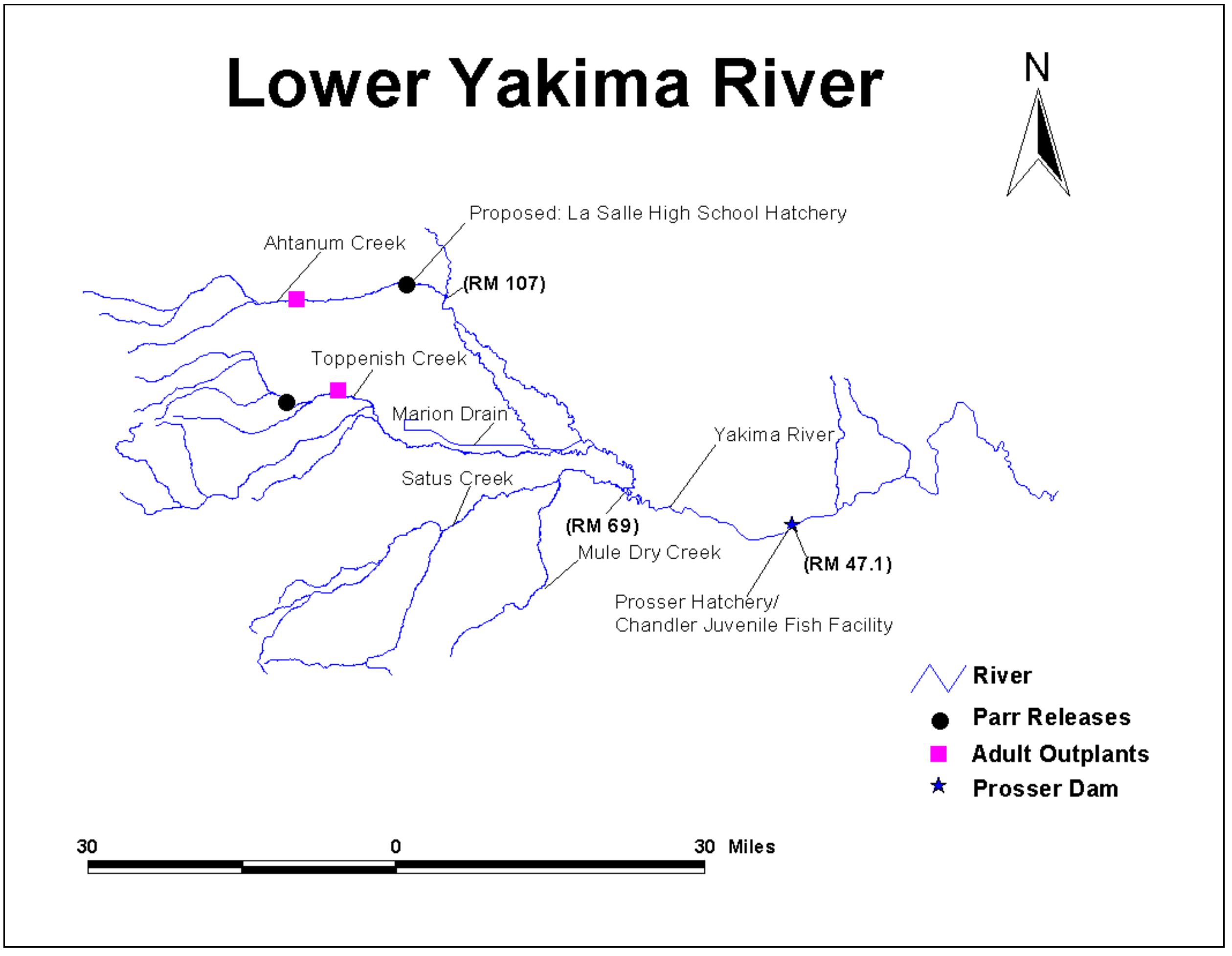

Figure 11. Coho Program Sites in the Lower Yakima River Subbasin

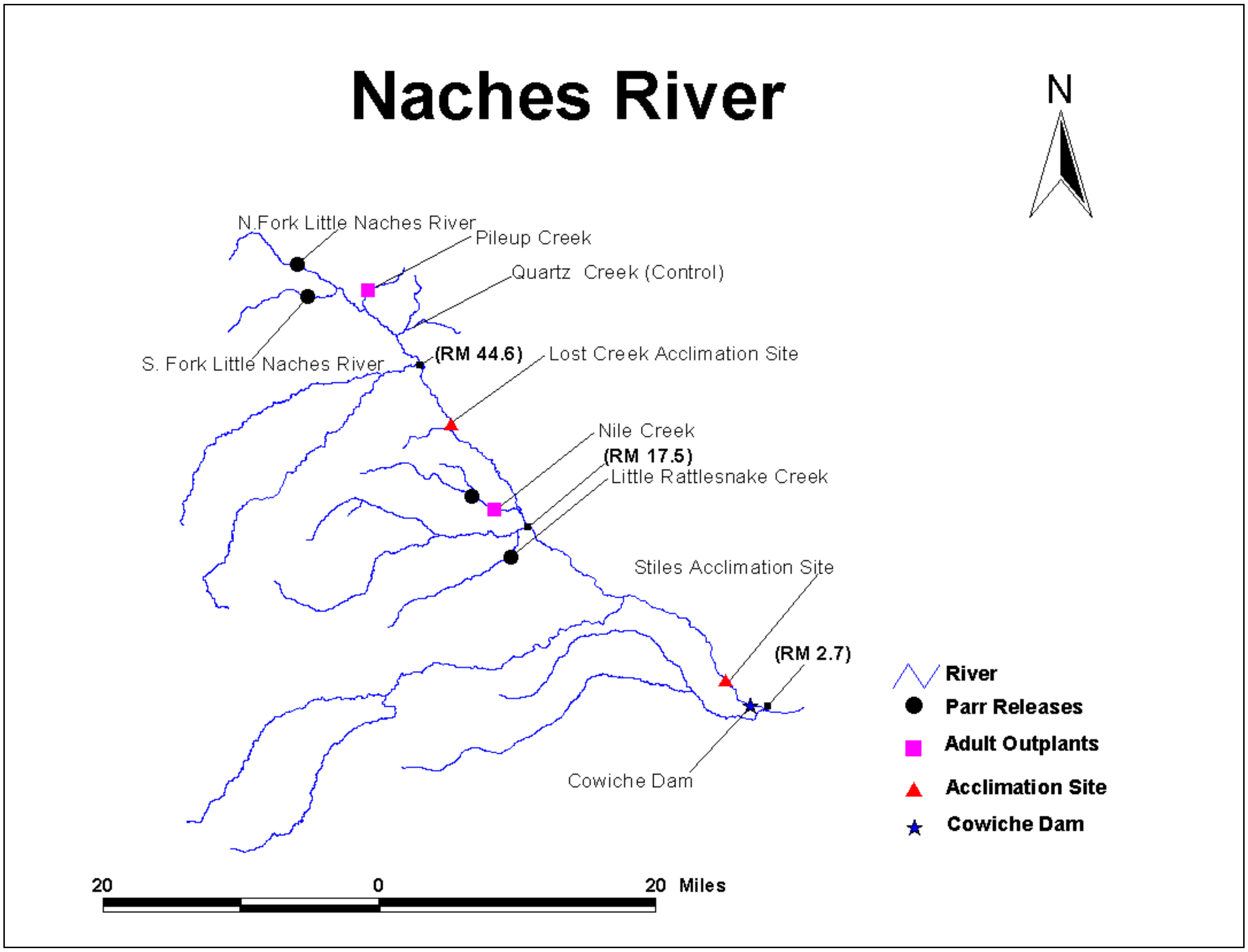

Figure 12. Coho Program Sites in the Naches River Subbasin

Rationale for Release Locations: In general, parr release creeks were chosen because they once were coho habitat; because the existing habitat looks better than that in other streams (e.g., other streams have passage problems); and because they have facilities or characteristics that allow monitoring to be done. In addition, the streams chosen in each subbasin reflect a broad enough geographic range within the subbasin to test over-winter survival differences; and, in most cases (unless the purpose is to study ecological interactions with listed species), the release numbers and the locations in each stream minimize overlap with habitat of listed species. The following paragraphs are examples of the rationale for choosing some of the release streams. Similar rationale applies to the other release streams.

Ahtanum: This watershed historically produced coho salmon. Coho are naturally producing in this reach of the creek, and with recent passage and instream flow improvements, the potential exists to colonize the middle and upper mainstem to the Forks. Juvenile monitoring capabilities exist with the current rotary trap located at RM 0.75.

Toppenish: It is thought that coho salmon historically resided in the Toppenish watershed (see Section 4.1.1). Toppenish Creek upstream of the WIP Dam (RM 44.2) affords good to excellent spawning and rearing habitat. An established juvenile monitoring site (rotary trap) exists on Toppenish Creek that would allow in-basin monitoring of production and migration timing. Generally good flow conditions during spawning would allow for accurate redd counts to estimate adult escapement. Counts may also be possible at the WIP diversion dam located at RM 3.4 (Satus Unit pump station).

Wilson Creek: Wilson Creek in the upper Yakima basin was historically a significant coho salmon tributary. Significant habitat improvements have been made and more are planned (personal communication, Scott Nicolai, YN, 2003). To this point, improvements to upstream access and screening of diversions are the primary items, with riparian restoration projects among others being planned. Currently the creek is thought to be under-utilized by anadromous fish, given the recent habitat improvements. The presence of coho salmon in the creek could provide a way to educate local citizens and spur an interest to further protect and enhance the creek for all salmonids. Monitoring and evaluation opportunities exist on the creek both for juveniles (either using a rotary trap or an existing diversion dam) and adults (using one of the existing diversion dams and fish ladders).

Risks: The primary NTTOC species identified by the YKFP as meriting special attention by the coho project are steelhead and bull trout (both ESA-listed species) and spring chinook.

There is steelhead spawning/rearing or rearing/migration habitat in several of the streams where coho parr would be released, including Toppenish and Ahtanum creeks, and the upper Yakima, Naches, and Little Naches rivers (see Figure 5, Section 4.1.2). In the Ahtanum, most steelhead redds are found several miles above the upper limit of where coho would be released (RM 23) (Brandon Rogers, YN, personal communication, March 2003). In Toppenish Creek, steelhead spawning areas begin above the WIP diversion dam (RM 44.2), in the zone where the agricultural valley transitions into shrub-steppe and ponderosa pine habitat. As a result, coho smolt releases would overlap steelhead spawning and rearing habitat in the Toppenish, as coho could be released between RM 44 and 55. However, most steelhead spawning takes place above the Forks area at RM 55 (Brandon Rogers YN, personal communication, March 2003).

Bull trout are also found in Ahtanum Creek (see Section 4.1.2), but not below the North and South forks (RM 23.1) (Eric Anderson, WDFW, personal communication, December 2002). A very low level of interaction risk was identified (Table 12). Bull trout are not known to occupy the other release creeks. Although spring chinook spawn and rear in the middle and upper reaches of Rattlesnake Creek and rear to some degree in the lower section, they use Little Rattlesnake Creek rarely, if at all.

Overall, Tables 10 - 13 show a low risk of interactions between coho and several other fish species. The highest level of interaction risk identified (20.5) was in Toppenish Creek, between coho and steelhead (Table 13).

Effects of smolt trapping are discussed in this section, Strategy 1f. **Effects of habitat use and distribution surveys** are discussed in Section 6.2, Strategy 2b.

Strategy 1d. Test egg-fry survival, adult productivity, and interactions with NTTOC by releasing adult coho in selected tributaries to the Yakima and Naches rivers.

Method: Adult coho would be trapped as part of the broodstock collection process (see Strategy 1e for locations and methods), and transported to selected streams for release. The streams and reaches that would be used are listed below and shown in Figures 10 - 12. Twenty pairs of fish would be released at each site, except in Taneum Creek, where 120 females and 160 males would be released. Taneum Creek will also be an NTTOC study stream, and has been the subject of extensive surveys by WDFW (see Section 6.3, Strategy 3b). Not all streams would be planted every year. The rationale for using these streams is similar to that for the selection of the parr release streams.

- Upper and lower Yakima
  - Taneum Creek: From Taneum diversion (mainstem RM 2.25) to North Fork/South Fork confluence (RM 12.7)
  - Wilson Creek: From Cherry Creek (RM 1.1) to Bull Ditch (RM 7.8)
  - Reecer Creek: RM 0 – 2.
  - Ahtanum Creek: From Goodman Road (RM 2.8) to North Fork/South Fork confluence (RM 23.1)
  - Toppenish Creek: From Toppenish Lateral Canal (RM 44.2) to North Fork (RM 55.4)
- Naches
  - Pileup Creek: From USFS Road #19 crossing (RM 0.25) to end of spur road (RM 2)
  - Nile Creek: From USFS boundary (RM 3) to Glass Creek confluence (RM 7.5)

Egg-fry survival/adult productivity study methods are described under Strategy 1f. NTTOC studies are described in Section 6.3, Strategy 3b.

Risks: Tables 10 - 13 show a low risk of adverse ecological interactions between adult coho and their progeny and other fish species. As is the case for parr releases in some streams, adult releases are not risk-free, but due to the nature of some of the studies (interaction studies), some risk must be imposed in order to accomplish the research.

Strategy 1e. Transition from use of Lower Columbia/hatchery origin coho to Yakima/natural origin coho broodstock as quickly as possible.

Method: For Phase 1A, in-basin broodstock were collected at Prosser Dam on the Yakima River (RM 47) between mid-September through mid-November. Phase 1A results suggest that returning fish lack stamina, because they are spawning well below their acclimation sites much higher in the basin, although return numbers higher in the basin are slowly increasing (see Section 4.1.1).

In Phase IB, the goal is to produce one million coho smolts that are released each year from in-basin fish. Appendix A projects how many fish would be collected depending on the run size, and the conditions under which the goal of having all broodstock from in-basin fish might be met. The program proposes the following protocols:

- Collect broodstock at Cowiche and Roza dams, when possible, because they are closer to current acclimation sites and preferred spawning and rearing habitat.
- Collect natural-origin returns (NORs) as a first priority, and hatchery-origin returns (HORs) as a second priority.
- Collect only 50% of the NORs each year and 75% of HORs.

These protocols would address the stamina issue in two ways:

1) by collecting at Roza and Cowiche, the program would be taking fish for broodstock that have demonstrated the ability to return much further upstream than Prosser;

2) by using natural-origin fish for broodstock while at the same time allowing for natural production, the program would encourage the development of a population adapted to local conditions, including migration distance.

Broodstock would be collected at Prosser Dam, at the Roza Adult Monitoring Facility on the upper Yakima (RM 128), and at Cowiche Dam on the Naches (RM 3.6). Broodstock would be collected randomly and in proportion to the projected run size past each collection site. Based on the pre-season run forecast and the number of experimental and broodstock fish required, the total number of fish to be collected is proportioned in weekly increments throughout the run. This results in a pre-season, weekly collection target number (low in the tails of the run, higher in the peak). All fish would be scanned with a coded wire tag detector (wand) to determine origin (hatchery or natural). Annual fluctuation in run size and the run composition of wild to hatchery adults will dictate how quickly and consistently in-basin and natural-origin broodstock numbers increase.

All adults collected in the Yakima basin for broodstock are trucked to the holding ponds at Prosser Hatchery. They are treated with formalin and checked weekly for ripeness. When ripe, they are spawned at Prosser Hatchery. Spawned-out carcasses would be returned primarily to tributary sites and possibly to mainstem areas near the acclimation sites.

Risks: Adult steelhead return to spawn at the same time as coho, so could be trapped during coho broodstock collection. The primary effect would be migration delay and stress from handling; a small amount of mortality is possible, but rare. Bull trout are rarely seen in these areas, and are seen primarily in the spring, so are unlikely to be affected by coho broodstock collection in the fall.

The trap for broodstock collection at Cowiche Dam would be run for coho purposes only (Roza is being operated to mark steelhead). Because it has not been operated in the fall to date, the number of steelhead the project would handle is unknown. Based on NMFS steelhead radio-telemetry study (Hockersmith et al. 1995), Toppenish, Satus, Marion Drain, lower Naches and upper Yakima combined accounted for only 10% of the steelhead over-winter areas. Because steelhead tend to hold primarily in the lower mainstem over winter, it is unlikely that many steelhead would be encountered at the Cowiche trap during the coho broodstock collection period.

Dates and times of operation at each facility, as well as its permitting status, are as follows:

<u>Roza</u>: Oct 1–Dec 7, 7 days/week, 24 hours. It is operated under a Section 10 permit (currently being processed`), to radio tag and PIT tag adult steelhead. For the past 10 years, the mean steelhead count at Roza has been 79 steelhead, with numbers ranging from 15 to 216. Counts were in excess of 100 between return years 2000 and 2002: specifically, 108, 141, and 238 for 2000, 2001 and 2002 respectively. The coho program would operate within the limits of the existing permit, so would cause no additional adverse effects on steelhead. According to Mark Johnston, trap operator, bull trout have been captured at Roza Dam—20 fish in 1999, less than 5 other years. All were encountered in the spring, so the likelihood of encountering them during coho broodstock collection is low, and coho trapping would not exceed current trap operations.

Cowiche: Oct 1–Dec 7, 7 days/week, 24 hours. Bull trout could be in the area, but no data exist on their use of the area (Eric Anderson, WDFW, personal communication). The probability is low of encountering them because, based on their life history characteristics, they would be unlikely to be migrating during this period. As stated previously, the project expects to encounter low numbers of steelhead during the broodstock collection period (Hockersmith et al. 1995, BPA et al. 1999b).

Prosser: Oct 1–Dec 7, 5 days/week, 24 hours. The trap would operate under existing permits. As stated in BPA et al. 1999b, the project would encounter adult steelhead during broodstock collection at Prosser Dam. However, because less than 20% of the returning steelhead use the right bank ladder during the coho broodstock collection period, the impact would not be adverse. Mortality at this facility would be low because any non-target fish entering the collection facility are immediately netted from the livebox and passed through a window back into the ladder exit area (BPA et al. 1999b). The primary effect would be a slight delay in migration.

Strategy 1f. Monitor and evaluate factors that will determine when a self-sustaining and naturally producing population of coho is re-established in each subbasin, including adult productivity, egg-fry survival, over-winter survival (parr-smolt), smolt-smolt survival, and smolt-adult survival.

Methods:

Adult-to-adult productivity. This represents one of the four criteria defining Factor 1 of project success (P>= 1.0). Adult productivity will be measured at each subbasin broodstock collection facility for both natural and hatchery components. Adult-to-adult survival for each subbasin is calculated as follows:

$P_{adult} = S_1/S_2$;

where P_{adult} is the estimated adult-to-adult survival; S_1 is the number of returning adults past Roza or Cowiche dam; and S_2 is the number of adults from the parent brood year producing the S_1 returning adults. A “P” value that averages greater than 1.0 over several generations indicates that the population is sustainable and increasing.

The Roza facility provides for 100% interrogation. The adult fish passage efficiency for the Cowiche Dam fishway is unknown, but based on video monitoring and visual observation for the last three years, it is thought to be 80% or better. All returning adults at each facility will be wanded with a portable detector for the presence of a CWT to distinguish wild and hatchery origin fish. Any fish that spawns or drops out below Roza or Cowiche dams obviously will be excluded from the adult-adult productivity calculation. An estimated percentage of the returning adult population that displays this behavior can be determined by subtracting the Roza and Cowiche fish counts from the Prosser Dam video fish counts. However, it is not possible in this group of fish to determine their origin, whether natural or hatchery.

Because it is anticipated that a high component of the run will spawn downstream of Cowiche and Roza dams, and that there will be a need (at least in part) to collect broodstock at Prosser Dam, an estimate of adult-to-adult survival will be made at Prosser. This will be calculated using the video counts and the wild-to-hatchery ratio determined from fish handled at the Prosser denil ladder.

Egg-to-fry survival/adult productivity. Egg-to-fry survival will be estimated for selected redds in the Yakima and Naches subbasins, with corresponding gravel samples taken to determine gravel quality. Target streams would be those where adults are released.

