Leavenworth National Fish Hatchery Complex
Mid-Columbia Region

Briefing Document for FWS Review of the Leavenworth, Entiat, and Winthrop National Fish Hatcheries

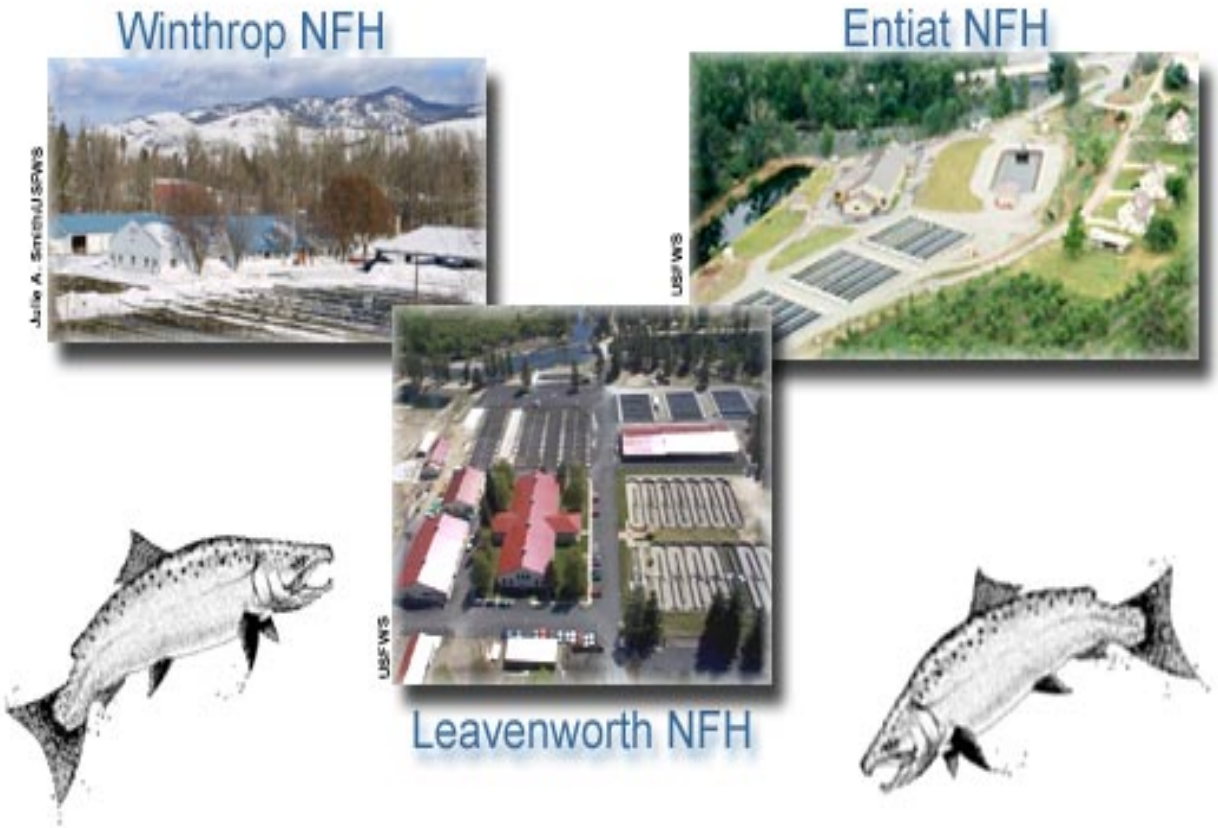


Figure xx. Aerial view of Leavenworth National Fish Hatchery Complex hatcheries. **(from LNFHComplexrpt2005)**

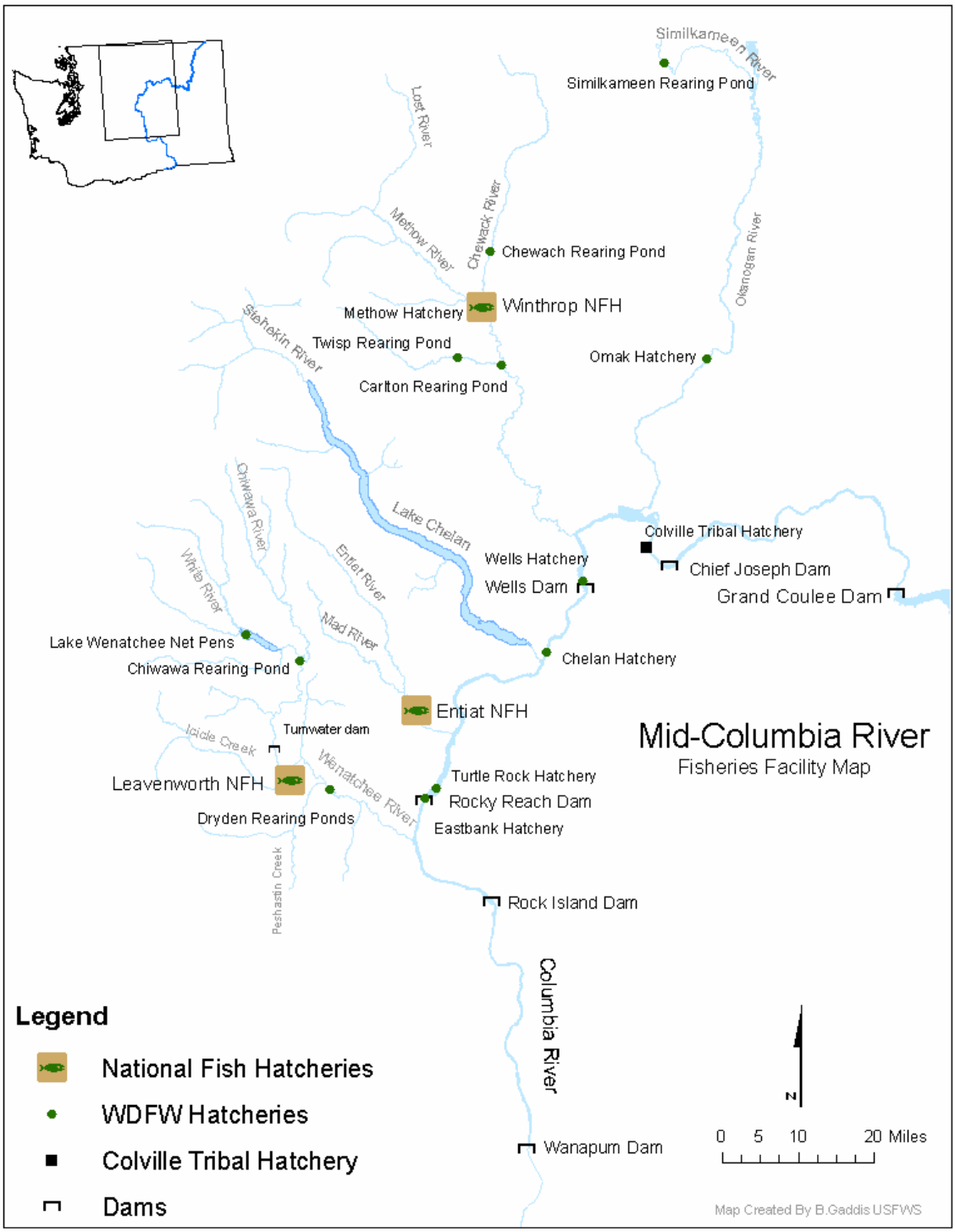


Figure xx. Location of Leavenworth National Fish Hatchery Complex hatcheries. **(from LNFHComplexrpt2005)**

I. Introduction to the Leavenworth National Fish Hatchery Complex.

(To be developed)

II. Leavenworth National Fish Hatchery.

A. Description of hatchery.

- Leavenworth NFH is situated on Icicle Creek near Leavenworth, WA. Icicle Creek flows into the Wenatchee River (WRIA 45), tributary to the Columbia River. Fish returning to Leavenworth NFH must travel about 800 km (4.5 km Icicle Creek, 42 km Wenatchee River, and 740 km Columbia River), and must negotiate passage through seven Columbia River hydroelectric dams. **(LNFHhgmp, P. 2)**
- Leavenworth NFH is situated on Icicle Creek near the town of Leavenworth in Chelan County, Washington. Icicle Creek flows into the Wenatchee River, tributary to the Columbia River. Fish released from and adults returning to Leavenworth NFH must travel about 496 miles (2.8 miles, Icicle Creek; 25.6 miles, Wenatchee River; and 468 miles Columbia River), and must negotiate passage through seven Columbia River hydroelectric dams. **(LNFHchmp, P. 11)**
- The hatchery sits on 160 acres of fill within the Wenatchee River floodplain. **(LNFHchmp, P. 11)**
- The hatchery facilities consists of a nursery/office building, maintenance shop, feed/cold-storage building, four equipment storage buildings, three water reuse pump buildings, seven well structures, one covered sand settling basin, two screen chambers, and four residences (one of which was converted to an I & E office). **(LNFHchmp, P. 12)**
- Facility goals include: **(LNFHchmp, P. 1)**

  Goal 1: Produce fish species and numbers commensurate with those lost/affected by the construction of Grand Coulee Dam. Assure that hatchery operations support Columbia River Fish Management Plan (U.S. v. Oregon) production and harvest objectives.

  Goal 2: Minimize impacts to ESA listed and other native species, their habitat, and the environment.

  Goal 3: Provide the public with quality aquatic interpretation and education, customer service and comprehensive outreach to enhance public understanding, participation and support of Service and Leavenworth NFH programs.

- The facility is used for adult collection, egg incubation and rearing of spring Chinook salmon. The goal of this program is to provide fish to satisfy legally mandated harvest in a manner which minimizes the risks of adverse effects to listed wild populations. **(LNFHhgmp, P. 2)**
- The facility is also used for the acclimation and release of coho salmon in cooperation with the Yakama Indian Nation. Coho salmon were once widely distributed within the Columbia River Basin. The Yakama Nation seeks to return coho to these basins through a long-term multiphase mid-Columbia River reintroduction project. **(LNFHComplexrpt2005, P. 26)**
- Leavenworth NFH has reared and released Chinook salmon annually since 1940, except for brood years (BY) 1967 and 1968. **(LNFHComplexrpt2005, P. 5)**
- Leavenworth NFH spring Chinook salmon were first collected from commingled upriver stocks intercepted at Rock Island Dam (1940-1943). Some early imports of spring Chinook salmon from the lower Columbia River (1942) and McKenzie River, Oregon (1941) were part of homing studies, and probably few, if any, contributed to future production. Occasionally Leavenworth NFH has imported eggs from other Columbia River hatcheries, primarily Carson NFH, and also Cowlitz and Little White Salmon NFH's. Fish and/or eggs have not been imported to

Leavenworth NFH since 1985 and brood has consisted of adults that volunteer into the hatchery ladder. **(LNFHComplexrpt2005, P. 5)**