A minimum of five redds from each creek will be capped. Redds determined to have the best chance of being successfully capped will be selected. The spawned-out female will be captured and measured for fork length; the Prosser Hatchery egg fecundity-to-fork length relationship will be used to estimate the number of eggs each female deposited. The redd cap—a nylon-mesh cloth bag with an attached live box at the cod end—will be placed on the redd 1-2 weeks before the expected emergence date, calculated based on Temperature Units (TUs). To estimate date of fry emergence, a HOBO thermograph located near each redd will be used to determine cumulative TUs. Emergent fry will be enumerated daily from each respective livebox.

Over-winter (parr-smolt) survival. All parr will be PIT tagged and monitored at various traps and detectors. New traps on a few tributaries will allow researchers to determine if parr have remained in the release stream over the winter or if they left before the normal smolt migration period in the spring. PIT detectors at those traps, as well as at mainstem points (Roza, CJMF, McNary) will help researchers calculate over-winter survival.

Smolt-to-smolt survival. Smolt-to-smolt survival can be estimated only for *hatchery* smolts released from each subbasin. The absence of effective juvenile monitoring sites in appropriate places in either the upper Yakima or Naches subbasins precludes estimating the number of *naturally produced* coho smolts from each subbasin.

To monitor out-migration, smolts would be trapped at existing and new rotary traps:

Ahtanum Creek: RM 0.75 (Fullbright Park) (existing trap)

Toppenish Creek: RM 26.5 (existing trap)

Yakima River: RM 128 (Roza Dam) (existing trap)

Taneum Creek: RM 4 (diversion dam) (new trap)

Wilson Creek: RM 2 (irrigation dam) (new trap)

Naches River: RM 18.4 (Selah-Naches diversion) (new trap)

Hatchery smolt-to-smolt survival for each subbasin is calculated as follows:

$S_H = S_{H\text{ at CJMF}} / S_{H\text{ released}}$

Where S_H is the estimated hatchery smolt-to-smolt survival rate; $S_{H\text{ at CJMF}}$ is the estimated number of hatchery smolts past CJMF; and $S_{H\text{ released}}$ is the total number of hatchery fish released from both subbasins.

Prior to acclimation (usually in fall or late winter), all hatchery fish will be coded wire tagged in the snout, but not adipose clipped. Each group and acclimation/release site will have its unique CWT code. In addition, 1,250 fish from each group and acclimation/release site will be PIT tagged at the Prosser Hatchery by YN personnel. Coded wire tagging will be subcontracted to USFWS and conducted at Prosser Hatchery for the Yakima stock fish and at Cascade Hatchery for the Cascade stock fish.

The total number of fish placed into each of the four ponds will be determined from the total number of CWT fish minus any mortalities between the time of marking and transfer to the ponds. The estimated number of smolts passing CJMF is determined using the spring chinook smolt entrainment rate vs. percent flow-diverted relationship.

A relative smolt-to-smolt survival comparison from CJMF to McNary Dam for natural and hatchery smolts will be made using the PIT tag data. The McNary Dam relative smolt survival index value as calculated by YN statistician D. Neeley will be used to compare relative smolt-to-smolt survival between these two groups of fish.

Smolt-to-adult survival. Smolt-to-adult survival can be estimated for both naturally and hatchery produced coho. Naturally and hatchery produced smolts are counted at CJMF, and returning adults are counted at Prosser Dam. This represents our best method to compare relative smolt-to-adult survival rates between naturally and hatchery produced fish. In addition, smolt-to-adult survival for hatchery fish released as smolts from the acclimation sites to returning adults at Prosser, Cowiche and Roza dams can be estimated. However there is no similar method to estimate smolt-to-adult survival for naturally produced smolts originating from the upper Yakima and Naches subbasins. Though the majority of naturally produced smolts in the upper Yakima occur upstream of Roza Dam, this facility has not proven reliable for estimation of juvenile out-migrants. Currently in the Naches subbasin, the majority of spawning appears to occur downstream of the Selah-Naches diversion, which potentially could be developed into a suitable juvenile monitoring site (see Section 6.4, Strategy 4c).

Estimates of smolt-to-adult survival for naturally produced and hatchery fish is a continuation of the smolt-to-smolt survival discussed above. The fraction of naturally produced or hatchery adults will be multiplied by the total number of adults passing each dam to estimate the total number of naturally produced and hatchery fish returning to that facility. The estimated number of naturally produced smolts at CJMF will be used for the natural to hatchery smolt-to-adult comparison, and the estimated number of hatchery smolts that out-migrated from each acclimation site will be used to determine the hatchery smolt at release-to-adult survival.

Risks: With the exception of a few smolt traps and PIT detectors, facilities already exist to do much of this monitoring. Handling as described rarely leads to mortality and would be within existing limits and protocols at Prosser, and as already described at Roza and Cowiche. The most significant risk is to the coho when they are tagged, as some mortality can occur (by some estimates, up to 20% of PIT-tagged fish, due to the stress caused by handling) (Prentice et al. 1994). PIT tagging survival at Cle Elum for spring chinook tagged in the fall/winter by YN personnel has averaged 96-97% (Mark Johnston, personal communication, 2003). The coho, though valuable, are considered research fish, so the risks normally associated with PIT tagging fish are considered acceptable. Mortality is also associated with coded wire tagging, but again, the risk and loss of fish are considered acceptable in order to collect data for the research.

Effects of new PIT detectors. Although new PIT detectors would be needed at the Selah-Naches diversion, at diversions on Wilson and Taneum creeks, and the rotary traps in the Ahtanum and Toppenish subbasins, they would be placed at existing facilities, so no environmental disturbance would occur.

Effects of redd capping. Placing the redd caps requires digging a 6-inch-deep trench around the perimeter of the redd just before the coho are expected to emerge, then backfilling with gravel. The amount of sediment raised would be no more than the fish itself raises. No other effects on other species or the stream environment would occur.

Effects of smolt traps. To monitor migration numbers and timing, coho smolts would be trapped at existing or new traps in selected subbasin streams. Existing traps include those at Roza Dam and CJMF on the Yakima mainstem, and rotary traps on Ahtanum Creek at RM 0.75 and on Toppenish Creek at RM 26.5.

The CJMF facility is the primary juvenile monitoring facility in the Yakima basin and is operated year-round. The Roza trap is operated for spring chinook PIT tagging 24 hours a day from November 1 through March 31. Coho will be trapped and PIT tagged as part of the spring chinook operation. The trap is checked in the morning, and captured fish are PIT tagged and released later the same day. Because the coho program would use the trap within existing parameters, it would cause no additional adverse effect on listed species.

The Ahtanum and Toppenish traps are operated to evaluate steelhead smolt production and migration timing (BPA-funded projects #199901300, 199705300 and 199603500) under existing NEPA documentation and ESA permits. Both traps operate between November 1 and June 30, 7 days a week, 24 hours a day.

At the Ahtanum and Toppenish facilities, the coho project would trap juveniles within the limits of existing permits. The primary effect on the steelhead is migration delay and stress from handling. During the period coho would be migrating and thus subject to trapping, steelhead would not be of a size to be prey for coho. The trap is checked daily; staff measure and weigh 50 steelhead smolts (and presumably coho) per day at each trap. Fish are anesthetized with a eugenol mixture of 1:9 clove oil to denatured ethanol per liter of water. Once sampled and fully recovered, fish are released below the trap.

The allowable incidental non-lethal take of steelhead is 5,000 annually for the Toppenish trap and 200 annually for the Ahtanum. Staff calculate a lethal take of 100 steelhead at the Toppenish trap and 4 at the Ahtanum trap. Bull trout are not found in these lower elevation waters. Because the coho smolt trapping program would operate within the limits of the existing steelhead ESA permits, it would cause no additional adverse effect on listed species.

New traps are proposed on Taneum and Wilson creeks in the upper Yakima subbasin; and at the Selah-Naches diversion canal on the Naches River. See Section 6.4, Strategy 4c for a brief discussion of the effects of the new traps.

6.2 Objective 2 Methods and Risks

Objective 2. Continue to investigate the coho life history in the Yakima basin.

Strategy 2a. Conduct spawner surveys throughout the Yakima basin.

Method: Conduct foot/boat surveys, with locations determined by past and current telemetry distributions. Currently these include the Yakima mainstem (Keechelus Dam to Granger); the mainstem Naches (Little Naches to confluence); and tributaries where coho have been released.

Conduct peak and end-of-season surveys between September 15 and November 30. Flag redds with ribbon and record locations using Global Positioning System (GPS).

Risks: These surveys pose little or no risk to other species or to the environment. The primary risk is to the 100 coho that would be radio-tagged. As these are research fish, the potential mortality is considered a necessary risk in order to accomplish research objectives.

Strategy 2b. Determine, in general terms, where coho currently are found in the basin and their abundance.

Method: Conduct snorkel and electro-fishing (both boat and backpack) surveys to determine the geographic and seasonal distribution and relative abundance of juveniles. Parameters measured will be presence/absence and relative abundance (i.e., catch per unit effort (CPUE) or fish per linear meter). Specific locations and times proposed are:

Snorkeling: Systematic sampling (10%) of preferred habitat (side channel areas and mainstem pools) in the following streams:

- Upper Yakima: Easton to Ellensburg
- Naches mainstem: Little Naches River to confluence
- Release tributaries (Taneum, Ahtanum, Toppenish, Pileup, and Nile creeks), to coincide with release reaches

Summer, 3 days for each major subbasin, 1-2 days for each tributary

Juvenile electro-fishing surveys (boat): Systematic sampling of preferred habitat in Yakima mainstem: 10 half-mile reaches between Roza Dam (RM 128) and Granger (RM 83).

One in summer, one in fall/winter

Juvenile electro-fishing surveys (backpack): Backwater channel areas in the following rivers:

- Upper Yakima mainstem: Easton Dam to Wilson Creek
- Naches mainstem: confluence to the Little Naches River
- Little Naches River: confluence to North Fork and lower half mile of tributaries (based on presence of redds)

November-February, 5-10 days/month, not every area annually

Risks:

Electro-fishing. Electro-fishing has the potential to injure fish. Although most if not all stunned adult and juvenile fish appear to recover sufficiently to swim away, long-term effects or effects that do not result in immediate mortality are not well understood (USDI FWS 2001). During research in the Columbia River basin, an electro-shocking injury level for incidentally shocked juvenile salmon has been estimated at 10 percent (M. Schuck, fishery biologist, Washington Department of Fisheries, pers. comm. [in] Scholz 1992). Barton and Dwyer (1997) found that, for juvenile bull trout, electro-shock resulted in increased plasma glucose and plasma cortisol levels indicative of acute stress (in USDI FWS 2001).

We estimate that a maximum of 45 steelhead juveniles and 0 bull trout juveniles could be captured and released during the boat electro-fishing surveys in the Yakima mainstem, with the potential for an unintended lethal take of 10 steelhead annually. This assumes 60 hours of actual electro-fishing time annually and is based on springtime boat electro-fishing surveys conducted in 2002 between Zillah and Sunnyside Dam by YN personnel (Linda Lamebull, YN, personal communication, 2003). In these 2002 surveys, 35 *O. mykiss* were captured as an incidental species over the course of 3 months of electro-fishing. Total time spent electro-fishing was 46.9 hours, averaging an encounter rate of 0.75 steelhead per hour. To reduce the potential for fish mortality, YN will use trained personnel, will apply the NMFS electro-fishing guidelines (NMFS 1998) and guidelines found in Fredenburg (1992), and will meet all requirements of the ESA Section 10 permit required by NMFS for electro-fishing in areas with listed steelhead.

Assuming a similar rate of encounter for backpack surveys, and an hour of electro-fishing at each site, we estimate that up to 50 steelhead per site would be captured and released, with an unintended lethal take for all sites of 5 steelhead.

Snorkeling. It is possible that a snorkeler could frighten a fish from its hiding place, causing it to be caught and eaten by a predator. However, the low number of surveys per year on any particular stream (up to 17,000 meters on the Upper Yakima and Naches and 8,000 meters on the tributaries for the distribution/habitat usage surveys), the short amount of time a snorkeler would spend in any reach, and the snorkeler's training to observe only, make it unlikely that the surveys would cause injury to or significantly disrupt normal behavior of listed fish as described in the NMFS definition of "harass" (NMFS 1996).

Strategy 2c. Determine life history timing.

Method: Use PIT-tagged fish to monitor hatchery smolt out-migration timing from the acclimation sites and selected parr release tributaries to CJMF and to McNary Dam.

Monitor naturally produced outmigrants (fall-spring) by PIT tagging summer-winter juveniles in rearing areas (see Table 2 for locations) and interrogating them at Roza Dam; at new detection sites in the upper Yakima, Naches, and lower Yakima subbasins (see Table 2); and/or at CJMF and at McNary Dam. For fish that are interrogated at one of the PIT tag detection sites, life history information would be recorded. If taken at Roza, CJMF, or one of the tributary rotary traps, timing and fork length would be recorded.

Evaluate PIT-tagged adults/jacks at mainstem dams and at the denil ladder at Prosser Dam.

Risks: See Section 6.1, Strategy 1f.

6.3 Objective 3 Methods and Risks

Objective 3. Assess ecological interactions.

Strategy 3a. Study coho residualism in release locations where steelhead also are found.

Method: Because Phase 1A studies found low levels of residualism in hatchery coho smolts released in the upper Yakima and Naches basins (Section 5), Phase 1B residualism studies are proposed only near the new release site at Taneum Creek.

- Randomly sample downstream of the new release site in early summer.
- Conduct snorkel surveys in a downstream direction, using two snorkelers along each bank.
- Record the number of coho per section.

Risks: Snorkel surveys would not cause environmental impacts (see Section 6.2, Strategy 2b). Studies in the Yakima basin have so far shown low rates of hatchery smolt residualism (see

Section 5). Fish culturing practices are not expected to change, so those low rates are expected to continue.

Whether planted coho parr will residualize in greater numbers than smolts remains a question. Although there is some overlap with steelhead spawning habitat in a few creeks, most coho parr plants are proposed downstream of steelhead habitat (see Section 6.1, Strategy 1b). Bull trout probably would not be affected by any residualized coho, as most bull trout habitat is upstream of fry planting areas. If there were overlap, however, coho parr likely would be prey for bull trout. See more discussion in Section 6.1, Strategy 1c.

Strategy 3b. Study interactions between natural-origin coho or surrogates and other salmonids.

Methods: Although Phase 1A studies show little risk of negative ecological interactions between hatchery coho smolts and other fish species (see Section 5), concerns remain about the potential for naturalized coho to negatively affect listed or sensitive species, particularly as coho numbers increase. Naturally produced coho appear to be returning in larger numbers than hatchery coho (see Table 15, Section 6.1, Strategy 1a).

Competitive interactions between coho and other species are often investigated using two general techniques: controlled field studies and laboratory investigations. Each general approach has potential strengths and weaknesses. Field studies may lack statistical power, but are seldom criticized for lacking relevance to actual conditions. In laboratory conditions, on the other hand, statistical power is easily achievable through controlled replication, but natural conditions which closely parallel the stream ecosystem are difficult to replicate.

Alternative approach considered: The project considered conducting a controlled experiment similar to one being conducted in the Wenatchee basin, using hatchery-fed fry as surrogates for natural fish. Two stream reaches or two tributaries would be selected, where one reach or one tributary is seeded with hatchery coho (treatment) and the other is the control. Using snorkel surveys in both the treatment and control reaches/tributaries, the following parameters would be measured:

- distribution of coho and species of concern;
- macro/micro habitat usage by individual coho and species of concern (water depth, flow, cover, substrate type and velocity);
- body length and weight and condition factor for both coho and species of concern.

The results would be evaluated, looking for significant changes over the summer in macro/micro habitat shifts, changes in distribution, and/or changes in condition factor or growth rates.

Proposed approach: The proposed study approach is similar to the alternative except that naturally produced fish would used, and the surveys would be done using electro-fishing.

The project proposes to sample one treatment and one control tributary in the Naches and upper Yakima subbasins. The paired streams are (see Figures 10 and 12 in Section 6.1):

- Upper Yakima: Taneum (treatment: RM 2.25 – 12.7); Swauk (3 control reaches from RM 1-14 coincide with WDFW study reaches)

- Naches: Pileup (treatment: RM 0.25 - 2); Quartz (control: RM 1 - 2)

In the upper Yakima, the two streams selected coincide with streams and reaches that have been the focus of WDFW *O. mykiss* abundance, distribution, and growth surveys for at least ten years; their data will provide an excellent baseline from which to monitor changes that might be attributable to the introduction of coho. The streams selected in the Naches will not have that level of baseline data available but have been subject of similar studies by the coho program in the late 1990s.

In Taneum Creek, 120 adult females and 160 adult males would be released in the fall and allowed to spawn naturally. In Pileup Creek, twenty pairs of adults would be released. In summer, during low flows, project staff would install a block net and electro-fish three 200-meter reaches in each of the four streams to measure abundance. The fish would then be captured, weighed, measured, and released. Changes in abundance would be examined. The control reaches, particularly in Swauk Creek, would help researchers determine if variations are attributable to environmental conditions. If they see variation in the treatment stream that is outside the range of variation in the control stream, it could signal that further study is needed to determine if the change is attributable to the coho introductions.

Risks: These studies require deliberately posing a risk of negative interactions between coho and steelhead. As discussed in BPA's most recent Supplement Analysis of the effects of the Yakima coho program (BPA 1999), researchers in other areas have reported conflicting results in studies of coho competitive interactions with other species. Some studies showed that coho displaced other species, while others showed apparent differences in preferred habitat between species. In 1998, the YN conducted field experiments with coho fry to address the impacts of coho on the growth, abundance, and broad-scale geographical displacement of cutthroat and rainbow/steelhead trout in the Yakima basin. 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. 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; Dunnigan 1999). However, sample size was small, and the primary focus of the study was not species interactions. See summary in Section 5.

It is unknown whether adults planted will reproduce successfully, or, if they do, whether their progeny will increase coho densities enough to provide statistically significant results. Alternatively, if the coho successfully spawn in natural habitat, and if they in fact pose a competitive risk to other species, it might be too late to eliminate the coho from the habitat. Although the risk assessment (Table 10) showed a risk to upper Yakima steelhead of 18 out of a possible 100 (fairly low), the uncertainty number was almost 10, indicating a noticeable difference of opinion on the level of risk among the biologists doing the assessment.

Electro-fishing poses a certain amount of risk to all fish in the study reaches, but use of trained personnel and compliance with established electro-fishing guidelines and permits would minimize the risk (see Section 6.2, Strategy 2b). An initial estimate of take of listed fish is approximately one percent of all fish sampled.

6.4 Objective 4 Methods and Risks

Objective 4. Develop and test use of additional acclimation, culturing, and monitoring sites.

Strategy 4a. Develop additional acclimation sites in upper Yakima River subbasin (Holmes, Boone Pond, and Taneum Creek).

Method: In Phase 1A, the project relied on a few permanent fixed sites at which to acclimate and release coho smolts. However, the project has had problems at these sites because many fish are lost to predation before they are released, or fish get out at the wrong times and compromise the experimental design. In Phase 1B, the project proposes to develop and use new acclimation sites in the upper Yakima subbasin: Holmes, Boone Pond, and Taneum Creek (for smaller release numbers). If excessive bird predation continues, existing alternate sites (Clark Flat or Easton Ponds), new natural ponds or net pens, or improvements at Roza Dam such as floating net enclosures in the forebay, would be used.

The general characteristics and risks of using each site or method are discussed below.

<u>Holmes Acclimation Site:</u>

Location: Upper Yakima (RM 159.5) about two miles north of Ellensburg, WA, in T18N, R18E, Section 13, SW corner. This site was once an historic side channel that now functions as the fish bypass route for the Cascade canal. It enters the mainstem Yakima River below an I-90 crossing about 1.5 road miles east of the Thorp exit. The Cascade diversion dam is located at about RM 161.3, and the side channel enters the mainstem around RM 159.

Within the side channel are two ponds, most likely the remains of gravel extraction adjacent to I-90 for construction of the interstate highway. The only action required to make the site suitable for coho acclimation would be to block the outlets using nets or dam boards. Approximately 200,000 out-of-basin coho smolts would be acclimated there, but numbers could fluctuate, depending on production of Yakima-origin smolts.

Ownership: private.

Ecotype: historic floodplain, now disturbed ground used for agriculture.

Water Quality: Further downstream from this site, in Section 33, the Yakima River is 303d-listed for copper (WDOE 1998).

Listed fish species: steelhead.