- The Leavenworth NFH spring Chinook salmon program is intended to function as a segregated harvest augmentation program and the Icicle Creek stock utilized by Leavenworth NFH is not included in the ESA-listed UCR spring Chinook salmon ESU. Genetic analysis indicates current brood is more closely related to the lower Columbia River stocks than the natural population in the Wenatchee River (Ford *et al*. 2001). Inclusion of stock other than Leavenworth NFH is believed minimal as few natural or other hatchery adults have been observed in the adult holding ponds at this facility. **(LNFHComplexrpt2005, P. 5)**
- Leavenworth NFH receives coho yearlings (primarily reared at the lower Columbia River hatcheries of Willard NFH, Eagle Creek NFH, and Cascade SFH) on station in winter for 1-4 month acclimation and subsequent release. Yearlings had initially been acclimated behind dam 5 in Icicle Creek; however, more recently they are acclimated in Leavenworth NFH's Yakama Nation renovated Foster-Lucas ponds prior to release into Icicle Creek. **(LNFHComplexrpt2005, P. 26)**
- Rearing facilities include two – 15' x 150' adult holding ponds, 45 – 8' x 80' raceways, 14 – 10' x 100' covered raceways, 72 troughs, 108 starter tanks, plus 40 small and 22 large Foster- Lucas ponds (FL's not used for Chinook production, currently used for coho acclimation by the Yakama Nation). Hatchery water rights total 99,010 L/min, though average flow to the hatchery is 70,410 L/min. Water sources include seven wells, Icicle Creek, and Snow and Nada Lakes located in the Alpine Lakes Wilderness. **(LNFHComplexrpt2005, P. 5)**
- Leavenworth NFH spring Chinook salmon program is funded by the Bureau of Reclamation (BOR) at about $1,000,000 annually, and is staffed by 18 FTE's. Fish marking, evaluation, and fish health programs are not included in the above operational costs. Other USFWS offices funded by the BOR conduct these programs. **(LNFHhgmp, P. 1)**
- The hatchery was originally authorized through the Grand Coulee Fish Maintenance Project in 1937 and again by the Mitchell Act in 1938. Operations began in 1942. Leavenworth is one of three mid-Columbia hatcheries constructed by the BOR as mitigation for the Grand Coulee Dam-Columbia Basin Project. **(LNFHhgmp, P. 2)**
- The hatchery is staffed full-time during daylight hours, and personnel in residential quarters are on the hatchery grounds. Raceways and nursery tanks are equipped with a low-water alarm system. Although the alarm can be heard for a great distance, the system will also automatically phone staff to warn them of the problem. If power is lost to the facility, there is an emergency back-up system that automatically engages to restore power. **(LNFHhgmp, P. 24)**
- Currently, Leavenworth NFH operates with a staff of 15. This includes the hatchery manager, fish biologist, receptionist, purchasing agent, information and education specialists, animal caretakers, and maintenance personnel. In addition, the hatchery is the administrative headquarters of the Leavenworth NFH Complex. Leavenworth Complex staff consists of the administrative and outreach functions. With Complex staff, the total number of employees located at LNFH is 20. **(LNFHchmp, P. 11)**
- The Columbia River Fish Management Plan *(US v Oregon)* directs the operation/production of this facility. **(LNFHhgmp, P. 15)**

B. Hatchery water sources.

- The hatchery's water delivery system consists of three major components and conveyance systems: 1) the gravity intake on Icicle Creek, 2) the Snow Lake Supplementation Water Supply

Project and, 3) the well system on hatchery property. **(LNFHhgmp, P. 21)**

- Water sources include seven wells, Icicle Creek, and Snow and Nada Lakes located in the Alpine Lakes Wilderness. **(LNFHComplexrpt2005, P. 5)**
- LNFH permits/certificates for hatchery water sources include: Icicle Creek, 18,900 GPM; Snow/Nada Lakes, 16,000 Acre Feet; Groundwater, 5,500 GPM. . **(LNFHhgmp, P. 22, Table 9)**
- The intake is located at rm 4.5, approximately 1.5 miles upstream of the hatchery. Water is conveyed to the hatchery through a buried 31-inch pipe system. This water enters a sand settling basin and on through two screen chambers prior to its arrival at the hatchery. The water intake structure consists of a diversion dam, fish ladder, wide bar trash rack (6 inch spacing) and another narrower bar trash rack (1 1/2 inch spacing) located in a building. This structure is currently not properly screened, but plans are underway to bring it into compliance. The intake structure is inspected daily as part of standard protocol for signs of fish and/or debris. At no time in the past year have any fish been observed on the rack at the intake. **(LNFHhgmp, P. 21)**
- During construction of the hatchery, it was recognized that surface flow in Icicle Creek might at times be insufficient to meet production demands. A supplementary water supply project in Snow Lake and Nada Lake was therefore developed and a water right to 16,000 acre feet of Snow Lake was obtained. These lakes are located approximately 7 miles from the hatchery and about one-mile above it in elevation. A ½ mile tunnel was drilled and blasted through granite to the bottom of Snow Lake and a control valve was installed at the outlet of the tunnel. Operation of the control valve is determined by Icicle Creek flow and water temperature. The control valve is typically opened mid-July or as soon as the creek water consistently reaches 58F (D. Davies pers. comm.). Water drained from Snow Lake enters Nada Lake, which drains into Snow Creek, a tributary to Icicle Creek that enters at rm 5.5. Thus, supplemental flows, ranging from 45 to 60 cfs from Snow Creek, enter Icicle Creek one-mile above LNFH's intake system. **(LNFHhgmp, P. 22)**
- During critical periods of the rearing cycle, well water is used to cool/warm stream water, and stream water to warm well water. **(LNFHhgmp, P. 22)**
- Upstream passage problems and instream flows. **(LE-003, P. 176)**
    - Icicle Creek. At RM 4.5, the water diversion dam for the LNFH and the Cascade Orchards Irrigation District Company intake, blocks fish passage at low flows (Cappellini 2001a; USFWS 2001).
    - Icicle Creek. During drought years, the stream is dewatered from the LNFH/ Cascade Orchards Irrigation District Company diversion dam at RM 4.5 downstream to RM 2.6, where LNFH returns flows to Icicle Creek (D. Rieman, Icicle Creek Watershed Council, pers. comm., 2001).
    - Icicle Creek. At RM 5.6, there is a natural boulder field. During the migration seasons in 1999 and again in 2000, a total of 75 bull trout, spring chinook, and steelhead were radio tagged, placed above the LNFH and tracked. In either year, none of these fish migrated past the boulder field (Cappellini 2001b). The study concluded that the boulder field was a substantial velocity and gradient barrier to fish at the range of flows and water temperatures experienced between 1999 and 2000. According to the USFWS, this conclusion identifies the boulder field as the first potential natural fish passage barrier on Icicle Creek (Cappellini 2001a).
    - Icicle Creek. It is unknown whether the Icicle/Peshastin Irrigation District water diversion at RM 5.7 acts as a barrier to fish passage (Cappellini 2001a).
    - Icicle Creek. At RM 24.0 there is a natural falls that is a barrier to upstream fish passage (Mullan et al. 1992).

- Irrigation diversions in Icicle Creek remove 48%, 79% and 54% of the mean August, September and October flows, respectively (Mullan et al. 1992). **(LE-003, P. 186)**
- Major water right withdrawals from Icicle Creek are the Icicle/Peshastin Irrigation District (117 cfs at RM 5.7), Leavenworth NFH (42 cfs at RM 4.5), and the Cascade Orchards Irrigation Company (12 cfs at RM 4.5).
- During drought years, Icicle Creek is known to dewater from the LNFH intake diversion (RM 4.5) downstream to RM 2.6 where the LNFH returns flows to Icicle Creek (D. Riemen, Icicle Watershed Council, pers. comm., 2001). **(LE-003, P. 186)**

C. Adult broodstock collection facilities.

- All broodstock used for production are volunteers to the facility. Adults swim up the collection ladder and into one of two holding ponds. The holding ponds measure 15 x 150 feet, and are joined in the middle by an adjustable slide gate. The gate is opened, and adults are allowed to enter the second pond during sorting, counting, etc. The holding ponds supply attraction water for the ladder. **(LNFHhgmp, P. 23)**
- Returning Leavenworth Complex spring Chinook adults are primarily collected via voluntary entrance to hatchery fish ladders in the months of mid-May to early-July. Collected adults are retained in holding ponds through early September. **(LNFHComplexrpt2005, P. 8)**
- A Vaki River Watcher fish counter was installed in the holding pond entrance in May 2003. This unique counter, with an advertised accuracy of 95%, is capable of counting fish movements up and downstream. Each fish passing through the counter has a silhouette image scanned with a date and time attached to the computer generated file. Also from the image, species, length and height can be determined. In addition to the silhouette image, this model also takes up to five digital pictures for later species verification. The counter was purchased to help increase the accuracy of adult counts, but additional benefits include a reduction in stress by limiting the number of times an adult is handled for counting purposes. **(LNFHchmp, P. 41)**
- In May 2004, a PIT tag detector/reader was installed just upstream of the fish counter. This reader allows for additional data collection including travel time and survival. **(LNFHchmp, P. 41)**

D. Broodstock holding and spawning facilities.

All broodstock used for production are volunteers to the facility. Adults swim up the collection ladder and into one of two holding ponds. The holding ponds measure 15 x 150 feet, and are joined in the middle by an adjustable slide gate. The gate is opened, and adults are allowed to enter the second pond during sorting, counting, etc. The holding ponds supply attraction water for the ladder.

E. Incubation Facilities.

From fertilization to the eyed stage, eggs are in individual bucket incubators receiving one gallon per minute of ground water. Throughout the incubation period, eggs are treated daily with 1,667 ppm of formalin for fungus control. During the eyed stage, eggs are culled for BKD, mortalities picked and the remaining eggs enumerated. Deep troughs with trays are used for incubation to the buttoned-up stage. Eggs from each female are individually incubated until the eyed stage at which time dead eggs are removed. Viable eggs are counted

and moved into deep trough trays for hatching and larval development. All incubation takes place in 44°-50° F well water. Eggs from females with high levels of Bacterial Kidney Disease are discarded unless needed to meet production goals. The first take of eggs hatch in mid-October.

Number of eggs taken and survival rates to eye-up and/or ponding.

Year	Total eggs taken	Survival rate to eye-up
1988	3,811,000	96 %
1989	6,086,752	96 %
1990	5,002,287	96 %
1991	3,027,595	96 %
1992	2,075,629	93 %
1993	1,914,216	97 %
1994	2,361,879	93 %
1995	965,402	96 %
1996	2,060,619	97 %
1997	2,240,533	97 %
1998	2,263,338	97 %
1999	1,892,607	96 %
2000	1,917,429	97 %

Surplus eggs are taken to allow for the culling of moderate to high risk BKD infected eggs. It is common practice to cull (destroy) eggs that have a very high ELISA rating. We use historical data to determine egg collection levels. The culled eggs are disposed of in an earthen pit on station property.

The dry-weight method is used to enumerate eggs. Several random samples of 100 eggs are taken from each basket containing several families. An average weight is obtained after combining sample eggs. Average weight is 117 eggs/ounce.

From fertilization to the eyed stage, eggs are in individual bucket incubators receiving one gallon per minute of ground water. Throughout the incubation period, eggs are treated daily with 1,667 ppm of formalin for fungus control. During the eyed stage eggs are culled for BKD, mortalities picked and the remaining eggs enumerated. Deep troughs with trays are used for incubation to the button-up stage. Our goal is low density incubation, 1,500 eggs per tray, which is well below the IHOT recommendation of 5,000 eggs per single tray. Water flows in the deep troughs is 15 gallons per minute.

Eggs are incubated in pathogen free (well) water. Water temperature is continuously monitored and recorded via a computer. Water temperatures are converted to temperature units for each spawning day. For the Leavenworth SCS stock, it takes about 750 temperature units to reach the eyed stage and 1,700 temperature units to the button-up stage or initial feeding.

Well water passes through a de-gassing media prior to entering the nursery. Water oxygen levels are always near saturation. When cleaning the nursery, the effluent passes through a pollution abatement facility prior to entering Icicle Creek.

F. Indoor Rearing Facilities

Fry are removed from incubators when they are 99% buttoned-up. After a few days of acclimation and when all fish are on or near the surface, feeding commences in mid-December. Fry are fed BioOregon's starter feed. Commonly, newly buttoned-up fish are 1,250 to 1,350 fish/pound when they are moved to nursery tanks. There are 108 starter tanks. [Need to locate size] During late February, fry are moved outside to 30, 8 x 80 raceways and remain there until after the previous broodyear is released and other raceways are cleaned and disinfected.

G. Outdoor Rearing Units

There are 45 – 8 x 80 raceways, 14 – 10 x 100 covered raceways, and 40 small and 22 large Foster-Lucas ponds (not used for SCS production, but currently used for coho acclimation by the Yakama Nation). All production ponds are full after inventory is complete. After spawning, the two adult ponds are cleaned and disinfected to receive fingerlings. In early October, fish from 30 raceways are moved to the two adult holding ponds and additional fish are added to the remaining 15, 8 x 80's. This action empties raceways for the next years fry. Fish will remain in these raceways until release. Rearing space is managed so that density indices (the ratio of weight of fish to rearing unit volume and fish length) at no time exceed 0.2. In order to achieve these low indices, total production was reduced from 2.2 million to 1.625 million smolts. Reduced production numbers appears to have led to a decline of incidence of BKD.