Risks: This site currently is in use for coho acclimation. Its use was analyzed in a Supplement Analysis to the YFP EIS (BPA 2003). BPA found that use of the site would cause no additional environmental impacts beyond what was already analyzed in the YFP EIS (BPA et al. 1996) and subsequent Supplement Analyses and related biological assessments and biological opinions. Use of the site also was subject to consultation with NOAA Fisheries, who concurred with BPA's determination that impacts to listed species would be negligible (letter from Patricia R. Smith, BPA, to Allyson Ouzts, NOAA, February 24, 2003).

BPA (2003) determined that there would be no effect to species under jurisdiction of USFWS beyond those already addressed in existing consultation. The shoreline of the upper pond is highly vegetated with wild rose, red osier dogwood, and other brushy species, which prevents cattle from accessing it. (Cattle do access the un-vegetated lower pond.) Project staff use the farmer's existing roads to access the ponds and the weir site. The roads and other access areas show evidence of considerable disturbance, with canarygrass and knapweed being the dominant species, so it is highly unlikely that sensitive plant species are present or affected.

Boone Pond Acclimation Site:

Location: Upper Yakima (RM 180.5), about two miles south of Cle Elum, Washington, adjacent to Interstate 90. The pond was created during I-90 construction, and is directly connected to the Yakima River. Approximately 250,000 coho would be acclimated there initially, but numbers could increase if production of Yakima-origin fish improves.

The pond is shallow, fed by two small perennial streams from the south. Shorelines are steep on the north, east, and south. The site could be used by placing a barrier net across the backwater. However, the water level of the pond directly reflects water level in the river, which is low in the spring, when coho would be acclimated. Water level could be increased by constructing a check dam using masonry blocks (or possibly inflatable dams as are used for flood control), and hand-digging. A PIT detector could be placed at a notch in the check dam to monitor out-migration.

Ownership: private.

Ecotype: historic floodplain, now disturbed ground.

Water Quality: The area of the site appears to be on the 303d list for pesticides (WDOE 1998). The listing was based on tissue samples.

Listed fish species: steelhead.

Risks: The effect of developing this site probably would be low. Little additional ground disturbance would be required; the small amount necessary to install the check dam could be done by hand. In general, riparian and upland vegetation structure is limited; the disturbed nature of the site is evident by the prevalence of knapweed, though some wetland vegetation (e.g., cattails) is also present. The site is grazed by horses, but the landowners have initiated upland vegetation enhancement. Although the pond is in the floodplain, installation of a check dam would lead to, at most, only minor, short-term increases in sediment downstream, especially using standard erosion control practices. Water quality issues would need to be investigated.

Taneum Creek Acclimation Site:

Location: U.S. Bureau of Reclamation (USBOR)/Taneum ditch company diversion located at approximately RM 4.

Ownership: Uncertain, possibly USBOR.

Ecotype: Floodplain; ponderosa pine/cottonwood riparian zone along creek.

Water Quality: Supports *O. mykiss* population. Experiences low flow in late summer and fall below the diversion (lowest four river miles); this segment of the stream is 303d-listed for low instream flows and temperature (WDOE 1998).

Listed fish species: steelhead, bull trout.

Risks: This site would be used to test releases of a smaller number of smolts into a tributary stream (as opposed to mainstem smolt releases); and to test survival of early-run vs. late-run fish. Effects of volitional smolt releases are discussed under Strategies 1a and 1b.

Development of this site would cause minimal environmental impacts because the site has already been developed with construction of the fish bypass system. Fish would be acclimated within the fish bypass structure, thus no structures would be set up on the existing site.

Effects of all proposed new sites on ESA-listed terrestrial or avian species are expected to be low to negligible. ESA-listed species in the Yakima basin include bald eagle, spotted owl, snowy plover, lynx, and grizzly bear (all listed as Threatened), and gray wolf (listed as Endangered). There are also a variety of state-listed species in the basin (Berg and Fast 2001). Given the proximity of the Holmes and Boone Pond sites to I-90, it is unlikely that listed birds or wildlife occupy the areas; but if they do, they would be only temporarily disturbed by the installation of equipment, and perhaps by staff accessing the site for feeding and other activities. Effects on listed fish species of coho releases from these sites were discussed in Section 6.1, Strategies 1a and 1b.

Existing Natural Ponds:

Existing ponds that are fed by tributary streams and/or are connected to the main stem of the river are a priority for acclimating. Natural ponds provide the smallest amount of operating and maintenance costs of any alternative. The ponds mimic natural conditions and provide large holding capacities. A temporary dam structure or net would be placed across the outlet of the pond. The disadvantages to natural ponds, however, is that fish access from the river to the pond is blocked for the acclimation period (4-6 weeks).

Generators		**Water**	**Excavation**	**HPA**	**Portable**	**Cost**
Primary	**Backup**	**Intake**	**Permits**			
NO	NO	NO	NO	NO	NO	LOW

Floating Net Enclosures:

Net pens are an alternative because they are fairly inexpensive and water supply is not an issue. The pens would consist of a large 4-sided net with a bottom and predator netting on top. Shore cables would anchor the floating platforms. The bottom of the pen would be either anchored to the bottom of the river or lead weights would be used to retain its form. Permitting may be an issue: floods or debris could damage the pen, causing smolts to be released early; however, the pen would not obstruct migrating or resident fish.

Generators		**Water**	**Excavation**	**HPA**	**Portable**	**Cost**
Primary	**Backup**	**Intake**	**Permits**			
NO	NO	NO	NO	NO	YES	LOW

Strategy 4b. Test use of mobile acclimation vessels in several sub-watersheds.

Rationale: In Phase 1A, the project relied on a few permanent fixed sites at which to acclimate and release coho smolts. However, the project has had problems at these sites because many fish are lost to predation before they are released, or fish get out at the wrong times and compromise the experimental design. In Phase 1B, the project proposes to test the feasibility of using mobile acclimation vessels at three sites in the upper Yakima, Ahtanum, Toppenish, or Naches subbasins. If they prove effective (if coho redd numbers increase), the mobile acclimation vessels could be rotated between sub-watersheds to supplement natural production as necessary.

Method: The proposed acclimation vessels are portable vessels consisting either of vinyl liners that fit over steel frames that would be placed temporarily on the ground; or fiberglass or aluminum raceways or a small circular tank fitting on the back of a flat bed trailer. Vinyl raceways are approximately 80 feet x 8 feet x 4 feet deep; fiberglass or aluminum-sided raceways would be approximately 20 feet x 6 feet by 4 feet. Each holds approximately 10,000 smolts. Up to 10,000 coho smolts annually (of the 1 million programmed for the Yakima basin) would be acclimated in these portable raceways. They require a level site near a road. Sand or matting material might placed on the ground to protect the bottom of the raceway, if necessary. Water to the raceway would be gravity fed, using a 4-inch PVC pipe that would run downhill from the creek to the raceway, with another pipe discharging wastewater back into the creek.

Potential sites in the Ahtanum, Toppenish, Wilson Creek, Nile Creek, Little Rattlesnake and North Fork of the Naches are similar to those identified for parr releases (see descriptions in Section 6.1, Strategy 1c). All sites may not be used every year; their use depends on personnel schedules and materials. The goal is to test three locations for at least one year during the Phase 1B period.

Risks: The effect of installing mobile acclimation vessels is likely low. Once specific sites are proposed, they would be subject to NEPA and possibly ESA reviews. They would need to be assessed for the presence of wetlands and listed plant species, to ensure that placement of the vessels and staff access to them does not harm or destroy sensitive vegetation. Research on the source and receiving waters would have to be done to determine effects on water quality of discharges from the vessels. Temporary use permits could be required from Washington Department of Ecology (WDOE) for use of the water. If sites are on U.S. Forest Service land, coordination with the Forest Service would be required, including compliance with that agency's NEPA process.

In most cases, other than placing matting or sand, no ground disturbance would be required. All piping would be laid on the surface of the ground, and no blading or leveling of the site would be done. Therefore, no cultural resources surveys would be required. Sites likely would be in floodplains, but the limited and temporary project activities would not decrease the capacity of the floodplain to hold floodwaters, destabilize or disturb soils in the floodplain, or lead to increased erosion or sediment load downstream. However, at the Ahtanum site, it is possible that some ground disturbance could be necessary. See Strategy 4d, this section, for a discussion of potential effects.

ESA-listed species in the Yakima basin include bald eagle, spotted owl, snowy plover, lynx, and grizzly bear (all listed as Threatened), and gray wolf (listed as Endangered). There are also a variety of state-listed species in the basin (Berg and Fast 2001). Specific sites would need to be identified and the presence of these species assessed. Birds or wildlife occupying the area could be temporarily disturbed by the installation and removal of the vessels, and perhaps by staff accessing the site for feeding and other activities, but the effect would be minor and temporary—an intermittent disturbance over a period of two months.

Effects on listed fish species of coho releases from these sites were discussed in Section 6.1, Strategy 1c.

Strategy 4c. Establish additional monitoring sites in the Yakima and Naches subbasins.

Method: The project proposes to install three new smolt traps to monitor out-migration and survival in new release areas:

- Naches River (Selah-Naches Diversion Canal, RM 18.4)
- Wilson Creek irrigation dam (RM 2)
- Taneum Creek (RM 4)

Risks:

Selah Naches Diversion Canal. Two options exist: 1) to place a capture box on the outfall pipe of the canal; or 2) to place a rotary trap in the canal immediately upstream of the outfall. Option 2 would probably catch more fish and give better monitoring results for the project but it poses more risk to listed fish, because more of them would also be captured.

Wilson Creek irrigation dam: Either a box trap or rotary trap could be installed at the site of the dam. The site is adjacent to the freeway and already disturbed (evidenced by canarygrass in the creek). Listed fish are unlikely to be trapped at this location because there is little if any spawning or rearing habitat for them in Wilson Creek.

Taneum Creek: Install a rotary trap in the canal between the headgate and screens, or in the creek immediately upstream of the canal headgate. Steelhead would be trapped at this facility.

Strategy 4d. Test use of a small-scale fish culturing facility.

Method: The proposed site is on land owned by and adjacent to LaSalle High School, at RM 2.2 on Ahtanum Creek. School officials recently expressed interest in the possibility of developing the site as a small-scale, full-life-cycle coho rearing facility. At this point, a reasonably foreseeable option would be to use this site to rear 30,000 coho eggs to summer parr. However, no specific proposal exists at this time.

If a proposal were to be developed, facilities could include a shed to house incubation raceways using stacked trays or Heath trays; portable raceways for rearing up to 30,000 parr or smolts (the acclimation and rearing vessel would be the same); and a holding pond for adults.

The adult holding pond likely would consist of a portable vessel. If a small incubation raceway is used for egg incubation using stacked trays, then once the eggs hatch, the stacks can be removed and the raceway used as the start vessel until the fish are ready to be ponded (moved outside to the big rearing raceways). There is an existing building that could be used for an incubation shed (although a prefabricated or portable cinder-block shed could also be used), and the site has a pump that pumps surface water out of the creek.

Risks: All required facilities and vessels would occupy approximately ¼ acre of already disturbed land. It is unlikely that rare vegetation or sensitive terrestrial or avian species would be found or affected, given the previous disturbance and the site's proximity to the school and other development.

To achieve gravity flow at this site, we probably would need to excavate at least two feet to install the portable raceway below grade, with the water inflow and discharge pipes laid on the surface. This could result in the removal of approximately 1,280 cubic feet of soil from the floodplain. Effects on floodplain characteristics, including the floodplain's capacity to contain flood waters, would be evaluated during the permitting process.

Ahtanum Creek water would be used for rearing and acclimation. Summer water temperatures at the site are unknown. The latest available information from Washington Department of Ecology (WDOE) has no listings for Ahtanum Creek (WDOE 1998). The site has no well, so ground-water would not be available to reduce water temperature, if necessary. Flow requirements for rearing are 5-6 gallons per minute; approximately half this amount is needed for incubation. Wastewater would be discharged directly back into the creek. Even if the project were to rear coho to smolts—up to 25,000 smolts at 20 fish per pound at release (1,250 pounds of fish)—the project would be well within the WDOE limit of 20,000 pounds of fish before a settling pond is required. If the rearing vessel is installed partly below ground surface, the discharged wastewater would be cooler and probably would not increase water temperature in the creek.

If a specific proposal were made, the project would further evaluate existing water quality and supply, and if federal funding were involved, undertake a NEPA and ESA review (including, potentially, surveys for listed species, wetlands, and cultural resources). State review through the JARPA (Joint Aquatic Resource Permits Application) process also would be undertaken.

6.5 Objective 5 Methods and Risks

Objective 5. Determine long-term facility needs.

Strategy 5a. Investigate potential permanent rearing sites more suitable than Prosser for coho.

Rationale:

- The project's experience with rearing coho at Prosser has not been good. The water temperature at Prosser is too warm for summer rearing coho, and, due to agricultural pollutants, occasionally sub-lethal to lethal conditions have been experienced at the hatchery. The project has repeatedly lost fish there, which makes it difficult to meet production levels and to develop a locally adapted population. Lost fish means that dollars invested in feasibility studies and facilities are not used effectively.
- Prosser's capacity is limited to 500,000 coho smolts. In order to meet release goals of one million coho smolts annually, half the production must be reared out-of-basin, potentially slowing the project's ability to establish a locally adapted population.

Method: Project staff believe that, in order for coho to be reintroduced successfully, a more suitable rearing facility must be found or developed. For Phase 1B, the project proposes to investigate potential sites.

These investigations would be primarily "paper" research or site visits. Existing records on water quality, temperature, and flows; on water rights and ownership; and on other relevant issues would be researched. Research would be supplemented by site visits and initial engineering calculations. No major ground disturbance would be required, although ground water evaluations with test pits and test wells may be important parts of the site evaluations. The potential for small-scale as well as larger facilities would be examined, as well as the less favored option of rearing progeny of Yakima returns out-of-basin.

Risks: There is no environmental risk to this research. The research would benefit the project by finding and evaluating sites that could be suitable for coho incubation and rearing. Should feasibility studies prove promising, the information gathered could be used in evaluating proposals for a long-term reintroduction program.

Strategy 5b. Investigate the feasibility/desirability of establishing additional permanent, fixed acclimation sites in the upper Yakima, Naches, or other subbasins.

Method: This would be primarily an analytical exercise, similar to that for Strategy 5a.

Risks: This exercise poses no environmental or project risks.

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APPENDIX A. HYPOTHETICAL BROODSTOCK COLLECTION NUMBERS FOR YAKIMA COHO

Appendix A. Hypothetical Broodstock Collection Numbers for Yakima Coho

Fecundity:	3004.8	3004.8 eggs/female	
Assumed run ratio:		HOR	0.667
		NOR	0.333
Assummed sex ratio:	0.5		
Assummed 1-to-1 male/female spawning			
P.Hatchery collect-spawn survival:		90%	
P.Hatchery egg-release survival:		80%	

Broodstock Criteria: 50% cap on NORs & 75% cap on HORs as a function of run size

HOR Cap:	0.75
NOR Cap:	0.5

Run Size	NOR	HOR	Natural Escapement of NORs	Natural Escapement of HORs	Total Natural Escapement	Cap of 50% of NORs (40% denil capture efficiency)	Cap of 75% of HORs (40% denil capture efficiency)	Max. Broodstock Available	Actual NORs Collected	Actual HORs Collected	In-Basin Smolts Produced	Out-of-basin Needs Expressed as Smolts	Broodstock females	Broodstock males	Total
1000	333	667	266	467	733	67	200	267	67	200	288,497	711,503	462	462	924
1200	400	800	320	560	880	80	240	320	80	240	346,196	653,804	462	462	924
1400	466	934	373	654	1,027	93	280	373	93	280	403,896	596,104	462	462	924
1600	533	1,067	426	747	1,173	107	320	427	107	320	461,595	538,405	462	462	924
1800	599	1,201	480	840	1,320	120	360	480	120	360	519,294	480,706	462	462	924
2000	666	1,334	533	934	1,467	133	400	533	133	400	576,994	423,006	462	462	924
2200	733	1,467	586	1,027	1,613	147	440	587	147	440	634,693	365,307	462	462	924
2400	799	1,601	639	1,121	1,760	160	480	640	160	480	692,392	307,608	462	462	924
2600	866	1,734	693	1,214	1,907	173	520	693	173	520	750,092	249,908	462	462	924
2800	932	1,868	746	1,307	2,053	186	560	747	186	560	807,791	192,209	462	462	924
3000	999	2,001	799	1,401	2,200	200	600	800	200	600	865,491	134,509	462	462	924
3200	1,066	2,134	852	1,494	2,347	213	640	853	213	640	923,190	76,810	462	462	924
3400	1,132	2,268	906	1,587	2,493	226	680	907	226	680	980,889	19,111	462	462	924
3466	**1,154**	**2,312**	**923**	**1,618**	**2,542**	**231**	**694**	**924**	**231**	**694**	**999,930**	**70**	**462**	**462**	**924**
3600	1,199	2,401	959	1,681	2,640	240	720	960	240	720	1,000,000	0	462	462	924
3800	1,265	2,535	1,012	1,774	2,787	253	760	1,013	253	760	1,000,000	0	462	462	924
4000	1,332	2,668	1,066	1,868	2,933	266	800	1,067	266	800	1,000,000	0	462	462	924
4500	1,499	3,002	1,199	2,101	3,300	300	900	1,200	300	900	1,000,000	0	462	462	924
5000	1,665	3,335	1,332	2,335	3,667	333	1,001	1,334	333	1,001	1,000,000	0	462	462	924
5500	1,832	3,669	1,465	2,568	4,033	366	1,101	1,467	366	1,101	1,000,000	0	462	462	924

APPENDIX B. COST ESTIMATES FOR YAKIMA COHO PROGRAM

CONTENTS

I. INTRODUCTION

1.1 PROGRAM DESCRIPTION

There are two project phases covered in this cost estimate. Feasibility Phase 1B is described in detail in the YAKIMA COHO MASTER PLAN. An implementation phase following feasibility is assumed for the purpose of the evaluation of possible future expenses. Implementation may or may not be the selected outcome and the program described below may or may not be the one chosen:

- Broodstock collection will gradually be moved upstream from Prosser to Cowiche and Roza dams.
- Rearing is assumed to occur at a new, central hatchery located in the Yakima basin.
- Acclimation will continue in the same locations that are being used now, or at identified alternatives if they are not available.

1.2 METHODS USED

An explanation of the procedures used to estimate capital and operating expenses for the hatchery rearing component of the program are given in the YKFP COHO REARING FACILITIES SITING REPORT, YAKIMA BASIN. Acclimation capital cost estimates were made based on the plan presented in the Master Plan. Construction estimating guides, vendor quotes, and previous acclimation site construction costs were used to produce the values. Operating costs are assumed to be similar to those that are being incurred now by the Mid-Columbia program. Monitoring and evaluation costs are based on the current Yakama Nation program.

1.3 PROJECT SCHEDULE

The timing of the capital expenses will depend on the funding agency review process, on permitting, and on the outcome of program evaluation studies. The project schedule (see the Siting Report for details) assumes that a decision to move out of the feasibility phase is made in 2010. Step 3 of the three step NPPC review process, final design, is planned for 2012 and a funding decision would follow. Major new construction would then begin in 2012 if funding is approved.

1.4 FACILITIES PLAN EVALUATED

	2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
FEASIBILITY PHASE 1B											
IMPLEMENTATION											
BROOD CAPTURE											
Prosser											
Roza/Cowiche											
REARING											
Lower River Hatcheries											
New Central Hatchery											
ACCLIMATION											
Holmes											
Boone											
Easton											
La Salle											
Stiles											
Lost Creek											
Naches											
Taneum											
Mobile											

2. SUMMARY OF COST ESTIMATES

	2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
OPERATING COSTS											
OPERATING COSTS											
Rearing	Mitchell Act*	Mitchell Act	Mitchell Act	Mitchell Act	Mitchell Act	Mitchell Act	Mitchell Act	282,000	282,000	282,000	282,000
Brood and Acclimation	353,000	353,000	353,000	353,000	353,000	353,000	353,000	353,000	353,000	353,000	353,000
Monitoring and Eval.	564,000	716,000	716,000	716,000	716,000	716,000	716,000	716,000	716,000	716,000	716,000
TOTAL OP. COSTS	917,000	1,069,000	1,069,000	1,069,000	1,069,000	1,069,000	1,069,000	1,351,000	1,351,000	1,351,000	1,351,000
CAPITAL COSTS											
Brood Capture	0	0	0	0	0	0	0	0	0	0	0
Rearing	0	0	0	0	0	0	0	8,000,000	2,000,000	1,000,000	0
Acclimation	106,000	1,800	81,000	0	81,000	0	0	730,000	0	0	0
TOTAL CAP. COSTS	**106,000**	**1,800**	**81,000**	**0**	**81,000**	**0**	**0**	**8,730,000**	**2,000,000**	**1,000,000**	**0**
TOTAL COSTS	**1,023,000**	**1,070,800**	**1,150,000**	**1,069,000**	**1,150,000**	**1,069,000**	**1,069,000**	**10,081,000**	**3,351,000**	**2,351,000**	**1,351,000**

Notes:

All costs are in 2004 dollars.