Table 13. Survival estimates for juvenile SCS, LNFH.

Broodyear	Fry to Fingerling (%)	Fingerling to Smolt (%)
1988	98.8	98.3
1989	98.4	98.2
1990	97.5	98.4
1991	97.4	98.7
1992	98.7	97.0
1993	98.7	98.1
1994	99.1	97.9
1995	98.3	96.4
1996	98.2	98.3
1997	98.8	97.1
1998	99.0	96.8
1999	98.8	98.1

H. Release locations and facilities.

Smolt releases are made directly into Icicle Creek so adults returning from these releases can provide sport and tribal fishing opportunities while minimizing adverse affects to listed fish. There is no primary intent for returning adults to be used for any purpose other than harvest, broodstock, and stream nutrient enhancement. **(LNFHhgmp, P. 2)**

I. Outmigrant monitoring facilities.

Travel time, arrival date, and survival of PIT-tagged spring Chinook smolts released from Leavenworth Complex facilities are estimated to McNary Dam. **(LNFHComplexrpt2005, P. 33)**

J. Additional or special facilities.

- In recognition of its significance to the United States' cultural heritage, the Washington State Advisory Council on Historic Preservation and the United States Department of the Interior entered the Leavenworth National Fish Hatchery in the National Register of Historic Places, July 27, 1998. **(LNFHchmp, P. 13)**
- The three primary Leavenworth Hatchery buildings of historic and archeological significance include the hatchery/office building, cold storage/freezer building and the garage/shop building. These were all constructed between 1939 and 1940 and have always been important to the function of Leavenworth as a state-of-the-art hatchery. The design and size of the buildings was originally based on the number and types of fish to be reared. In the late 1930's, biologists estimated the massive scale for Leavenworth based on the abundant native salmon runs in the upper Columbia River that would be blocked by Grand Coulee Dam. The three buildings have been altered to some extent, but remain as dominant features of the hatchery. **(LNFHchmp, P. 13)**
- Other historical structures and facilities include the three original historic ponds and wood frame sheds in the original Icicle Creek channel. These structures were removed in the summer of 2003 during the implementation of the Icicle Creek Restoration Project. The original hatchery trays and troughs used for salmon egg incubation, 40 small and 15 of the 30 large rearing ponds, known as Foster-Lucas ponds, and the Icicle Creek diversion canal built in 1939 all currently exist. The canal remains virtually unchanged since its construction and is an important element of the hatchery landscape. **(LNFHchmp, P. 13)**
- The Snow Lake Reservoir and tunnel was built by the Bureau of Reclamation to serve as a supplemental water source for the hatchery during the summer months when Icicle Creek is low and warm. Snow Lake, a natural wilderness lake located in the Alpine Lakes Wilderness area, is approximately 8 miles to the southwest of the Leavenworth Hatchery and sits almost one mile in elevation above the hatchery. The USFWS is the landowner of more than 700 acres surrounding the Snow Lake Reservoir. The engineers and construction crews, during the years 1939-1942, tapped Snow Lake with a pipe and valve system located near its base. The concept works much like a faucet. When water is needed, the valve from Snow Lake is opened and water sprays from the pipe, down the rocky slope into Nada Lake, where Snow Creek originates, which feeds directly into Icicle Creek. The lake water helps maintain a consistent cool water flow in Icicle Creek (Nielson 1940). A 7 x 9 ft. tunnel was cut through 2, 250 ft. of solid granite rock to the bottom of Snow Lake. This amazing engineering feat required several crews of men to cut the tunnel. In the summer of 1938, the Forest Service constructed the 30" wide trail from the Icicle Creek road up to Nada and Snow Lakes to make access possible for the project. A year-round base camp was established at Nada Lake for the construction crews. (Grand Coulee Project Report 1938:46). **(LNFHchmp, P. 13)**
- Other historic resources of the Leavenworth facility include seven Leavenworth residences, built from September 1940 to March 1941. Each house was a Bureau of

Reclamation design following the very same floor plan. They are 1 ½ story side-gabled houses with moderately pitched roofs and are simply finished with clipped gables, boxed eaves and single car garages. All of the houses have a rear shed roof dormer. Four of these residences exist today and have been altered to some degree. Another housing area was located on the south end of the hatchery property and served as living quarters for a crew of carpenters in 1939. They have recently been remodeled and now serve as office space for the Mid-Columbia River Fishery Resource Office. **(LNFHchmp, P. 13)**

K. Outreach and public education facilities/programs.

- The Leavenworth National Fish Hatchery serves 150,000 visitors annually. Permitted Special Uses on hatchery lands include a cross-country ski trail system managed by the Leavenworth Winter Sports Club, summer horseback rides and winter sleigh rides operated by Icicle Outfitters, outdoor theater managed by Leavenworth Summer Theater and the Friends of Northwest Hatcheries and the Boy Scouts utilize the former Gun Club Building for weekly meetings and activities. Other uses for the public include guided and self-guided hatchery tours, sport fishing for spring Chinook salmon, walking on the accessible Icicle Creek Nature Trail, and bicycling and picnicking at Hatchery Park. Requests are received throughout the year for special events produced by community organizations. The largest special event is the Wenatchee River Salmon Festival held annually in September for the public. This multi-partner nature festival provides interactive natural resource education, promotes outdoor recreation and shares the cultural significance of salmon to the people of the northwest. **(LNFHchmp, P. 30)**
- The Leavenworth National Fish Hatchery Complex houses one of the most comprehensive Information and Education Outreach Departments (I&E) in the National Fish Hatchery System. Serving Leavenworth, Entiat and Winthrop National Fish Hatcheries, this department is managed by an Outreach/Public Affairs Supervisor and staffed with an Environmental Education Specialist, Interpretive Specialist/Friends Group liaison and Information Receptionist. The I&E department shares and distributes its time and staffing between the three stations and serves many partners in both the private sector, schools, tribes and multiple local, city, state and federal government agencies. Funding for the I&E program comes from the Complex budget and is supplemented by financial support from fundraisers, local community contributors, sponsors, and grants raised and managed by the Friends of Northwest Hatcheries. **(LNFHchmp, P. 53)**

L. Special issues or problems (e.g. water and property rights issues, law suits, etc.).

- Use of a non-indigenous/non-listed stock for the program (Carson stock). **(LNFHhgmp, P. 8)**
- **Surface water intake problems (**to be addressed in rehabilitation of Icicle Creek water delivery system**).**
    - Deteriorated surface water intake pipeline that is susceptible to a potential catastrophic failure.
    - Instream structures that inhibit upstream passage of adult fish**.**
    - Freezing at intake grates: to be addressed in rehabilitation of Icicle Creek water delivery system, possibly bringing warm well water to intake area.
    - Screens at intake are not compliant with NOAA fish exclusion guidelines and are of poor design and orientation (From APRE).
    - The current Icicle Creek water intake and some of the delivery system is part of the original construction of the Hatchery (1939 and 1940). The system is

deteriorating rapidly and causing operational and maintenance problems and uncertainties for the Hatchery.

  - Icicle Creek transports large amounts of silt and sediment during heavy spring runoff resulting in accumulation of significant amounts of sediment at the intake and intake works. The failure to remove these materials results in restricted flows into the intake over time, especially during the summer months. **(LNFHchmp, P. 39)**
  - Discussions are ongoing with neighboring property owner concerning existing water intake pipeline easements. The outcome of these discussions could affect placement of intake pipeline, operation and modification of fish bypass ditch, and placement of intake.
  - ESA listed species in Icicle Creek: USFWS-ES office in Wenatchee is very concerned about passage issues for bull trout and summer steelhead at lowermost structure in Icicle Creek (Structure #5) and at intake structure.
  - The effluent/pollution abatement ponds at all three Leavenworth Complex hatcheries need rehabilitation.
  - Water Quantity: Water is extremely limited during summer irrigation withdrawal season. Hatchery well field depends on recharge via bypass channel, and future use of the canal raises issues related to available well water. Summer quantities are supplemented by water from Snow Lakes. (From HGMP: expansion water right considered but considered unlikely because water in watershed is already over-appropriated and the wells are considered to be in continuity with the Icicle Creek.)
  - Water Temperature: Icicle Creek water experiences extreme temperature in winter and summer, with summer temperatures being particularly limiting.
  - The middle and lower decks of 8'x80' raceways need to be plumbed with ground water (Identified as need by BOR).
- Icicle Creek restoration is now occurring. This involves the removal of old in-stream structures used for adult holding during the initial phase of the Grand Coulee fish program. This will allow salmonids (and others) access to an additional portion of the old river channel, but does not allow them to areas above the intake for the hatchery. **(LNFHhgmp, P. 8)**
- Water quality and quantity can have negative impacts on the production program at LNFH. **(LNFHhgmp, P. 8)**
- Anadromous salmonid populations in the Wenatchee sub-basin are influenced by the following out-of-sub-basin impacts; degraded estuarine habitat, fish harvest, unfavorable ocean conditions, and the effects of seven Columbia River reservoirs and hydroelectric dams on smolt and adult migration **(LNFHhgmp, P. 16)**
- Within the sub-basin, human alterations to the environment are exacerbating naturally limiting conditions by reducing habitat quality and quantity, thereby reducing a species' chances of successfully completing its life cycle. These alterations have primarily occurred in the lower gradient, lower reaches of watersheds in the lower sub-basin and include road building and replacement, conversion of riparian habitat to agriculture and residential development, water diversion, reduced large woody debris (LWD) recruitment, and flood control efforts that include LWD removal, berm construction, and stream channelization. **(LNFHhgmp, P. 16-17)**
- Leavenworth NFH reduced yearling production from 2.2 million to a release goal of 1.625 million in release year 1993. The release date has remained consistent around the third week in April and although some attempt is made to coincide with a discharge event, this facility is constrained within a spill window negotiated with Chelan PUD for Rock Island Dam.

(LNFHComplexrpt2005, P. 30)

III. Icicle Creek spring Chinook hatchery program, Leavenworth NFH

A. General information.

- Leavenworth NFH has reared and released Chinook salmon annually since 1940, except for brood years (BY) 1967 and 1968. **(LNFHComplexrpt2005, P. 5-6)**
- Leavenworth NFH spring Chinook salmon were first collected from commingled upriver stocks intercepted at Rock Island Dam (1940-1943). Some early imports of spring Chinook salmon from the lower Columbia River (1942) and McKenzie River, Oregon (1941) were part of homing studies, and probably few, if any, contributed to future production. Occasionally Leavenworth NFH has imported eggs from other Columbia River hatcheries, primarily Carson NFH, and also Cowlitz and Little White Salmon NFH's. **(LNFHComplexrpt2005, P. 5-6)**
- Fish and/or eggs have not been imported to Leavenworth NFH since 1985 and brood has consisted of adults that volunteer into the hatchery ladder. **(LNFHComplexrpt2005, P. 5-6)**
- Leavenworth NFH reduced yearling production from 2.2 million to a release goal of 1.625 million in release year 1993. The release date has remained consistent around the third week in April and although some attempt is made to coincide with a discharge event, this facility is constrained within a spill window negotiated with Chelan PUD for Rock Island Dam. **(LNFHComplexrpt2005, P. 30)**
- Hatchery Benefits include: **(LNFHchmp, P. 1)**
  - **Harvest Contribution:** Spring Chinook salmon from Leavenworth NFH have, over the years, supported successful sport and tribal fisheries in the Wenatchee River and Icicle Creek, and to a lesser extent, the Columbia River and ocean (refer to Chapter 3 for more discussion on harvest). For example, in 2002, the sport catch in Icicle Creek was 1,202, with a tribal harvest of 3,793 and 6,458 adults returned to the hatchery (WDFW 2002).
  - **Economic Benefit:** During times of good ocean and river conditions that result in healthy adult returns, significant economic activity is generated through harvest of Leavenworth NFH spring Chinook salmon. For example in 2003, Washington Department of Fish and Wildlife estimated that 4,016 anglers fished a total of 29,133 hours during the Icicle Creek fishery (WDFW 2003).
- In addition, the role of a Federal mitigation hatchery is to compensate for natural habitat lost to Federal hydro-power projects. It follows then, that the economic benefit of the mitigation hatchery is interwoven into the economic benefit of the hydro-power project/s being mitigated for and that the hatchery can be characterized as an operating expense of the hydro-power project. The Service recognizes that mitigation hatcheries serve a significant role in supporting economically important fisheries.