*Mitchell Act now funds rearing of Yakima coho and this support is expected to continue until a new hatchery is built.

CENTRAL HATCHERY REARING

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Staff	4	4	2	2	2	4	4	4	4	2	2	4		
Water requirement (cfs)	4.9	5.5	3.9	1.9	0.1	2.1	3.5	4.8	9.1	9.0	7.1	5.1		
Pump horsepower	14.7	16.5	11.7	5.7	0.4	6.4	10.5	14.3	27.4	27.0	21.2	15.3		
DIRECT OPERATING COSTS													**TOTAL**	% of Total
Labor	$ 14,000	$ 14,000	$ 7,000	$ 7,000	$ 7,000	$ 14,000	$ 14,000	$ 14,000	$ 14,000	$ 7,000	$ 7,000	$ 14,000	$ 133,000	47%
Electricity	$ 1,059	$ 1,187	$ 845	$ 413	$ 25	$ 459	$ 753	$ 1,028	$ 1,975	$ 1,943	$ 1,529	$ 1,104	$ 12,321	4%
Operating Supplies													$ 10,000	4%
Goods and Services													$ 15,000	5%
Fish food													$ 31,200	11%
SUBTOTAL													**$ 201,521**	71%
General and Admin.													$ 40,304	
SUBTOTAL													**$ 241,825**	
SUPPORT SERVICES														
Maintenance, Repairs													$ 30,000	11%
Pathology													$ 10,000	4%
TOTAL													**$ 282,000**	100%

VALUES USED IN THE COST ESTIMATES **$ 7.05** $/lb

Labor rate	$ 3,500	$/mo. (rate includes fringe)	Electrical rate	$ 0.10	$/kwh
Fish food	$ 0.60	$/lb	Hp/cfs ratio	3.0	
Conversion rate	1.3	lb feed/lb fish			
Pounds reared	40000	lbs			

BROOD COLLECTION AND ACCLIMATION														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**TOTAL**	
			Acclimation							Brood				
Staff	2	4	8	8	8	2	2	2	2	6	6	2	52	months
DIRECT OPERATING COSTS														% of Total
Labor	$ 5,600	$ 11,200	$ 22,400	$ 22,400	$ 22,400	$ 5,600	$ 5,600	$ 5,600	$ 5,600	$ 16,800	$ 16,800	$ 5,600	$ 145,600	41%
Vehicles	$ 900	$ 1,800	$ 3,600	$ 3,600	$ 3,600	$ 900	$ 900	$ 900	$ 900	$ 2,700	$ 2,700	$ 900	$ 23,400	7%
Travel													$ 10,000	3%
Operating Supplies													$ 10,000	3%
Goods and Services													$ 15,000	4%
Land rental													$ 20,000	6%
Fish food													$ 24,000	7%
SUBTOTAL													**$ 248,000**	
General and Admin.													$ 49,600	
SUBTOTAL													**$ 297,600**	
SUPPORT SERVICES														
Maintenance, Repairs													$ 20,000	6%
Smolt Transportation													$ 25,000	7%
Pathology													$ 10,000	3%
TOTAL													**$ 353,000**	
VALUES USED IN THE COST ESTIMATES														
Average labor rate	$ 2,800	$/mo. (rate includes fringe)												
Fish food	$ 0.60	$/lb												
Conversion rate	1.5	lb feed/lb fish												
Pounds reared	26667	lbs												

MONITORING AND EVALUATION - 2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Staff	4	4	4	4	4	4	4	4	4	4	4	4		
OPERATING COSTS													**TOTAL**	% of Total
Labor	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 16,000	$ 192,000	34%
Vehicles	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 21,600	4%
Travel													$ 10,000	2%
Goods and Services													$ 5,000	1%
SUBTOTAL													**$ 228,600**	
General and Admin.													$ 45,720	
SUBTOTAL													**$ 274,320**	
SUPPORT SERVICES														
PIT tags													$ 90,000	16%
Marking													$ 200,000	35%
TOTAL													**$ 564,000**	

VALUES USED IN THE COST ESTIMATES

Labor rate $ 4,000 $/mo. (rate includes fringe)

MONITORING AND EVALUATION - 2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Staff	6	6	6	6	6	6	6	6	6	6	6	6		
OPERATING COSTS													**TOTAL**	% of Total
Labor	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 288,000	51%
Vehicles	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 2,700	$ 32,400	6%
Travel													$ 10,000	2%
Operating Supplies													$ 5,000	1%
Sensitive Equipment													$ 20,000	4%
SUBTOTAL													**$ 355,400**	
General and Admin.													$ 71,080	
SUBTOTAL													**$ 426,480**	
SUPPORT SERVICES														
PIT tags													$ 90,000	16%
Marking													$ 200,000	35%
TOTAL													**$ 716,000**	

VALUES USED IN THE COST ESTIMATES

Labor rate $ 4,000 $/mo. (rate includes fringe)

General and Administrative Costs 20%

ACCLIMATION CAPITAL EXPENSE SUMMARY

MAIN SITES	Numbers Released	Cost
Yakima Basin		
La Salle	30,000	$ 20,000
Holmes	215,000	$ 5,000
Boone	215,000	$ -
Taneum	40,000	$ 1,800
Basin Subtotal	***500,000***	
Naches		
Stiles	250,000	$ -
Lost Creek/Naches	250,000	$ 730,000
Basin Subtotal	***500,000***	
PROJECT TOTAL	***1,000,000***	

ALTERNATIVE SITES	Smolt Capacity	
Clark Flat	250,000	$ 354,000
Roza	250,000	$ 90,000
Easton	250,000	$ -
Mobile	3 @ 10,000 each	$ 243,000

CAPITAL EXPENSE ESTIMATE DETAIL

EXISTING SITES

Description: These sites have existing water supplies and rearing units.

Assumptions include:

Land use will be at no cost.

CAPITAL COST ESTIMATE

	Description		Quan.	Units	Unit Cost	Cost	Totals
HOLMES		215,000					
Bridge	Deck replacement					$ 5,000	
							$ 5,000
BOONE		215,000					
No improvements needed							
							$ -
TANEUM		40,000					
Screens in bypass						$ 1,000	
Alarm system	Cellular autodialer, sensor		1	ea	$ 800	$ 800	
							$ 1,800
EASTON		250,000					
No improvements needed							
							$ -
LA SALLE		30,000					
Rearing pond	Excavate, line, plumb rearing pond		1	ea	$ 20,000	$ 20,000	
							$ 20,000

LOST CREEK/NACHES

Description: Naches is a replacement for Lost Creek. Ground water from an infiltration gallery would be pumped to above ground ponds.
Alternative water supplies may be wells or pumped surface water.

Assumptions include: Land use will be at no cost.

Calculations:

Fish Acclimated (maximum)			*Rearing Unit (2)*			
Number	250,000			Vol. Density	0.3	lbs/cft
Size	20	#/lb		Total Volume	41,667	cft
Weight	12,500	lbs		Water Depth	3	ft
Water Requirements				Width (each)	50	
Water density	10	lbs/gpm		Length (each)	139	
Min. water	2.8	cfs				

CAPITAL COST ESTIMATE

	Description	Quan.	Units	Unit Cost	Cost	Totals
REARING UNIT						
Grade land	Grub and level	0.5	acre	$ 5,000	$ 2,500	
Sand base	3" deep, spread and leveled	130	cy	$ 50	$ 6,500	
Ponds	Steel walled, plastic lined, assembled	2	ea	$ 50,000	$ 100,000	
Predator nets	Steel supports, wire frame	13889	sft	$ 3	$ 41,667	
						$ 150,667
WATER SYSTEM						
Water study	Evaluate and design groundwater supply	1	ea	$ 30,000	$ 30,000	
Gallery construction	Trench excavation, pipe, gravel, filter cloth	1	ea	$ 50,000	$ 50,000	
Pumps	1.5 cfs ea, 15' head, 5 hp submersible	3	ea	$ 5,000	$ 15,000	
Pump controls	Sequential start, ON/OFF	1	ea	$ 2,000	$ 2,000	
Aeration tower	Packed column	1	ea	$ 2,000	$ 2,000	
Piping	Fittings, thrust blocks, pipe, valves, installec	300	ft	$ 80	$ 24,000	
Discharge ditch	Excavate, rock	250	ft	$ 50	$ 13,000	
						$ 136,000
ELECTRICAL						
Generator	15 Kw ea, 24 hour fuel tank	2	ea	$ 15,000	$ 30,000	
Generator building	Concrete floor, louvered doors, fan	200	sft	$ 70	$ 14,000	
Generator electrical	Automatic transfer switch, wiring	1	ls	$ 10,000	$ 10,000	
Site electrical	Wire pumps, generator	1	ls	$ 10,000	$ 10,000	
Alarm system	Autodialer, sensors	1	ea	$ 1,000	$ 1,000	
						$ 65,000
MISC						
Office/storage building	Wood frame building	200	sft	$ 70	$ 14,000	
Access roads	Gravel surface	500	ft	$ 10	$ 5,000	
Fence	6' chain link	800	ft	$ 20	$ 16,000	
Site restoration	Re-vegetate, landscape	1	ls	$ 2,000	$ 2,000	
						$ 37,000
PERMITS						
SEPA/NEPA	Environmental checklist	1	ea	$ 200	$ 200	
JARPA	Shorelines, floodplain	1	ea	$ 200	$ 200	
NPDES	Discharge permit	1	ea	$ 1,000	$ 1,000	
Water Rights	Impact study	1	ea	$ 20,000	$ 20,000	
Env. Land Audit	Soil pollution evaluation	1	ea	$ 2,000	$ 2,000	
ESA	Biological evaluation	1	ea	$ 5,000	$ 5,000	
						$ 28,400
SUBTOTAL						**$ 417,067**
Administrative		20%				$ 83,413
SUBTOTAL						**$ 500,480**
Unlisted items		15%				$ 62,560
Design	Design drawings, parts specs, bid docs	15%				$ 62,560
Construction mgmt		5%				$ 20,853
Contractor overhead		20%				$ 83,413
TOTAL						**$ 730,000**

CLARK FLAT

Description: Water from the spring chinook acclimation facility would flow by gravity to a coho acclimation pond.

Assumptions include:

Land use will be at no cost.

Calculations:

Fish Acclimated (maximum)			*Water Requirements*		
Number	250,000		Water density	10	lbs/gpm
Size	20	#/lb	Min. water	1,250	gpm
Weight	12,500	lbs		2.8	cfs
Rearing Unit (2)					
Vol. Density	0.3	lbs/cft			
Total Volume	41,667	cft			
Water Depth	3	ft			
Width (each)	50				
Length (each)	139				

CAPITAL COST ESTIMATE

	Description	Quan.	Units	Unit Cost	Cost	Totals
REARING UNIT						
Grade land	Grub and level	0.5	acre	$ 5,000	$ 2,500	
Sand base	3" deep, spread and leveled	130	cy	$ 50	$ 6,500	
Ponds	Steel walled, plastic lined, assembled	2	ea	$ 50,000	$ 100,000	
Predator nets	Steel supports, wire frame	13889	sft	$ 3	$ 41,667	
						$ 150,667
WATER SYSTEM						
Piping	Fittings, thrust blocks, pipe, valves, installed	200	ft	$ 80	$ 16,000	
Discharge ditch	Excavate, rock	250	ft	$ 50	$ 13,000	
						$ 29,000
ELECTRICAL						
Alarm system	Sensors, wiring	1	ea	$ 200	$ 200	
						$ 200
MISC						
Access roads	Gravel surface	100	ft	$ 10	$ 1,000	
Fence	6' chain link	800	ft	$ 20	$ 16,000	
Site restoration	Re-vegetate, landscape	1	ls	$ 2,000	$ 2,000	
						$ 19,000
PERMITS						
SEPA/NEPA	Environmental checklist	1	ea	$ 200	$ 200	
JARPA	Shorelines, floodplain	1	ea	$ 200	$ 200	
NPDES	Discharge permit	1	ea	$ 1,000	$ 1,000	
Env. Land Audit	Soil pollution evaluation	1	ea	$ 2,000	$ 2,000	
						$ 3,400
SUBTOTAL						**$ 202,267**
Administrative		20%				$ 40,453
SUBTOTAL						**$ 242,720**
Unlisted items		15%				$ 30,340
Design	Design drawings, parts specs, bid docs	15%				$ 30,340
Construction mgmt		5%				$ 10,113
Contractor overhead		20%				$ 40,453
TOTAL						**$ 354,000**

ROZA

Description: Net pen rearing in the dam impoundment. An alternative is a pumped system and above ground rearing units. An uncertainty is whether effluent treatment is required if net pens are used.

Assumptions include:

Land use will be at no cost.

Calculations:

Fish Acclimated (maximum)		
Number	250,000	
Size	20	#/lb
Weight	12,500	lbs
Net Pen		
Vol. Density	0.3	lbs/cft
Volume	41,667	cft
Depth	10	ft
Two Pens		
Length	46	ft
Width	46	ft
Radius	36	ft

CAPITAL COST ESTIMATE

	Description	**Quan.**	**Units**	**Unit Cost**	**Cost**	**Totals**
Net Pens (2)						
Net pen	With walkways, predator nets	2	ea	$ 20,000	$ 40,000	
Net pen	Delivery, installation	2	ea	$ 5,000	$ 10,000	
						$ 50,000
PERMITS						
SEPA/NEPA	Environmental checklist	1	ea	$ 200	$ 200	
JARPA	HPA, shorelines	1	ea	$ 200	$ 200	
NPDES	Discharge permit	1	ea	$ 1,000	$ 1,000	
						$ 1,400
SUBTOTAL						**$ 51,400**
Administrative		20%				$ 10,280
SUBTOTAL						**$ 61,680**
Unlisted items		15%				$ 7,710
Design	Design drawings, parts specs, bid docs	15%				$ 7,710
Construction mgmt		5%				$ 2,570
Contractor overhead		20%				$ 10,280
TOTAL						**$ 90,000**

MOBILE ACCLIMATION SYSTEMS

Description: Truck-mounted raceways with pumped water. Dual generators with an automatic transfer switch would supply power to the pumps. Some sites may have gravity flow capability.

Assumptions include:

Land use will be at no cost, roads to the sites exist, no effluent treatment is required.

Calculations:

Tank			*Fish Capacity*		
Length	40	ft	Density	0.45	lbs/cft
Width	8	ft	Fish size	20	#/lb
Height	4	ft	Fish	**10,080**	fish
Water depth	3.5	ft	*Water Requirements*		
Water volume	1,120	cft	Water density	10	lbs/gpm
Weight	69,888	lbs	Min. water	50	gpm
Intake					
Max approach velocity	0.2	ft/sec			
Min screen size	0.56	sft			

CAPITAL COST ESTIMATE

	Description	Quan.	Units	Unit Cost	Cost	Totals
REARING UNIT						
Trailer & tank	48' by 8' by 4'	1	ea	$ 26,000	$ 26,000	
Trailer supports	Steel plates and concrete blocks	10	ea	$ 200	$ 2,000	
Truck hauling	Moving to and from sites	150	mi	$ 3	$ 450	
						$ 28,450
WATER SYSTEM						
Intake screen	Round, with pump inside	2	ea	$ 200	$ 400	
Piping	Supply and discharge	100	ft	$ 3	$ 300	
Pumps	0.4 hp, submersible	2	ea	$ 350	$ 700	
Generators	3 kw, diesel	2	ea	$ 1,500	$ 3,000	
Transfer switch	Autotransfer switch	1	ea	$ 2,400	$ 2,400	
Mobile gen. trailer	Covered, 10' trailer with fan, fuel tank	1	ea	$ 10,000	$ 10,000	
						$ 16,800
ALARM SYSTEM						
Autodialer	Cellularm and phone	1	ea	$ 600	$ 600	
Sensors, batteries	Low water level and flow sensors	2	ea	$ 200	$ 400	
UV charger		2	ea	$ 500	$ 1,000	
						$ 2,000
PERMITS						
SEPA/NEPA	Environmental checklist	1	ea	$ 200	$ 200	
JARPA	HPA	1	ea	$ 200	$ 200	
NPDES	Discharge permit	1	ea	$ 1,000	$ 1,000	
Water Rights		1	ea	$ 200	$ 200	
ESA	Biological evaluation	1	ea	$ 5,000	$ 5,000	
						$ 6,600
SUBTOTAL						**$ 53,850**
Administrative		20%				$ 10,770
SUBTOTAL						**$ 64,620**
Unlisted items		15%				$ 8,078
Design	Design drawings, parts specs, bid docs	15%				$ 8,078
TOTAL (one site)						**$ 81,000**
TOTAL (three sites)						**$ 243,000**

KEY: LS = Lump Sum, EA = Each, LFT = Linear Feet, SFT = square feet, CFT = cubic feet, CY = Cubic Yards, MO = month, HRS = hours

COST SCHEDULE

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Holmes	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Boone	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Easton								$ -	$ -	$ -	$ -
La Salle	$ 20,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Stiles	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lost Creek	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Naches								$ 730,000	$ -	$ -	$ -
Taneum		$ 1,800	$ -	$ -	$ -						
Mobile	$ 81,000	$ -	$ 81,000	$ -	$ 81,000	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL	$ 106,000	$ 1,800	$ 81,000	$ -	$ 81,000	$ -	$ -	$ 730,000	$ -	$ -	$ -

APPENDIX C. COHO REARING FACILITIES SITING REPORT

YAKIMA COHO REARING FACILITIES
SITING REPORT

8/17/04
Yakima Klickitat Fisheries Project

I. SUMMARY

The Yakima Klickitat Fisheries Project (YKFP) manages a program that proposes to reintroduce naturally spawning populations of coho to the Yakima basin with the annual release of approximately 1,000,000 smolts. This project is currently in a feasibility phase; coho are now being reared by other fishery agencies for release in the targeted watershed. As the coho program matures, it will benefit from: the addition of more rearing capacity, improvements to rearing methods, and the centralization of management control at the Yakama Nation (YN).

Project schedules forecast the timing of major facility construction. To meet development goals, major capital funding support is needed in 2012.

Different basic types of rearing system options have been evaluated that may meet future program production requirements, they include:

- A large, central rearing hatchery.
- Several smaller hatcheries located in the watersheds.
- Existing public hatcheries, through expansion or change of use.
- Extended rearing at acclimation sites.
- Combinations of the above.

After reviewing these options, YKFP managers have selected a large, central hatchery as the preferred production alternative.
The selection of a specific hatchery site is a task that is expected to be completed during the feasibility phase of the project. Several potential sites have been identified and evaluation criteria have been developed with the main objective of producing quality pre-smolts that return to release areas in high numbers. The environment that the rearing occurs in is important to meeting this goal and the availability of the correct amount and quality of reliable water supplies will be a site feature requirement. Other siting criteria involve the environmental impacts of construction and operation, the flexibility to meet changing needs, operational considerations, and costs.

Many different sites have been identified that have rearing potential in the region. They include existing YN, USFWS (US Fish and Wildlife Service), and Mitchell Act funded hatcheries; other existing hatcheries and acclimation sites; and locations that require new development and construction. High priority sites from this list have been identified.
The next steps in the site evaluation process involve the collection of additional data. These efforts will culminate in the selection of a preferred hatchery site and back-up alternatives.

II. INTRODUCTION

A. BACKGROUND AND REPORT PURPOSE

The Yakama Nation (YN) and the Yakima Klickitat Fisheries Project (YKFP) are managing coho reintroduction efforts in the mid-Columbia region (Wenatchee, Entiat, and Methow basins) and in the Yakima basin; as well as a coho harvest augmentation program in the Klickitat. Each program involves the hatchery production of coho pre-smolts. This report summarizes the rearing requirements of the Yakima program, lists the criteria used to identify rearing sites, develops general program design options, and presents site details.