B. Stock/Habitat/Harvest Program Goals and Purpose.

1. Purpose and justification of program.
    - The hatchery was originally authorized through the Grand Coulee Fish Maintenance Project in 1937 and again by the Mitchell Act in 1938. Operations began in 1942. Leavenworth is one of three mid-Columbia hatcheries constructed by the BOR as mitigation for the Grand Coulee Dam-Columbia Basin Project. It is used for adult collection, egg incubation and rearing of spring Chinook salmon. **(LNFHhgmp, P. 2)**
    - Smolt releases are made directly into Icicle Creek so adults returning from these releases can provide sport and tribal fishing opportunities while minimizing adverse affects to listed fish. There is no primary intent for returning adults to be used for any purpose other than harvest, broodstock, and stream nutrient enhancement. **(LNFHhgmp, P. 2)**
    - Leavenworth, Entiat, and Winthrop National Fish Hatcheries (NFH) are mitigation hatcheries established by the Grand Coulee Fish Maintenance Project (1937) to compensate for anadromous fish losses above Grand Coulee Dam. **(LNFHComplexrpt2005, P. iv)**
    - Production numbers that provide harvest are outcomes of the *U.S. v. Oregon* decision. **(LNFHhgmp, P. 17)**

2. Goals of program.
    - The goal of this program is to provide fish to satisfy legally mandated harvest in a manner which minimizes the risks of adverse effects to listed wild populations. **(LNFHhgmp, P. 3)**
    - Although the role in harvest has varied considerably for LNFH, the current program is geared to provide a terminal (isolated) tribal and sport harvest in Icicle Creek. LNFH and Icicle Creek provide the only spring Chinook fishery in the upper Columbia Basin (above the Yakima River). **(LNFHhgmp, P. 16)**

3. Objectives of program.
    - Returning adults of LNFH origin are expected to return to Icicle Creek only, although some adults are harvested in lower Columbia and ocean fisheries. **(LNFHhgmp, P. 8)**

4. Type of program.
    - Isolated harvest/mitigation. **(LNFHhgmp, P. 2)**
        - The program is intended to function as a segregated harvest augmentation program. **(LNFHComplexrpt2005, P. 5-6)**

5. Alignment of program with ESU-wide plans.
    - Species and population (or stock) under propagation, and ESA status at the Leavenworth National Fish Hatchery (LNFH) are: Carson NFH ancestry stock of spring Chinook salmon *(Oncorhynchus tshawytscha)*, unlisted. **(LNFHhgmp, P. 1)**

- The Icicle Creek stock utilized by Leavenworth NFH is not included in the ESA-listed UCR spring Chinook salmon ESU. **(LNFHComplexrpt2005, P. 6)**
- Genetic analysis indicates current brood is more closely related to the lower Columbia River stocks than the natural population in the Wenatchee River (Ford *et al*. 2001). **(LNFHComplexrpt2005, P. 6)**
- Inclusion of stock other than Leavenworth NFH is believed minimal as few natural or other hatchery adults have been observed in the adult holding ponds at this facility. **(LNFHComplexrpt2005, P. 6)**
- The Upper Columbia Evolutionarily Significant Unit (ESU) of spring Chinook was listed as endangered under the federal ESA on March 16, 1999. The Washington State Salmon and Steelhead Stock Inventory (SASSI) has identified four spring Chinook stocks in the Wenatchee subbasin; the Chiwawa River, Nason Creek, Little Wenatchee River, and White River. A fifth stock, the Leavenworth NFH stock is unlisted (Carson NFH ancestry) and supports the only spring Chinook fishery in the mid and upper Columbia Basin. . **(LNFHchmp, P. 16)**

6. Habitat description and status
    - Leavenworth NFH is situated on Icicle Creek near Leavenworth, Washington. Icicle Creek flows into the Wenatchee River, tributary to the Columbia River. Fish returning to Leavenworth NFH must travel 800 km (497 miles; 2.8 miles Icicle Creek, 26 miles Wenatchee River, 468 miles Columbia River), and must negotiate passage through seven Columbia River dams. **(LNFHComplexrpt2005, P. 3)**
    - Icicle Creek is a 31.8 mile long, fourth order tributary, and drains a 211 square mile basin containing 85 tributaries, 14 glaciers and 102 lakes. The glaciers within the basin have the highest mean altitude (8,227 feet) of any glaciers in the North Cascades. Elevation of the basin ranges from 1,102 feet at the confluence with the Wenatchee River (hatchery is approximately 1,200 feet), to the 9,470 foot summit of Mt. Stuart, about 12.5 miles southwest of the hatchery. The USFS manages 87% of the Icicle Creek subbasin, of which 74% is within the Alpine Lakes Wilderness Area and is managed as a Tier 1 key watershed under the Northwest Forest Plan (USFS 1994). Therefore, public lands in the Icicle Creek drainage are managed for at-risk salmonids and other fish species. **(LNFHchmp, P. 11)**
    - The Wenatchee River drains a portion of the east slopes of the Cascade Mountains in north central Washington within Chelan County. The river flows generally in a southeasterly direction, emptying into the Columbia River at the City of Wenatchee at Columbia River Mile (RM) 468.4. The Wenatchee River subbasin encompasses approximately 1,371 square miles (877,400 acres), with 230 miles of major

streams and rivers. The subbasin originates in high mountainous regions of the Cascade Mountains, with numerous tributaries draining subalpine regions within the Alpine Lakes and Glacier Peak wilderness areas. It is bounded on the west by the crest of the Cascade Mountains, on the north and east by the Entiat Mountains, and to the south by the Wenatchee Range. The Little Wenatchee and White Rivers flow into Lake Wenatchee, the source of the Wenatchee River. From the lake outlet at Wenatchee RM 54.2, the river descends rapidly through Tumwater Canyon, dropping into a lower gradient section in the region of Leavenworth, where Icicle Creek joins the mainstem (RM 25.6). Other major tributaries include Nason Creek (RM 53.6), the Chiwawa River (RM 48.4), Chumstick (RM 23.5), Peshastin (RM 17.9), and Mission (RM 10.4) creeks. **(LNFHchmp, P. 11)**