The Yakima basin coho program is currently in a feasibility phase. This report evaluates rearing options if an implementation phase is proposed following feasibility evaluations (scheduled to end in 2010)..

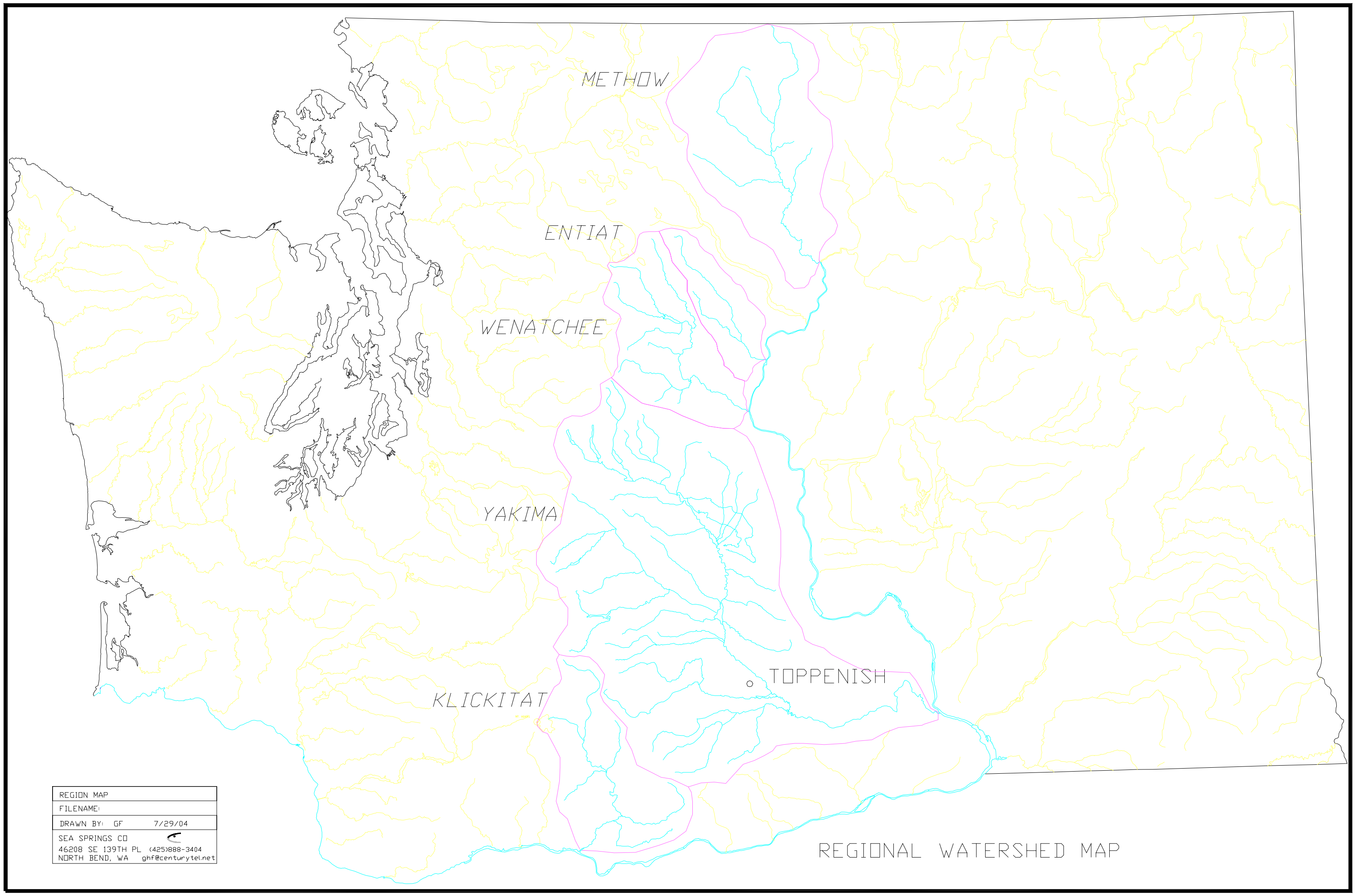
Identification of potential sites listed in the following section began with a review of existing literature. There have been several notable, thorough searches for fish hatchery sites in the Mid-Columbia region. Bugert, 1996, Fish Management Consultants, 1987, and Frederikson, Kamine & Associates, Inc., 1981 were closely reviewed. Other documents also provided insight into site identification and are listed in the references. Several references have concluded that the availability of new ground water supplies for major hatchery construction is limited in the Columbia basin.

Discussions with fishery experts in the Mid-Columbia region were invaluable during the site identification effort. Harry Senn of Fish Management Consultants provided key contributions and helped guide the preliminary searches. Input was also received from:

- NMFS (National Marine Fisheries Service): Connie Mahnken, Bill Waknitz
- USFWS: Julie Collins, Bill Edwards, Dave Kerry, Chris Pasley, Bill Wallien
- WDFW (Washington Department of Fish and Wildlife): Kevin Amos, Art Brown, John Easterbrooks, Manny Farinas, Bob Jateff, Jerry Moore, Rick Stilwater
- YN: Joe Blodgett, Jim Dunnigan, Dave Fast, Bill Fiander, Joel Hubble, Dave Lind, Keely Murdoch, Todd Newsome, Tom Scribner, Bill Sharp, Charlie Strom.

An ongoing step in the identification process is site visits. Information about water supplies, presence of wetlands, potential for flooding, current land use, construction layout, access, and utilities is collected during these visits. This information is being integrated with that from the documents reviewed and from the discussions with region experts to supply the data needed to make rearing site location decisions.

Figure 1. Region Map



B. COHO PROGRAM DESIGN

If feasibility questions are answered positively, the Yakima program proposes the continued acclimation/release of coho smolts in upstream sites near coho habitat. Fish may need to be transported long distances to these upstream locations from their rearing locations.

Acclimation will have a significant impact on rearing facility siting. The length of time that fish are in the release sites will determine the size of the fish that need to be produced. Short acclimation periods (less than 2 months) mean that fish need to be grown to a large size late into the spring at production locations. Long acclimation periods reduce late winter and spring water needs in the rearing facility. Also, the location of the acclimation sites affects hauling distances.

Broodstock capture methods are critical to genetic goals that feature local adaptation. However, due to the ease with which green and eyed eggs can be transported, the brood capture requirements are assumed not to significantly affect rearing facility siting. Where central facilities are located too far from brood capture sites to allow green egg transport, small egg eying hatcheries can be constructed.

C. FUTURE REARING REQUIREMENTS

The table below presents an overview of the 3 major coho projects managed by YN. The fish production values are currently being refined but for the purposes of planning a rearing system, these estimates are being used in the meantime. Large changes in rearing numbers may impact the rearing site selection recommendations.

Figure 2. Summary of Yakama Nation Coho Rearing Requirements

I FUTURE COHO PRODUCTION REQUIREMENTS

Release Location	Future Production (# of fish)	Current YN Capacity (# of fish)	New Production (# of fish)	New Production (lbs)	New Water (cfs)
MID-COLUMBIA					
Methow	500,000	0	500,000	23,000	6
Entiat	200,000	0	200,000	9,000	2
Wenatchee	1,000,000	0	1,000,000	45,000	12
YAKIMA					
Yakima	530,000	250,000	280,000	13,000	3
Naches	500,000	250,000	250,000	11,000	3
KLICKITAT					
Klickitat	1,000,000	0	1,000,000	45,000	12
OTHER					
Unknown	2,500,000	0	2,500,000	114,000	30
TOTAL	**6,230,000**	**500,000**	**5,730,000**	260,000	**69**

Values used in the calculations:

Size when removed from hatchery: 22 fish/lb

The Yakima Coho Reintroduction Program goals include the release of 530,000 coho in the upper Yakima and 500,000 in the Naches (Yakama Nation, 2003). Half of the hatchery production is currently produced at the YN Prosser Hatchery and the remainder from the ODFW Eagle Creek Hatchery.

D. SCHEDULING

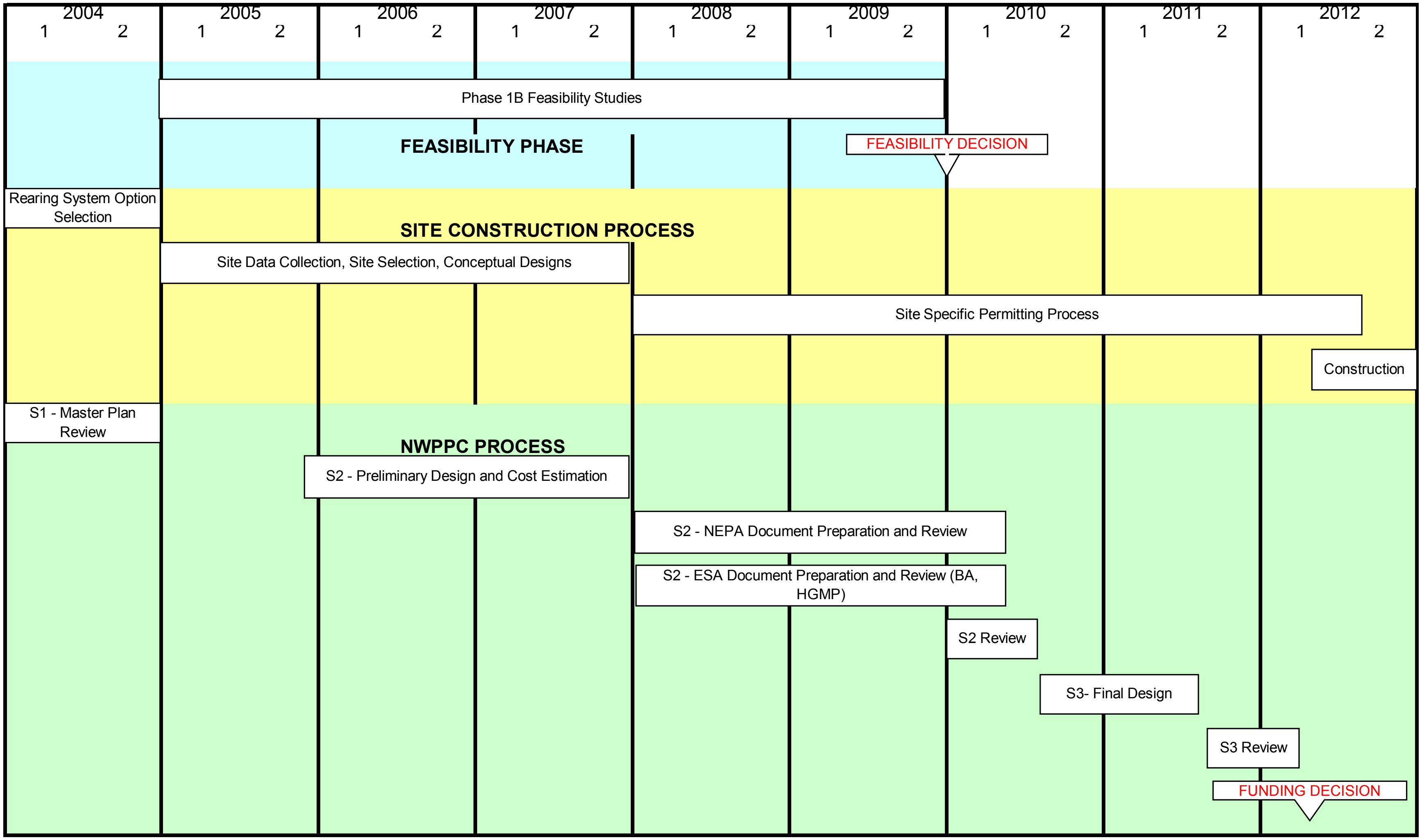
Several key decisions impact the Yakima Coho project schedule. The reintroduction programs will not be fully implemented until the decision to move beyond the feasibility phase is made. The program also depends on NEPA and ESA review and on funding determinations. A summary of the project timeline is shown in the figure below.

As described in the draft Yakima Coho Master Plan, it is proposed that feasibility studies continue through 2010. If the decision is made to move out of the feasibility phase, the last 2 steps of the Northwest Power Planning Council project review: "step 2 - preliminary design and cost estimation, as well as environmental (NEPA and ESA) review; and step 3 - final design review prior to construction and operation" would be completed. If the step reviews take 2+ years, funding for construction of new facilities will be available in 2012. Fast track permitting and construction may allow facilities to begin operation in late 2012.

Another important aspect of the project schedule involves the process required to design and permit new facilities. Development of major, new hatcheries has taken up to 10 years in the recent past. Siting, ownership negotiations, and permit application take the majority of this time. To avoid these long delays, the following proactive site development schedule is proposed:

- 2005 – 2007: finish collection of detailed data on the selected sites, select specific sites for evaluation, and complete conceptual designs.
- 2008: start the permit process with emphasis on those that may require long review periods, such as water rights.
- 2011 - Complete final designs.
- 2012 - Start construction when the environmental reviews are completed and funds are available.

Figure 3. Project Schedule



III. FACILITY SITING CRITERIA

A full list of the criteria developed to evaluate specific rearing sites is included in Appendix C, SITE SELECTION CRITERIA. Following is a general discussion of these criteria and their impact on facility siting.

Water is the most important consideration for fish rearing facilities. The production of high quality pre-smolts that are capable of surviving in the wild at high rates depends on the selection of superior, dependable water supplies.

A. REARING ENVIRONMENT

The requirements of the fish being reared provide the main criteria for siting facilities. Optimal coho rearing conditions are described in the Appendix F, TECHNICAL REPORT – REARING ENVIRONMENT. They have been selected based on literature reviews and discussions with fish culturists. Successful systems are described by researchers that maximize adult return rates. They include very low rearing densities, large volume rearing units, natural water temperatures, limited fish transportation in the pre-smolt or smolt stages, low flow densities, enriched rearing environments, limited predation, and mechanical feeding. Specific rearing conditions are proposed to duplicate those conditions:

- *Water pathogen load*: minimized for as long as possible, a priority for incubation and early rearing.
- *Maximum volume density*: a maximum of 0.2 lb/cft for fish larger than 100/lb.
- *Minimum flow density*: very water temperature and fish size dependant, 10 lbs/gpm for 20/lb fish in 50 F water. The peak water requirement for a 1,000,000 hatchery is 11 cfs.
- *Main rearing units*: large ponds during the fry to pre-smolt period, with minimum dimension of 30' wide by 100' long by 4' deep.
- *First and second winter water temperatures*: 33 to 43 F.
- *Summer water temperature*: daily peak of 65 F and maximum daily average of 62 F. Minimum of 55 F.
- *Rearing unit environment*: "enriched" with limited predation allowed.
- *Feed*: mechanical introduction where possible.
- *Trucking*: no movement, if possible, after fish reach a size of 40/lb.

Requirements for a sample hatchery using these criteria are estimated in Appendix B, WATER AND SPACE PROGRAMMING.

B. WATER QUANTITY AND QUALITY

A major consideration is flow quantity. Quantities at potential sites in the late fall during low flow periods are the most critical for surface supplies. Because high water temperatures result in high metabolic rates and because fish may be moved to acclimation sites early in the spring, the water requirements are greatest during this fall period. Surface water requirements peak at 11 cfs in September for the sample hatchery used in the Appendix B.

The reliability of flow is critical. Loss of water can result in fish mortality at times on the order of minutes. Facility design can reduce this risk with back-up power generation, redundant delivery systems, and the use of large volume rearing units. However, site selection is also important for reliability.

As discussed in the Appendix F, the natural temperature profile of surface water is important to producing a quality fish. However, surface supplies have several potential problems that can result in water supply loss. These include: ice formation on intake screens, migration of stream channels away from intakes, and debris deposition on intakes during floods. Surface water intakes in deep pools, at a stable section of a stream channel, and with adequate sweeping velocities solve many of these problems.

Another option that can be considered at some sites is infiltration galleries. These tap shallow water aquifers. There is less uncertainty in developing them than with deep wells, the design and the yield can be determined with test pits. They also have the advantage of some yearly and daily temperature fluctuation. Gallery construction is generally more expensive than wells, depending on local conditions.

Dual water supplies greatly reduce both reliability and quantity problems. Groundwater supplies do not suffer from the same intake vulnerability issues and low fall flow conditions that surface water supplies do. Sites that have groundwater supply capability, either in the form of deep wells or shallow infiltration galleries, have a high priority.

Underground aquifers that yield the large quantities of water needed for fish culture are uncommon. Thick layers of high permeability material (clean gravel) well below the water table must be located. Several such aquifers in the Columbia basin have been identified, but are developed for public supplies and existing hatcheries.

Gravity flow for both surface and ground water is preferred. With gravity flow, the cost of development of water supplies, the risks due to mechanical or power failures, and the operating costs are all reduced.

Water treatment can artificially produce supplies that meet program goals. There are varying degrees of conditioning, from low to very high. Following is a list of treatment processes in increasing order of complexity, cost, and reliability:

- Temperature control during incubation and early rearing. Chillers can delay hatching and first feeding reliably and cost effectively because water requirements are low during these rearing stages.
- Re-use through aeration. Simple aeration methods can cut water requirements by approximately ½.
- Cooling in winter and warming in summer in large impoundments.

- Turbidity reduction. Primary settling of the incoming supplies can reduce the solids loads of surface supplies.
- Sterilization of incubation and early rearing water. Ozone, UV, or chlorination/dechlorination sterilization techniques can reduce the incoming fish pathogen load of surface water supplies. The techniques are most effective with supplies that have a low turbidity (groundwater or treated surface water).
- Temperature control during later rearing. Chiller and heaters can change rearing water temperatures, but the large flow volumes make this option expensive even when used with re-use technology.
- Full re-use through aeration and ammonia removal. Water requirements can be reduced by up to 90% with bio-filtration and sterilization. These methods have high capital and operating costs and add elements of risk if sterilization is not effective or if the mechanical systems fail.

The first choice for water supplies will be those that do not need conditioning. Requiring the first, hatchery water chilling, will not be considered a major site drawback. Requiring the last, full re-use systems will be and such sites will have a low priority.

Water re-use without complex treatment is also possible. At hatcheries that use low rearing flow densities and/or have excess head that can be used for gravity flow re-aeration, the quality of second use water may be acceptable. Such water is routinely used in many existing hatcheries. The major disadvantage of re-use is disease transmission from the upstream stocks. This is minimized by low-stress rearing environments and good fish health practices.

Flooding imposes a risk to both fish and facilities. Because of the dependence of rearing sites on the proximity of large water volumes, they are subject to flood damage. The option of building facilities above 100 year flood elevations is not always possible due to impacts that result from the reduction of flood storage capacity. This imposes restrictions on siting. Future changes to the upstream watershed may change flood characteristics and should be considered as well.

Sites with water supplies that have adequate and reliable flow quantities, natural temperature profiles, low pathogen loads, and high general quality will be preferred. Other criteria are also important and will impact the site location decisions.

C. ENVIRONMENTAL IMPACTS

The potential environmental impacts of proposed facilities are reviewed during the permit process. The length of time, cost, and difficulty of obtaining the necessary construction and operating permits is an important site selection consideration.

Surface water withdrawals impact streams for the distance between the removal and the return. Hatcheries are non-consumptive except in the withdrawal reach. Sites and designs that allow discharge to occur just downstream of the intake minimize impacts. Large-scale groundwater use can affect users within the cone of influence of the well or gallery. Due to these potential impacts, the water rights permit application process for both supplies can be long and difficult.

Sites where wetlands are not disturbed during construction will have reduced impacts. Mitigation for disturbances that occur is possible but expensive and requires a lengthy design review process.

Major construction will involve ESA review. The presence of or negative impact to listed species can change the site development status. Other environmental and permit considerations include local land use zoning codes, disease transmission from the hatchery to downstream fish populations (both in hatcheries and in the wild), cultural resources, and receiving water quality standards.

USFS (US Forest Service) property includes special consideration for possible impacts to "survey and manage" species. Studies complicate and extend the permit process.

Sites that have minimal environmental impacts will take less time to develop, will have lower development costs, and fewer operational restrictions. A thorough review of those impacts early in the site selection process is recommended.

D. OPERATION

Proximity to other program facilities, especially acclimation sites, is also a consideration. Rearing facilities that are closer to acclimation sites will be given a higher priority.

Existing facilities that are operated by other agencies have both advantages and disadvantages. YN control and program flexibility are limited under these conditions. However, support in the form technical assistance and emergency response can be provided by the other agencies.

Staffing and management of the production facilities by Yakama Nation personnel is a production facility objective. Proximity to Toppenish allows a wider selection of operating staff candidates and for closer control of operations by program managers.

E. CONSTRUCTION

Design of the rearing unit systems has an indirect impact on the selection of sites. Low rearing densities improve fish condition and adult survivals (see Appendix F, TECHNICAL REPORT – REARING ENVIRONMENT) and facilities should have enough land to allow the option of constructing large rearing units.

Capital investments in rearing facilities require that property be usable for long periods. Control would ideally take the form of purchase with long-term leases as an option.

Other site development concerns include the availability of power, environmental liability, and access. Three phase power is needed to operate water pumps, chillers, and other major motor driven machinery. Delivery of three phase to remote locations adds expense and permit complications. Sites that have previously had other uses may be contaminated, resulting in liability exposure. Road construction to remote sites may add negative environmental impacts to the construction effort.

F. FLEXIBILITY

Fish rearing technology has changed frequently over the past 100 years. Incubation systems, rearing units (Foster Lucas ponds, to Burroughs ponds, to flow through raceways, for example), feeding practices, etc have all changed significantly. Sites should have the flexibility to adapt to these changes. Choices of water supplies (ground and surface) should be available to future managers and the space for constructing new facilities should exist.

Increasing production and rearing other species are future possibilities. Sites that have excess water and space have this capability

G. COST

Cost estimating procedures are outlined in the Appendix E, CAPITAL AND OPERATING COST BASIS. Costs for different rearing system options are estimated in the following section IV. C., PRODUCTION SYSTEM OPTIONS. These costs are preliminary, to be used for comparison purposes only. They are based on the construction and operating costs of similar facilities. When preferred options are selected, detailed, site specific costs estimates can be made.

Costs do not include other aspects of the programs. Activities like brood capture, acclimation (for most rearing system options), and monitoring and evaluation are not included in either operating or construction cost estimates.

In general, both capital and operation costs will be important to the site selection process. Sites with high operating costs are compared to sites with high construction costs by doing an equivalence analysis with an assumed effective annual interest rate.

Permit costs may be a significant part of the expense of developing new sites. Construction in environmentally sensitive areas, difficult site conditions, expensive land, complex water supply development, long piping distances, and distant utilities are other factors that can drive up capital costs.

IV. REARING SITE OPTIONS AND EVALUATIONS

A. INTRODUCTION

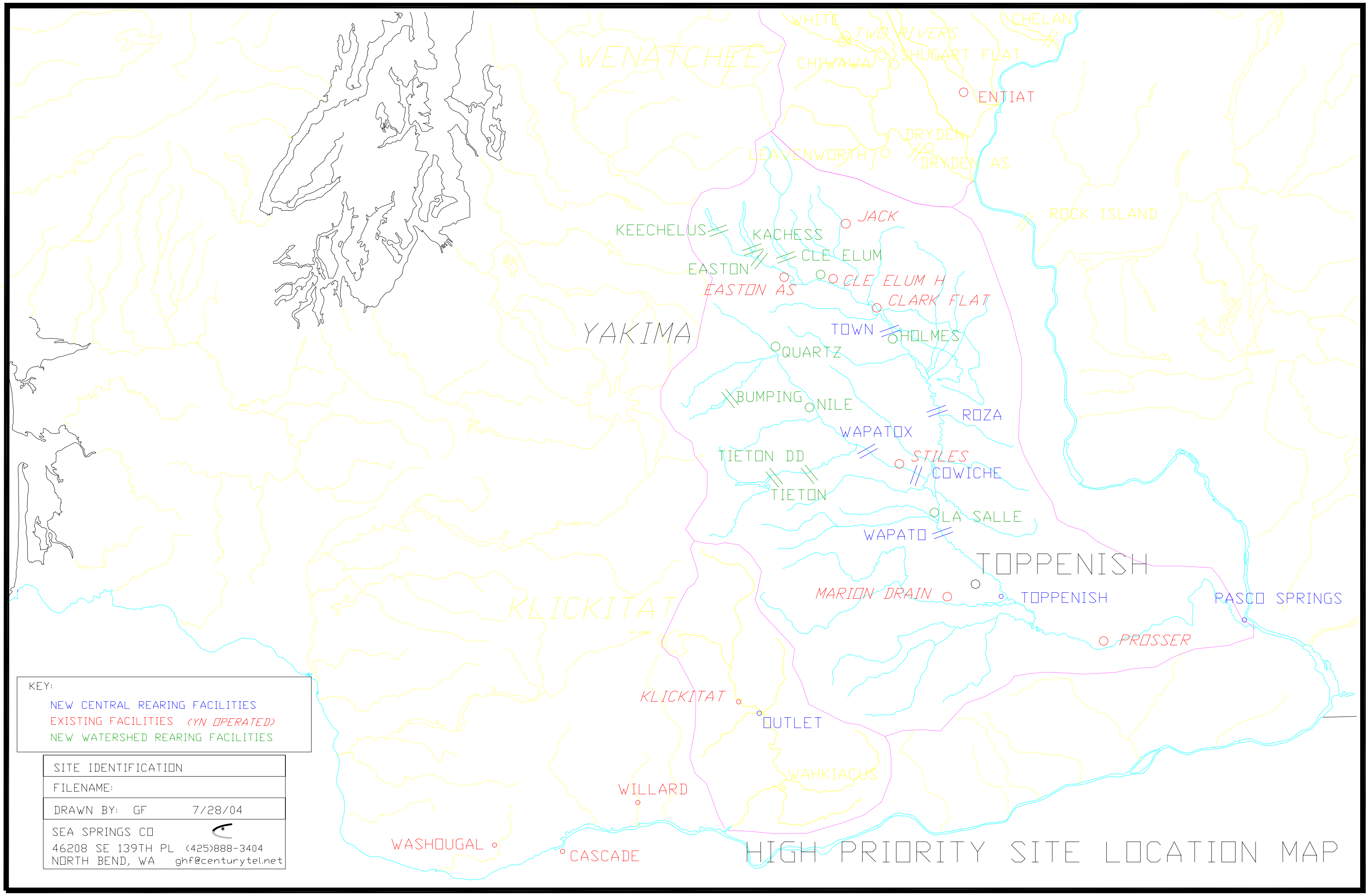
There are several general rearing systems that can meet the YKFP coho production requirements. "Systems" is used as a term for describing various general types of facilities or methods. They include building a few, large central hatcheries; constructing several smaller facilities in the watersheds; expanding and/or using existing hatcheries; rearing for extended periods at the acclimation sites; and combinations of the above. Each system has advantages and disadvantages.

The next section describes individual, specific sites that have been identified and that can be used as components in the general rearing systems described above. A following section discusses the systems and evaluates their advantages and disadvantages.

B. IDENTIFIED SITES

A full list of all sites is attached in Appendix D, SITE LIST. Following is a discussion of the higher priority sites from that list. Below is a map showing their location. Other sites may be identified in the future and developed for use by the program.

Figure 4. High Priority Sites



1. Existing Rearing Facilities

Existing facilities have the benefits of tested water supplies, secure water rights, experienced staff, completed construction and operating permits, known disease histories, and functioning components. Expansion of, or changing the use of existing hatcheries will be much less expensive than constructing new ones.

Existing facilities operated by the YN have the added benefit of direct management control. The YN has hiring freedom and receives overhead support for their operation.

Many existing facilities are designed for high density rearing in concrete raceways. See IHOT reports for more detailed descriptions of many of the hatcheries and their current rearing programs. Adaptation of the hatcheries to other rearing philosophies that may be more applicable to reintroduction programs and that generate higher adult survival rates could be difficult.

YN Hatcheries

Cle Elum FH (YKFP). Operates on pumped well and Yakima River water (water rights of 25 cfs surface and 17 cfs ground). Designed to produce 810,000 spring chinook smolts at 15/lb. Well water is 100% used for the high priority spring chinook program during spring and summer. An infiltration gallery near the Yakima, additional surface water rights, and/or re-use of chinook water could allow coho expansion.

Klickitat FH (WDFW/YKFP). Currently operated by WDFW; will transition to YN in the near future. Spring water (25 cfs), surface water (15 cfs), and rearing units may not be 100% used by the spring chinook, steelhead, and fall chinook programs under the transition plan.

La Salle FH (YKFP). Small (25,000 parr) coho hatchery planned to supplement Ahtanum stock.

Marion Drain FH (YKFP). Fall chinook supplementation hatchery using pumped irrigation return ground water. High flow rates through the summer and fall are advantages, the water supply capacity exists for expansion. High summer temperatures may impact use for full-term coho rearing.

Prosser FH (YKFP). Wells (2 with a theoretical maximum capacity of 5 cfs total) and Chandler Canal river water are the supplies. High summer temperatures limit the use of Yakima River water. Ground water availability limits summer capacity for coho and a river water back-up system is needed during fall canal shutdowns. Currently the only YN facility producing coho (500,000) for the programs.

Basin USFWS Hatcheries

Entiat NFH (USFWS). Currently used for broodstock holding and spawning for Wenatchee stock coho. Change of use from spring chinook to coho in the future may be possible. Expansion for coho would require more surface water or re-use of spring chinook water. Total current water right of 34 cfs from the river and wells, produces 400,000 yearling spring chinook per year. Potential for development of more ground water is limited.

Mitchell Act Hatcheries

Mitchell Act funds are being reduced. Several hatcheries have been closed due to these reductions and more may be. Finding alternative uses for these facilities may allow them to remain open. A drawback of the sites is their distance from the Yakima basin.

Cascade FH (ODFW). Currently rearing coho pre-smolts for the Yakima and Umatilla coho program. Capacity of 1.7 million coho smolts, with a water right of 44 cfs (actual use of 16 cfs) from Eagle creek. There is no ground water at the site and improvements to rearing units require Gorge Commission approval. Summer water temperatures are high.

Eagle Creek FH (ODFW). Used in the past for YN program coho rearing. Facility objectives are for the production of up to 3 million coho and 200,000 steelhead smolts.

Washougal FH (WDFW). Currently rearing *US v Ore* coho smolts for truck planting in the Klickitat. Produces 6 million fall chinook and 3 million coho, water rights of 33 cfs from several sources.

Willard NFH (USFWS). Currently rearing coho pre-smolts for the mid-Columbia program. Raceway covers have been recently installed to improve rearing conditions. Water supply is the Little White River, which is heavily, ground water influenced. Flow rates are stable and relatively high through the summer and fall periods. Reduced temperature fluctuation may hinder smoltification. Capacity of 2.5 million coho smolts, water use of up to 54 cfs from the Little White Salmon River.

Abernathy, Beaver Creek, Grays River, Gnat Creek, Klaskanine FH. These facilities are all closed and would be potentially available for coho production.

Acclimation/Rearing Sites

Several acclimation sites operated by YN and by WDFW may have potential to be expanded into yearling rearing facilities (see description in section C.4.). Most would need to have groundwater supplies developed to add necessary security and flexibility to the water systems.

Clark Flat Acc. Site. Component of the Cle Elum Hatchery complex on the Yakima, acclimating spring chinook. Summer river temperatures may be too high and winter intake icing may be problems for long-term rearing without adding groundwater.

Easton Acc. Site. Component of the Cle Elum Hatchery complex on the Yakima, acclimating spring chinook. Construction room is somewhat limited in the area. Groundwater may be available by pumping out of the nearby gravel borrow pits.

Holmes. Currently used by the Yakima Coho program for acclimation on the Yakima. Irrigation return water flows through two large ponds. Some spring water also flows through the pond system. Status of ground water is unknown. The freeway complicates access to the Yakima River. Site is for sale.

Stiles. Currently used by the Yakima Coho program for acclimation on the Naches. Spring water exists nearby and there may be groundwater on the site. Surface water intake is on an unstable section of the Lower Naches River and it may go dry during low flow periods.

2. New Rearing Facility Sites

Dams

Facilities built near dams have several advantages as potential rearing locations:

- They are good water intake structures, with deep pools that can be used in all flow conditions.
- Water temperature control may be possible at larger dams by varying the intake depth.
- Gravity flow supplies are possible at some locations.
- Water rights issues are minimized when water is returned to the base of the dam, allowing large withdrawals.
- Water heads created by the impoundments can allow facilities built downstream to be above flood elevations.
- Some dams create a groundwater supply with seepage under and around the structure. This "toe drain" water is sometimes collected into accessible locations.

A potential disadvantage is the loss of water when dam reservoirs are drained for maintenance. Potential sites include:

Bumping. Irrigation storage dam on Bumping. Toe drain water is available at several collection structures in the summer. Surface water from the dam discharge could be used in the late summer and fall. Construction room for ponds downstream of the dam exists on currently disturbed ground. Would require pumping to use Bumping R. water.

Cle Elum. High head irrigation storage dam on Cle Elum R. Toe drain water may be an option for a second source.

Cowiche (Nelson Springs). Low head irrigation diversion dam on Naches near Nelson Springs. Two water sources exits, the springs and Naches River water from the dam. A detailed hatchery proposal is presented in CH2M Hill, 1990. Combined spring flow is 8-20 cfs. Piping through road and highway easements would be required to delivery river water to the spring area.

Easton. Irrigation diversion dam on the Yakima. Gravity flow system is possible but land availability is limited for this option. Groundwater potential is likely limited.

Kachess. High head irrigation storage dam on Kachess R. Toe drain water is an option for a second source.

Keechelus. High head irrigation storage dam on Yakima. Toe drain water is an option for a second source. Dam is being rebuilt; toe drain flows will likely be reduced.

Tieton. High head irrigation storage dam on Tieton. Toe drain water is an option for a second source.

Town. Low head irrigation diversion dam on Yakima. Limited potential for groundwater development on right bank, unknown on left bank. Summer river temperatures are likely too warm.

Wapatox. Low head irrigation (no power) diversion dam on Naches. Groundwater development potential is unknown. The long term future of the dam is uncertain.

Other

These sites currently are undeveloped. They all have surface water and there is either some potential for developing ground water or springs exist.

Naches. Several sites on the Naches River meet the conditions that make them suitable for surface water intakes (deep pools, stable channels, and high sweeping velocities). These would need to be evaluated for ground water potential.

Outlet Springs. A large spring on the left bank of the Klickitat downstream of the hatchery near Glendale is unused. Another large unnamed spring on the left bank farther upstream is also unused. The major drawback with both areas is the lack of flat ground for hatchery construction on either side of the river and difficult access to the springs. Also, coho culture on Klickitat surface water at the hatchery has had severe, recurring problems with cold water disease.

Pasco NMFS. Irrigation seep groundwater from a collection system in Pasco is pumped over a levy into the Columbia by the USACE. Gravity flow facility may be possible, upstream of existing pumping system. Up to 60 cfs of flow is discharged from several springs.

Toppenish. A site near the confluence of Marion Drain and the Yakima River has the possibility of 3 water sources, surface water from the Yakima, spring water from Marion Drain, and groundwater.

Upper Yakima. Several sites on the upper Yakima River meet the conditions that make them suitable for surface water intakes. These would need to be evaluated for ground water potential.

C. PRODUCTION SYSTEM OPTIONS

The sites listed above would form various types of hypothetical rearing systems for coho production. Several basic system options are described in this section and the costs of building and running them are estimated.

The combination option might use existing hatcheries and new facilities together. Each system is analyzed separately to emphasize the differences and help determine the final mix.

The figure below summarizes the numbers of facilities that would be used in the hypothetical configurations. The approximate capital and operating costs are also summarized. Annual operating costs are converted to a present value (the value of a continuous annual payment converted into a lump sum payment made now) and added to the capital costs for comparison purposes in the last column.

Figure 5. Summary of System Costs

	NUMBER OF SITES	CAPITAL COST	ANNUAL OPERATING	PRESENT VALUE OF OPERATING	TOTAL PRESENT VALUE
1. New Central Hatchery	1	**$ 11,000,000**	$ 315,000	$6,300,000	**$17,300,000**
2. New Watershed Hatcheries	2	**$ 15,400,000**	$ 409,500	$8,190,000	**$23,590,000**
3.A. YN Existing Hatcheries	2	**$ 4,400,000**	$ 409,500	$8,190,000	**$12,590,000**
3.B. Other, Public Hatcheries	2	**$ -**	$ 409,500	$8,190,000	**$8,190,000**
4. Acclimation Rearing Sites	6	**$ 4,290,000**	$ 687,488	$13,749,750	**$18,039,750**

Note: a 5% average annual interest rate was assumed for the future to determine the present value (single payment equivalence) of the annual operating expenses

Option #4, ACCLIMATION REARING SITES, includes the capital and operating costs associated with acclimation as well as rearing. The other options do not.

An option not developed in detail is that of using private contract growers. Cost is the main advantage to using these facilities. There would be no capital costs charged to the programs if existing hatcheries are used and do not need modification. Operating costs would also less. Recent private contracts for rearing yearling salmon to WDFW specifications have been in the $4/lb range.

1. Large, New Central Rearing Hatchery

For the purposes of this report, large will be used to mean facilities that produce 1,000,000 or more smolts per year. Their water requirement generally limits locations to the major rivers in the region with enough minimum flow to allow the withdrawal of 12 cfs per million fish reared.

Eggs from brood captured in the watersheds would be hatched and reared up to the pre-smolt stage at this facility. They would then be trucked to the acclimation sites for final rearing and release.

For purposes of developing costs, standard hatchery designs are used for the estimates. Egg incubation in vertical stack incubators, first feeding in high density fry tanks, and rearing in concrete raceways are assumed. Rearing system technologies are evolving rapidly and newer designs may be incorporated in the final designs.

A central hatchery would be supplied with both ground and surface water. This provides the maximum amount of flexibility and reliability to the facility. It is likely that both supplies will need to be pumped and reliable back-up power supplies and alarm systems will be included in designs and cost estimates.

Advantages of this rearing system include the reduced operating costs that result from economies of scale, management and control is simplified, trucking distances are reduced, and new construction allows the latest hatchery designs to be incorporated. Disadvantages include the risk of rearing all the Yakima local stock at one location, the concentration of environmental impacts on one location, and the high capital cost of construction and permitting.

Figure 6. Hypothetical Rearing System - Large Central Hatchery

	Releases (# of fish)	Production Facility	Production Quantity	Release Location
YAKIMA				
Yakima	530,000	Central	530,000	Upper Yakima
Naches	500,000	Central	500,000	Naches
TOTAL	**1,030,000**		**1,030,000**	

Figure 7. Costs - Large Central Hatchery

	Production Quantity	Capital Cost	Operating Cost
YAKIMA			
Central	1,000,000	$ 11,000,000	$ 315,000
TOTAL	1,000,000	**$ 11,000,000**	**$ 315,000**

2. Multiple, New, Watershed Hatcheries

Small rearing facilities in each watershed could be developed to meet the areas coho requirement. Such sites would minimize fish transportation stress, reduce the environmental impacts of a large facility, and provide long-term acclimation in the targeted watershed.

Figure 8. Hypothetical Rearing System – Multiple, New, Watershed Hatcheries

	Releases (# of fish)	Production Facility	Production Quantity	Release Location
YAKIMA				
Yakima	500,000	Hatchery 1	500,000	Upper Yakima
Naches	500,000	Hatchery 2	500,000	Naches
TOTAL	**1,000,000**		**1,000,000**	

Figure 9. Costs – Multiple, New, Watershed Hatcheries

	Production Quantity	Capital Cost	Operating Cost
YAKIMA			
Hatchery 1	500,000	$ 7,700,000	$ 205,000
Hatchery 2	500,000	$ 7,700,000	$ 205,000
TOTAL	1,000,000	**$ 15,400,000**	**$ 410,000**

3. Existing Public Hatcheries

There are two options for using existing hatcheries. One is to make changes to YN operated facilities (3.A.) to allow them to meet program rearing goals. The other is to use other public hatcheries (3.B.) with excess capacity.

The YN hatcheries used as examples in the hypothetical option described below (option 3.A.), Cle Elum and Prosser may need considerable alterations in order to add coho production. This is reflected in the capital cost estimate.

Figure 10. Hypothetical Rearing System – YN Existing Hatcheries

	Releases (# of fish)	Production Facility	Production Quantity	Release Location
YAKIMA				
Yakima	500,000	Existing Hatch 1	500,000	Upper Yakima
Naches	500,000	Existing Hatch 2	500,000	Naches
TOTAL	**1,000,000**		**1,000,000**	

Figure 11. Costs – YN Existing Hatcheries

	Production Quantity	Capital Cost	Operating Cost
YAKIMA			
Existing Hatch 1	500,000	$ 2,200,000	$ 205,000
Existing Hatch 2	500,000	$ 2,200,000	$ 205,000
TOTAL	1,000,000	**$ 4,400,000**	**$ 410,000**

Other existing, public hatcheries in the region (option (3.B.) would not need capital improvements to continue functioning in support of the Yakima coho reintroduction program. Operating costs should be similar to those of other facilities.

4. Acclimation Rearing Sites

Another possible rearing system uses is long-term rearing capacity constructed at each acclimation site. The design of the acclimation component of the programs can make this option more or less attractive. If the model is for many, small acclimation sites scattered through the watersheds, long term rearing at those sites will be difficult and costly.

If single, large acclimation sites are constructed in each watershed, long-term rearing may be more feasible. Predator and waste controls could be built into those facilities. Current results show that returning adults scatter widely below the point of release. If that behavior continues as stocks adapt to local conditions, an alternative acclimation plan may be to construct single, larger facilities in each basin at the upper end of the habitat. Returnees would disperse in the habitat below those release points. Larger, fewer acclimation sites may allow them to be constructed with long-term rearing capabilities.

Smaller tributaries (such as Cle Elum, Big, Swuak, Wilson, Reecer, Pileup, Rattlesnake, Nile, Little Naches, Toppenish, etc) would have short-term acclimation ponds that would not be used for rearing. Pre-smolts from the larger acclimation/rearing sites would be trucked to them if coho were found to not be naturally distributing themselves from the larger release sites.

The examples shown below assume that single acclimation sites are constructed near the upper end of habitat in the watersheds. Fry would be delivered to these sites and rearing would occur in them until 12 months later when they would be released as smolts.

This method is different than system 2 described in a previous section, multiple watershed hatcheries in that there would be more rearing sites and their location would be in the upper habitat where fish would be directly released.

This system has several drawbacks; including the difficulty of developing water supplies that can reliably survive year-round use, the potential for high predator losses, the cost of obtaining long-term leases or ownership of multiple properties, and the possible environmental impacts of fish wastes at these sites.

There are several major advantages to this rearing system. Long-term acclimation at the release locations will likely maximize adult survival rates, may have a positive impact on the dropout factor, and eliminates trucking stress.

Figure 12. Hypothetical Rearing System – Acclimation Rearing Sites

	Releases (# of fish)	Production Facility	Production Quantity	Release Location
YAKIMA				
Yakima	500,000	Yak. Acc/Rear 1	200,000	Upper Yakima
		Yak. Acc/Rear 2	200,000	Upper Yakima
		Yak. Acc/Rear 3	100,000	Upper Yakima
		La Salle	30,000	Ahtanum
Naches	500,000	Naches Acc/Rear 1	250,000	
		Naches Acc/Rear 2	250,000	Upper Naches
TOTAL	**1,000,000**		**1,030,000**	

Figure 13. Costs – Acclimation Rearing Sites

	Production Quantity	Capital Cost	Operating Cost
YAKIMA			
Keechulus	200,000	$ 880,000	$ 139,000
Teanaway	200,000	$ 880,000	$ 139,000
Holmes	100,000	$ 440,000	$ 117,000
La Salle	30,000		
Nile	250,000	$ 1,100,000	$ 150,000
Quartz Cr.	250,000	$ 1,100,000	$ 150,000
TOTAL	1,030,000	**$ 4,400,000**	**$ 695,000**

5. Combinations

The rearing system that is selected may be some combination of the above elements.

V. RECOMMENDATIONS

A. NEXT STEPS

Studies are now being conducted or planned that are relevant to rearing facility siting and design. They include: raceways vs. large pond acclimation; adult plants: parr plants; rearing (short-term) on spring chinook re-use water; stable vs. highly fluctuating yearly rearing temperature profiles: length of acclimation period; and growth profile evaluations.

Future steps in the site selection process include the collection of more data on high priority sites, emphasizing: surface flows, surface temperatures, and groundwater availability. Test rearing at selected sites for one full year prior to operation should be included in the project scheduling.

B. PREFERRED ALTERNATIVE

Options have been evaluated by YKFP program mangers and the preferred alternative for a rearing system for the Yakima Coho reintroduction program is a new, large, central hatchery. This option is described in a previous section, IV.C.1. LARGE, NEW, CENTRAL REARING HATCHERY. The advantages of such a system include:

- Improved adult survival by constructing a facility that optimizes rearing environment conditions.
- Decreased risk of inter-watershed disease transfers and program interruptions by siting the facility in the basin.
- Reduced trucking stress allowed by siting the facility in the basin.
- Minimized operating costs by rearing fish in a central location.
- Improved management and control of hatchery production.

A specific site has not yet been selected. Locations that are being evaluated are listed in section IV.B. IDENTIFIED SITES.

Rearing coho pre-smolts for the Mid-Columbia reintroduction program as well as the Yakima program at such a facility will be considered. Potential central hatchery sites will be evaluated that would be capable of producing the approximately 2,000,000 fish total that are planned to be released from both programs.

VI. APPENDICES

A. REFERENCES

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B. WATER AND SPACE PROGRAMMING

SAMPLE GROWTH MODEL

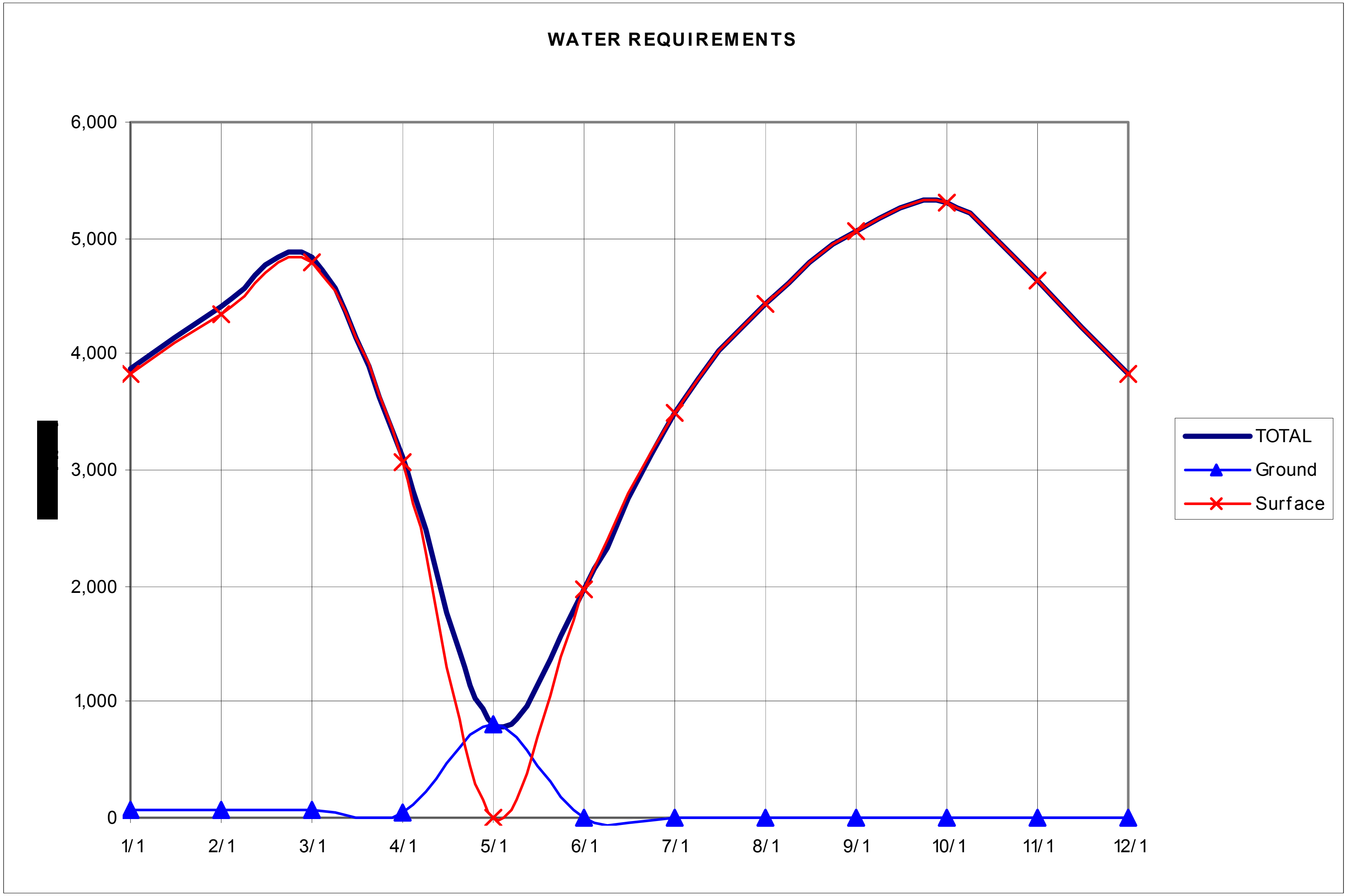
Period	Rearing Unit	Water Source	Water Temp. (^oF)	Mort. #/mo.	Number Reared	Number Trucked	Number at Hatchery	Fish Size lbs	Fish Size #/lb	Fish Size inch	Flow Index*	Vol. Index*	Flow Density lbs/gpm	Volume Density lbs/cft	Weight at Hatchery lbs	Min. Flow gpm	**Min. Flow cfs**	Min. Volume cft	**# of Rearing Units**
6/1																			
7/1																			
8/1																			
9/1																			
10/1	Adult	Ground	46	115	1,261		1,261	7								631	**1.4**	5,045	**1**
11/1	Adult	Ground	46	115	1,147		1,147	7								573	**1.3**	4,587	**1**
12/1	Inc	Ground	43	50,000	1,433,333		1,433,333									64	**0.1**		**11**
1/1	Inc	Ground	43	50,000	1,383,333		1,383,333									61	**0.1**		**11**
2/1	Inc	Ground	43	50,000	1,333,333		1,333,333									59	**0.1**		**10**
3/1	Inc	Ground	43	50,000	1,283,333		1,283,333	0.0010	1000	1.49	1.57	0.05	2.3	0.07	1,283	57	**0.1**		**10**
4/1	Inc	Ground	43	50,000	1,233,333		1,233,333	0.0010	1000	1.49	1.57	0.05	2.3	0.07	1,233	55	**0.1**		**10**
5/1	RW	Mixed	50	50,000	1,183,333		1,183,333	0.0015	667	1.88	1.16	0.05	2.2	0.09	1,775	814	**1.8**	18,883	**1**
6/1	RW	Surface	55	11,111	1,133,333		1,133,333	0.0040	250	2.37	0.97	0.05	2.3	0.12	4,533	1,979	**4.4**	38,256	**2**
7/1	RW	Surface	57	11,111	1,122,222		1,122,222	0.0090	111	3.22	0.90	0.05	2.9	0.16	10,100	3,485	**7.7**	62,733	**3**
8/1	Pond	Surface	55	11,111	1,111,111		1,111,111	0.0140	71	3.63	0.97	0.05	3.5	0.18	15,556	4,433	**9.9**	85,706	**3**
9/1	Pond	Surface	52	11,111	1,100,000		1,100,000	0.0200	50	4.05	1.07	0.05	4.3	0.20	22,000	5,061	**11.2**	108,642	**4**
10/1	Pond	Surface	48	11,111	1,088,889		1,088,889	0.0238	42	4.36	1.27	0.05	5.6	0.22	25,926	4,670	**10.4**	118,926	**4**
11/1	Pond	Surface	43	11,111	1,077,778		1,077,778	0.0270	37	4.57	1.57	0.05	7.2	0.23	29,129	4,069	**9.0**	127,480	**5**
12/1	Pond	Surface	40	11,111	1,066,667		1,066,667	0.0286	35	4.57	1.74	0.05	8.0	0.23	30,476	3,833	**8.5**	133,375	**5**
1/1	Pond	Surface	40	11,111	1,055,556		1,055,556	0.0303	33	4.81	1.74	0.05	8.4	0.24	31,987	3,822	**8.5**	133,000	**5**
2/1	Pond	Surface	41	11,111	1,044,444		1,044,444	0.0333	30	4.81	1.67	0.05	8.0	0.24	34,815	4,343	**9.7**	144,760	**5**
3/1	Pond	Surface	43	11,111	1,033,333	0	1,033,333	0.0370	27	5.10	1.57	0.05	8.0	0.26	38,272	4,790	**10.6**	150,085	**5**
4/1	Pond	Surface	45	11,111	1,022,222	500,000	522,222	0.0455	22	5.33	1.45	0.05	7.7	0.27	23,737	3,064	**6.8**	89,071	**3**
5/1	Pond	Surface	50	11,111	1,011,111	511,111	0	0.0667	15	6.04	1.16	0.05	7.0	0.30	0	0	**0.0**	0	**1**
Released					1,000,000														

INPUTS

ADULTS			*Source*
Adult size:	7	lb	IHOT Standards pg. 21 (Table 4)
Eggs per female:	2500		WDFW, 1997
Adult loss during holding:	20%		
Pond space required per fish	4	cft	IHOT Hatchery pg. 21 (Table 4)
Water flow required per fish	0.5	gpm	IHOT Hatchery pg. 21 (Table 4)
Adult water pond volume:	7560	cft	
INCUBATION			
Fert. to ponding mortality:	15%		HGMP, pg. 26, 1999
Inc. capacity (Heath, #/per tray)	9,000		IHOT Hatchery pgs. 22-23 (Tables 5-8)
Max. eggs allowable (stack)	135,000		IHOT Hatchery pgs. 22-23 (Tables 5-8)
Water flow per full stack	6	gpm	IHOT Hatchery pg. 26 (Table 13)

REARING		*Source*
Number released:	1,000,000	
Pond. to release mortality:	20%	HGMP, 1999
Raceway Volume Index:	0.3	WDFW
Pond Volume Index:	0.3	WDFW
Flow multiplier	1.5	Standard flows are reduced by this factor
Volume multiplier	6	Standard densities are reduced by this factor
Trough water volume:	189	cft
Raceway water vol.:	3000	cft
Pond water volume:	30240	cft

Note: The highlighted areas are inputs to the worksheet.


WATER REQUIREMENTS
[redacted]
6,000
5,000
4,000
3,000
2,000
1,000
0
1/ 1
2/ 1
3/ 1
4/ 1
5/ 1
6/ 1
7/ 1
8/ 1
9/ 1
10/ 1
11/ 1
12/ 1
TOTAL
Ground
Surface

C. SITE SELECTION CRITERIA

REARING SITE EVALUATION CRITERIA	
CRITERIA	NOTES
Water supplies	
Back-up water supply.	An independent, secure, second source of water.
Ground and surface water.	A choice of water temperatures and quality.
Summer temperature.	Moderate temperatures that match natural streams.
Fall flow.	Early fall flow volumes may be limited for surface supplies as demand peaks.
Winter temperature.	Low temperatures that match natural streams. Low frequency of intake icing.
Water quality.	Multiple quality considerations
Pathogen load.	The presence of reportable or diseases that impact fish culture in the upstream watershed.
River intake channel stability.	Potential for channel motion at intake, towards or away.
Deep pools for water withdrawals.	Intake operational under all flow conditions.
Sweeping velocities.	Required for a legal intake and important for debris removal.
Flood risks.	Risk to fish and facilities.
Future of upstream watershed	Impact of development, logging, etc. on flood flows, flood frequency, and water quality.
Environmental Impacts	
Surface water rights.	Sensitivity of the stream reach to withdrawal.
Groundwater rights.	Impact of large removal on other users.
Wetlands.	Room for construction to occur away from wetland areas.
Endangered species.	Disturbance of critical habitat either not allowed or must be mitigated.
Receiving water quality standards.	Impact of discharge on receiving waters.
Cultural resources.	Cultural reviews need to be done early in the site selection process.
Local zoning codes.	Change of use applications can be complicated by surrounding landowners.
Operation	
Proximity to Toppenish.	Staff hiring and management benefits.
Proximity to acclimation sites.	Short trucking distances reduce stress to fish.
Independent operation.	Independence improves program flexibility.
Support from other agencies.	Sites operated with other agencies may have operational advantages.
Proximity of other fish propagation facilities.	Disease risk from upstream facilities and risk to downstream facilities.
Construction considerations	
Area property ownership.	Permit processing will be complicated by adversarial landowners.
Potential to obtain control of the property.	Sites can either be leased for long periods or purchased.
Usable land on the site.	Ground must be suitable for construction, flat and dry.
Environmental liability.	Previous uses can add contamination that requires clen-up.
Availability of phone, electricity, roads.	Cost and reliability of access and utilities.
Cost	
Construction costs.	
Operating costs.	
Flexibility	
Adaptability to future culture practices.	
Other species production potential.	
Expansion potential.	

D. SITE LIST

	Type	Owner	Operator	Water Source
POTENTIAL REARING FACILITY SITES - EXISTING				
YN OPERATED FACILITIES				
Cle Elum	Existing hatchery	Yakama Nation	YKFP	Yakima R., wells
Klickitat	Existing hatchery	Yakama Nation	YKFP	Klickitat R., springs
Marion Drain	Existing hatchery	Yakama Nation	YKFP	Marion Drain
Prosser	Existing hatchery	Yakama Nation	YKFP	Yakima R., wells
YN PLANNED FACILITIES				
La Salle	Planned hatchery	Yakama Nation	YKFP	Ahtanum C., gallery
USFWS HATCHERIES				
Entiat	Existing hatchery	USFWS	USFWS	Entiat R., springs
MITCHELL ACT HATCHERIES				
Abernathy	Existing hatchery		USFWS	
Beaver	Existing hatchery		WDFW	
Big Cr	Existing hatchery		ODFW	
Bonneville	Existing hatchery		ODFW	
Carson	Existing hatchery		USFWS	
Cascade	Existing hatchery		ODFW	
Clackamas	Existing hatchery		ODFW	
Eagle	Existing hatchery		USFWS	
Elochoman	Existing hatchery		WDFW	
Fallert Cr	Existing hatchery		WDFW	
Gnat Cr	Existing hatchery		ODFW	
Grays R.	Existing hatchery		WDFW	
Kalama Falls	Existing hatchery		WDFW	
Klaskanine	Existing hatchery		ODFW	
Klickitat	Existing hatchery		WDFW	
Little White Salmon	Existing hatchery		USFWS	
N Toutle	Existing hatchery		WDFW	
Oxbow/Herman	Existing hatchery		ODFW	
Ringold	Existing hatchery		WDFW	
Sandy	Existing hatchery		ODFW	
Skamania	Existing hatchery		WDFW	
Spring Cr	Existing hatchery		USFWS	
Stayton Pond	Existing hatchery		ODFW	
Washougal	Existing hatchery		WDFW	
Willard	Existing hatchery		USFWS	
EXISTING ACCLIMATION SITES				
Clark Flat	Acclimation site	YKFP	YKFP	
Easton	Acclimation site	YKFP	YKFP	
Holmes	Acclimation site	YKFP	YKFP	
Jack	Acclimation site	YKFP	YKFP	
Lost	Acclimation site	YKFP	YKFP	
Stiles	Acclimation site	Private	YKFP	
OTHER EXISTING HATCHERIES				
Trout Lodge	Existing hatchery	Private	Private	

POTENTIAL REARING FACILITY SITES - NEW				
DAMS				
Bumping	Irrigation	USBOR	Yakima-Tieton ID	Bumping
Cle Elum	Irrigation	USBOR	Kittitas Rec. District	Cle Elum
Clear Creek	Irrigation	USBOR	USBOR	N. ForkTieton
Cowiche DD (Nelson)	Irrigation diversion			Naches
Easton DD	Irrigation diversion	USBOR	Kittitas Rec. District	Yakima
Horn Rapids DD	Irrigation diversion	Columbia ID	Columbia ID	Yakima
John Day	Power	USACE - Portland	USACE - Portland	Columbia
Kachess	Irrigation	USBOR	Kittitas Rec. District	Kachess
Keechelus	Irrigation	USBOR	Kittitas Rec. District	Yakima
McNary	Power	USACE - Walla Walla	USACE - Walla Walla	Columbia
Priest Rapids	Power	Grant County PUD	Grant County PUD	Columbia
Rock Island	Power	Chelan County PUD	Chelan County PUD	Columbia
Rocky Reach	Power	Chelan County PUD	Chelan County PUD	Columbia
Roza DD	Irrigation diversion	USBOR	Roza ID	Yakima
Sunnyside DD	Irrigation diversion	USBOR	Sunnyside ID	Yakima
The Dalles	Power	USACE - Portland	USACE - Portland	Columbia
Tieton	Irrigation	USBOR	Yakima-Tieton ID	Tieton
Tieton DD	Irrigation diversion	USBOR	Yakima-Tieton ID	Tieton
Town DD	Irrigation diversion	City of Ellensburg	City of Ellensburg	Yakima
Wanapum	Power	Grant County PUD	Grant County PUD	Columbia
Wapato DD	Irrigation diversion	Wapato ID	BIA	Yakima
Wapatox DD	Dam	PacificCorps	Puget Power	Naches
Wells	Power	Douglas County PUD	Douglas County PUD	Columbia
OTHER NEW SITES				
Boone		Private		Spring, surface, Yakima
Naches				Pumped river, Naches
Nile Spring		Private		Spring, Naches
Pasco Springs		NMFS		Springs, Columbia
Taneum		USBOR		Taneum
Toppenish		Private		Marion, Yakima, gournd
Outlet		Private		Spring, Klickitat
Upper Yakima				Pumped river, Yakima
Waikiki Springs		WDFW		Springs, Spokane

E. CAPITAL AND OPERATING COST BASIS

NEW FACILITY CONSTRUCTION COSTS

Funding summaries of recent hatchery construction projects in the region are used to estimate costs for future coho rearing facilities. The values are updated to 2004 dollars by assuming a future annual interest rate of 3% (the historic, average, effective rate).

HATCHERY	COST	START OF OPERATION	YEAR OF ESTIMATE	2004 VALUE
Cle Elum	$13,000,000	1997	1997	$16,000,000
Colville	$4,100,000	1990	1990	$6,200,000
Merwin	$8,170,000	1993	2000	$9,200,000
Methow	$9,227,000	1992	2000	$10,400,000
Imnaha (est)	$7,500,000		2000	$8,400,000

Hatchery details:

- The Cle Elum hatchery is operated by the YKFP. It is a research facility and has extra costs associated with that function. It is designed to produce 810,000 spring chinook (54,000 lbs) and the design water flow is 26 cfs.
- The Colville hatchery is operated by the CTCR and produces 50,000 lbs of trout per year. It has 13 cfs of pumped ground water and no surface water capability.

- The Merwin hatchery is operated by WDFW. It uses 11 cfs of gravity flow surface water from Merwin dam.
- The Methow hatchery is a spring chinook facility operated by WDFW. It has 10 cfs of pumped ground and 18 cfs of gravity flow surface water right. The production capability is 550,000 smolts (62,000 lbs) per year.
- The Imnaha hatchery is planned as part of the NE Oregon Hatchery Project. Expected capacity is 490,000 (41,000 lbs) spring chinook with a peak water use of 14.5 cfs.

These hatcheries have different production capabilities, different functions, and different site characteristics, which result in the wide range of construction costs. They are representative of the types of facilities that are proposed as new, central hatcheries; an average of these values will be used as the basis for a 1,000,000 (45,000 lb) coho pre-smolt, 12 cfs, rearing facility. This average is $8,400,000.

The above costs are assumed to include land purchase and all construction costs. Other capital expenses involved with rearing facility development that were not included are:

- Environmental evaluation and permitting: 15% of construction cost
- Facility design and engineering: 15% of construction cost

After including these expenses, the cost for a new coho hatchery becomes $11,000,000.

Scaling this amount for facilities that produce more or less than 1,000,000 coho will be done assuming that 40% of this cost does not change based on production and the other 60% changes ratiometrically. The unchanged portion reflects the amount of capital investment that is independent of the size of the facility, such as permits, some of the water supply development, utility delivery, etc. The formula for calculating rearing site development costs will then be:

NEW REARING FACILTIY COST FORMULA:
$11,000,000[.4+ 0.6*[(number of fish produced)/1,000,000]*

EXISTING FACILTITY CAPITAL COSTS

The use of existing facilities may have a wide range of costs. Some potential hatcheries will require no major alterations. Changing their function or using spare capacity will have minimal cost. However, adding capacity to existing facilities will be more expensive, especially if new water supplies and rearing units are needed. Each condition will be priced differently.

Hatcheries that are able to use all of their existing facilities are estimated to have not initial capital investment required.

Hatcheries that require the addition of significant, new coho facilities are estimated to cost 40% of the cost of developing new hatcheries:

EXISTING FACILTIY, NEW CAPACITY, COST FORMULA:
0.4{$11,000,000*[.4+ 0.6*[(number of fish produced)/1,000,000]]*

ACCLIMATION REARING SITE CAPITAL COSTS

The rearing system option that uses extended rearing in the acclimation sites will have lower individual development costs than large, central facilities. These sites will not include incubation and first feeding components and will have large, natural ponds for rearing units.

Recent acclimation site costs include $600,000 in 1996 ($700,000 in 2004 dollars) for the Twisp facility and an average of $3,700,000 ($4,500,000 in 2004 dollars) for each for the three Cle Elum sites. These values are bracketed by assuming expenses are 40% of central hatchery costs:

NEW REARING ACCLIMATION FACILTIY COST FORMULA:
0.4{$11,000,000*[(number of fish produced)/1,000,000]*

OPERATING COSTS:

The annual operating expenses of existing hatcheries are used for estimating.

HATCHERY	DIRECT HATCH. OP.	SUPPORT	ANNUAL CAPITAL AT (10%)	TOTAL	YEAR OF EST.	2004 VALUE AT (3%)	YEARLY PROD. (LBS)	COST ($/lb)
Methow				$ 371,000	1996	$470,000	62,000	$ 7.58
Cascade	$ 588,000	$ 94,080	58,800.0	$ 740,880	2002	$786,000	147,000	$ 5.35
Klickitat	$ 517,000	$ 191,290	51,700.0	$ 759,990	2002	$806,000	170,000	$ 4.74
Eagle	$ 826,000		82,600.0	$ 908,600	2003	$936,000	180,000	$ 5.20
AVERAGE								*$ 5.72*

Support services such as maintenance, administration, and pathology are included in the above.

A cost of $7.00 per lb produced will be used as the basis for operating costs for a 1,000,000 (45,000 lb) facility. This is higher than the above average because annual production is lower than for the listed facilities. An annual operating cost is then $315,000.

Scaling this amount for facilities that produce more or less than 1,000,000 coho will be done assuming that 30% of this cost does not change based on production and the other 70% changes ratiometrically. The unchanged portion estimates the fixed operating costs. The formula for calculating rearing site operating expenses for all production system options will be:

OPERATING COST FORMULA:
$315,000[.3+ 0.7*[(number of fish produced)/1,000,000]*

F. TECHNICAL REPORT - REARING ENVIRONMENT

(see separate document)

YAKAMA NATION COHO REARING FACILITIES

APPENDIX F: TECHNICAL REPORT – REARING ENVIRONMENT SPECIFICATIONS

7/28/04

I. SUMMARY

The pre-smolt rearing environment has a large impact on survival to adulthood. Densities, flow rates, water temperatures, water quality, feeding methods, and rearing unit conditions are important aspects of that environment. Due to the high value of returning adults to the coho reintroduction programs and potential limited numbers of smolt releases, emphasis is placed on maximizing adult return rates.

Optimal coho rearing criteria have been selected based on literature reviews and discussions with fish culturists. Successful systems are described by researchers that maximize adult return rates. They include very low rearing densities, large volume rearing units, natural water temperatures, limited fish transportation in the pre-smolt or smolt stages, low flow densities, enriched rearing environments, limited predation, and mechanical feeding. Specific rearing conditions are proposed to approximate those conditions:

- *First and second winter water temperatures*: 33 to 43 F.
- *Summer water temperature*: daily peak of 65 F and maximum daily average of 62 F. Minimum of 55 F.
- *Water pathogen load*: minimized for as long as possible, a priority for incubation and early rearing.
- *Maximum volume density*: a maximum of 0.3 lb/cft for fish larger than 100/lb.
- *Maximum flow density*: very water temperature and fish size dependant, 10 lbs/gpm for 20/lb fish in 50 F water.
- *Main rearing units*: large ponds, with minimum dimension of 30' wide by 100' long by 4' deep.
- *Rearing unit environment*: "enriched" with limited predation allowed.
- *Feed*: mechanical introduction where possible.
- *Trucking*: no movement after fish reach a size of 40/lb.

A system that meets most of the conditions is one that includes 6 or more months of rearing at each release site. Practical considerations may not allow all of these conditions to be met. Water and space availability, construction costs, and operational considerations may place limits on design options.

II. WATER

A. TEMPERATURES

A natural water temperature profile is important to producing quality fish. It is clear from the literature that low second winter water temperatures improves smolt characteristics. A summary of several studies that demonstrate the importance of cold winter temperatures and a natural fish growth profile follows:

- Steelhead held in 4 to 10 C water for several months prior to release had higher survivals than fish reared in constant 15 C water (Bjorn and Ringe, 1984).

- Atlantic salmon reared in natural water temperatures (winter temperatures down to 42 F) survived at higher rates than fish reared on a constant winter temperature of 52 F when transferred to seawater (Dickoff, et al, 1998). The authors concluded that increasing late winter temperatures are important to the smolting process.
- Recent research indicates that spring growth rates are important to adult survival. Beckman et al (1999) states: *"Maintaining fish at a relatively small size initially, then inducing rapid growth in the final spring, may result in high-quality smolts, with a substantial savings in feed costs. Conversely, promoting rapid summer–fall growth in fish destined for yearling release, then just maintaining size in the spring, may result in large but poorly performing fish."* Small size until the final spring is optimally managed with low incubation and second winter temperatures. Growth manipulation can be done by adjusting feed rates, but low ration in warm water may cause nutritional stress.
- Compensatory growth following winter starvation has been demonstrated (Griffioen, 1976) for coho and fish condition is not impaired (Larsen et al, 2001).

Further evidence comes from the aquaculture industry. Smolts reared on ground water and transferred to ocean net pens perform poorly. Smolts reared on surface water have superior smolting characteristics and higher survival.

Clear, beneficial results from rearing on cold winter temperatures have not been demonstrated in all cases. Appleby, et al (2002), in a study of spring chinook at the Klickitat hatchery showed that adult survivals were not increased with 6 week long cold acclimation water exposure. However, other investigators, as cited in the paper, did find that winter temperature fluctuations enhanced smoltification and emigration of salmonid juveniles.

Low first winter temperatures are also important. Chilling incubation water is relatively inexpensive and helps match the hatchery growth profile to that of natural fish. Rapid growth in the summer and second spring can then be utilized to attain smolt size targets. Keeping fish small entering the first summer also keeps pond flow and volume densities low which minimizes stress.

There were no peer reviewed studies found that evaluate the impact of warm summer temperatures. However, the Samish, Puyallup, and Toutle WDFW hatcheries have some of the highest adult coho return rates in the state, although these facilities all see temperatures in the low 70s in summer months (Harry Senn, personal communication). Also, as discussed above, cold winter water temperatures are beneficial. By extrapolation, the assumption can be made that a natural temperature profile through the summer is also desirable.

There is conflicting information on the upper limit for rearing temperatures in coho facilities. For the purposes of this siting work, an upper limit for the daily maximum will be 65 F and for the daily average, 62 F. The Wenatchee River near Wenatchee and the Columbia River at Rock Island Dam are above this value and both supplies are generally considered too warm for yearling salmonid culture. Cascade hatchery (Eagle Creek) in Oregon is just below this value and at the upper limit of temperature for coho. These numbers are general guidelines only and are site and facility specific. Hatcheries that have recurring disease problems, high rearing volume densities, and/or low flow volumes should have reduced upper limits.

B. DISEASE

The fish pathogen load of the water supply is another consideration when choosing a rearing site. The prevalence of regulated or reportable pathogens impacts the permitability and desirability of fish to be transported between watersheds. The most serious of these are regulated diseases (from NWIFC and WDFW, 1998):

- Viral Infectious Hematopoietic Necrosis virus (IHNV)
- Viral Infectious Pancreatic Necrosis virus (IPNV)
- North American Viral Hemorrhagic Septicemia virus (VHSV)
- Viral pathogens not known to exist in Washington
- Myxobolus cerebralis parasite

Watersheds that are known to contain these diseases are less desirable than those that do not for rearing site location.

Currently the entire Columbia is one Fish Health Management Zone and transfers anywhere in the drainage are allowed. However, in the future smaller Columbia basin zones may be created (personal communication, Kevin Amos, WDFW/NMFS) to minimize disease transfers and the possibility of this as a restriction is a site location consideration. Egg Health Management Zones may remain large due to the effectiveness of egg disinfection methods. Facilities that use pathogen free water supplies exclusively are not subject to the same transfer restrictions that untreated surface supplies are.

Disease is also important to the operation of facilities and to the production of quality fish. Water supplies that have known, difficult and recurring disease problems are less desirable.

C. FLOW DENSITY

Flow densities, if kept above minimum values do not appear to have a large impact on survival rates. In a study of pond vs raceway rearing for cutthroat (Tipping, 1998) the flow densities in pond groups was higher than in raceway groups that survived at lower rates (see Figure 1).

In general, water supply systems are very expensive components of hatcheries. Providing water at the levels described by Fuss and Byrne (2002), 1 lb/gpm for the test groups for example, would be cost prohibitive. As a result, flow densities at these low values are not proposed.

The method used for calculating water requirements by WDFW is described in Piper (1982). It assumes that water temperatures, elevations (parameters that determine the oxygen carrying capacity of water) and fish size impact the amount of water needed per unit weight of fish being reared. A flow index number taken from a table for a given water temperature and elevation is multiplied times the fish length in inches to yield the water requirement in lbs/gpm. Specifically, standard WDFW tables for 50 F and 1,000 ft of elevation yield a flow index of 1.74. A 20/lb coho is 5.51 inches, resulting in a flow density of 9.6 lbs/gpm.

The above calculation is performed for changing water temperatures and fish sizes for potential hatchery sites to predict water needs. A safety factor should also be applied that will vary depending on water quality considerations and on supply reliability.

D. WATER CHEMISTRY

Other quality parameters should also be considered when evaluating the rearing environment. These include: turbidity, dissolved gases, heavy metals, hardness, pH, and miscellaneous contamination potential. Very high turbidity levels (above 100,000 ppm) may cause problems such as: gill irritation for fry, reduced growth rates when fish visibility is reduced, and silt removal problems. Air supersaturation downstream of dams, high dissolved carbon dioxide/low oxygen levels in groundwater (assumed for all supplies and easily corrected), and the presence of dissolved hydrogen sulfide are potential gas issues. Heavy metals are generally introduced to water through improper facility construction, however, natural supplies can also contain them. Sensitivity of fish to toxic pollutants, including metals, increases at low alkalinity. Chemical spills from truck accidents, agricultural pesticides, and herbicide applications are other sources of water supply contamination. Suggested upper limits for many of these quality parameters are listed in Piper (1982) and in the Alaska Fish Culture Manual (ADFG, 1986). Most water supplies have some values outside these limits. However, coho are successfully reared in a variety of conditions throughout the Northwest. Developing specific criteria is difficult due to the interactive aspects of chemical reactions in water. The standards can be used as general guidelines and quality determinations should not be made until testing with live fish for a full rearing cycle is completed.

III. REARING UNITS

A. VOLUME DENSITY

Rearing volume density appears to be one of the most important variables impacting adult survivals. Numerous studies (discussed below and summarized in Figure 1) have demonstrated large and significant impacts. These studies included compounding experimental variables such as water flow rates and rearing environment. The type of rearing unit may also be important, as discussed in the next section. However, volume density is an significant common difference between controls and experimental groups in the studies.

Figure 1. SUMMARY OF REARING STUDIES

Author	*Comparison*	*Species*	*Study Volume Density (lbs/ft^3)*	*Control Volume Density (lbs/ft^3)*	*Study Flow Density (lbs/gpm)*	*Control Flow Density (lbs/gpm)*	*Study Duration (months)*	*Survival Advantage of Study Groups*
Banks, 1992	Racways vs raceways	Coho	0.87	2.59	3.49	8.08	12	23%
Fuss, et al, 2002	Nat. pond vs hatch. pond	Coho	0.19	3.30	1.0	11.8	10	270%
Tipping, 1998	Pond vs raceways	Cutthroat	0.02	1.12	14.5	5.7	7	60%

The study that showed the largest survival advantage due to changes in rearing conditions was done by Fuss and Byrne (2002). They compared coho reared in a large, “natural” pond at low densities for 10 months with fish reared in conventional raceways for 6-9 months and then transferred to hatchery ponds for the final 2-3 months of rearing. Important compounding variables included the mechanical introduction of feed, rock and large woody debris, and high predation rates (50%) in the treatment pond. However, density was one of the significant differences between the test groups. The large size of the survival rate advantage, 270% higher than controls and other coho releases in the region, is such that duplication of those results is a goal.

Ewing (1995) found that in 7 of 20 brood years of coho salmon, increased rearing density resulted in a reduced percent survival to adulthood. Banks (1992) showed significant but relatively small improvements in survival with decreased densities. Hopley et al (1993) showed no effect of stocking rate on survivability at the densities studied. These evaluations were done in conventional hatchery raceways at relatively high densities. None of the groups were reared at densities near those of Fuss and Byrne.

The duration of rearing in large volume rearing units is important as well. Tipping (2001a) found a 31% improvement for 4-7 months vs. 1 month of rearing in a large pond for cutthroat.

B. REARING UNIT SIZE

The benefits of low rearing densities are obtained in conjunction with large volume rearing units. The studies that show the largest advantage of low densities were performed in ponds. Density studies, described above, done comparing raceways to raceways showed less benefit than those comparing ponds to raceways.

It is unclear why large rearing units perform well but they may reduce stress by providing escape areas when fish perceive threats. The relationship between stress and disease has been demonstrated (Wedemeyer, 1984) and there may be also be a relationship between stress and survival fitness.

There are practical limits to the size of rearing ponds. The distance that feed can be distributed limits the width. The length is a function of pond hydraulics, long and narrow increases flow velocities. Also, the size of evaluation tag groups may determine the numbers of fish per rearing unit and ultimately the pond size.

A 80’ width is a practical limit to how far feed can be distributed to 300/lb fish. Ponds that have a 3 to one length to width ratio have operated successfully. Water depth may also be an important consideration, providing security from surface predators and moderated water temperatures in the winter and summer. However, depth should be limited by human safety considerations and should be kept to less than 4’.

Large ponds increase the cost of disease treatments that are applied to water, make removal of all or some fish by seining more difficult, and reduce the ability to visually monitor fish.

Advantages beyond that of increasing adult survival of large rearing ponds include:

- Providing a large oxygen reserve in case of emergency water flow interruptions.
- Allowing room for exercise with fish able to swim large distances and to school. Exercise may be beneficial (Khovanskiy et al, 1993)
- Reducing the incidence of disease outbreaks due to the low stress environment and low pathogen density.
- Having low construction costs.

C. ENVIRONMENT

Natural rearing environments have been proposed and evaluated. Flagg et al (1999) presents a strategy for conservation hatcheries that emphasizes the production of fish with "wild-like" attributes.

Large scale experiments with spring chinook at the Cle Elum Supplementation Hatchery have not demonstrated large advantages in survival due to the use of some natural rearing conditions. Painted raceway walls, floating covers, and subsurface feed introduction did not make large improvements in adult survivals.

Tipping (2001b) showed that for cutthroat, fish fed with demand feeders had a 10% higher survival rate to adulthood. The Fuss study also used mechanical feeding. With this evidence, there might be a small advantage to avoiding hand feeding methods.

Maynard (2004) describes a Puget Sound coho study currently underway that looks at the impact of bottom substrate, fir tree structure, and camouflage net covers in a raceway environment on adult survival rates. Adult return data has not yet been evaluated. If successful, elements of the study could be incorporated.

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