- Within the subbasin, human alterations to the environment are exacerbating naturally limiting conditions by reducing habitat quality and quantity, thereby reducing a species' chances of successfully completing its life cycle. These alterations have primarily occurred in the lower gradient, lower reaches of watersheds in the lower subbasin and include road building and replacement, conversion of riparian habitat to agriculture and residential development, water diversion, reduced large woody debris (LWD) recruitment, and flood control efforts that include LWD removal, berm construction, and stream channelization (Andonaegui 2001). For a complete and detailed description of the Wenatchee subbasin, see Andonaegui 2001 and WDFW 2002. . **(LNFHchmp, P. 17)**

7. Size of program and production goals (No. of spawners and smolt release goals).
    - Approximately 1,000 adults are needed for production. **(LNFHhgmp, P. 7)**
    - 1.625 yearling spring Chinook juveniles are released to Icicle Creek annually **(LNFHhgmp, P. 7)**
    - Leavenworth NFH reduced yearling production from 2.2 million to a release goal of 1.625 million in release year 1993. **(LNFHComplexrpt2005, P. 31)**
    - Additionally, up to 500 adults are secured (when possible) for transfer to Peshastin Creek. **(LNFHhgmp, P. 7)**
    - Leavenworth NFH spring Chinook releases are moderate in magnitude relative to other Columbia River Spring Chinook production programs. **(LNFHchmp, P. 26)**
    - Production numbers that provide harvest are outcomes of the *U.S. v. Oregon* decision. **(LNFHhgmp, P. 17)**

C. Description of program and operations.

1. Broodstock goal and source.

Table XX. History of SCS egg/brood source at LNFH.

Egg Source	Broodyear	Stock Origin
Rock Island Dam	1940 - 1943	**Commingled Upper Columbia**
McKenzie River, OR	1941	McKenzie River
Icicle Creek	1947, 58-63, 69, 71, 74, 76 to present	Volunteers to hatchery
Willamette River, OR	1965	Willamette River
Eagle Creek NFH	1966	Eagle Creek
Carson NFH	1970-73, 75-81, 85	Bonneville Dam
Cowlitz River, WA	1974, 76	Cowlitz River
Little White Salmon NFH	1974, 77-79	Little White Salmon River

The original broodstock used to start the program were commingled, and destined for the upper Columbia Basin. These adults were trapped at Rock Island Dam and brought to the Leavenworth facility. McKenzie River and Eagle Creek are tributaries to the Willamette River (lower Columbia River), all in the state of Oregon. The Little White Salmon stock started in 1967, when fish of unknown origin returned to the LWS River. These adults were probably descendants of several different stocks, and it is unclear what their exact lineage was. The Carson NFH stock originated from a collection of commingled adults captured at Bonneville Dam.

The following performance measures have been established at the hatchery.

Performance Measures	Hatchery Goal	5-Year Average	Range
Spawning population[1]	1,000	910	838 - 986
Fish release (millions)	1.62	1.56	1.29 - 1.68
Egg transfers (thousands)	0		
Fish transfers (thousands)	150*	66.9	50 - 148
Adults passed upstream	0		
Percent survival juvenile to adult[2]	0.50	0.26	0.08 – 0.62
Smolt size at release (fish/lb)	18	18.1	16.2 - 22.4

* - Short-term Colville Program.

[1] females plus males (including jacks spawned), averaged years, 1999 - 2003
[2] smolt to adult survival for BY's 1992 - 1996

Leavenworth NFH is currently a single species facility rearing only the "Carson lineage" stock of spring Chinook. However, Leavenworth NFH has not imported the Carson eggs or fry for over twenty years. Brood stock collection at the hatchery is managed to maintain the genetic integrity of the stock. The Service management goals are to ensure that adult brood stock is randomly collected for spawning across the run in proportion to the rate at which they return. To accomplish this, two adult holding ponds are utilized. The east pond is designated for brood stock and the west pond randomly collects returning adults. For example, as the fish return, a proportion is moved to the east pond, which will then be used as brood. This strategy requires constant monitoring of the number of fish going over Rock Island Dam. Using historical data to determine what percentage of the Rock Island Dam will return to Leavenworth NFH, one can calculate the proportion to keep as the runs progresses.

2. Adult collection procedures and holding.

All brood stock is obtained from adults volunteering to the hatchery's collection ladder. A barrier dam, located just above the ladder, blocks fish from areas above the hatchery. Adult spring Chinook return to the hatchery from May through July, and the collection ladder is typically operated throughout this period with adults collected from throughout the run. This action results in excess brood, which is periodically alleviated by donating surplus adults to various tribes and non-profit groups. Years where large adult returns are expected the fish ladder is opened and closed periodically. This strategy allows additional harvest by sport and tribal fishers and reduces the number of excess fish handled by hatchery personnel.

A Vaki River Watcher fish counter was installed in the holding pond entrance in May 2003. This unique counter, with an advertised accuracy of 95%, is capable of counting fish movements up and downstream. Each fish passing through the counter has a silhouette image scanned with a date and time attached to the computer generated file. Also from the image, species, length and height can be determined. In addition to the silhouette image, this model also takes up to five digital pictures for later species verification. The counter was purchased to help increase the accuracy of adult counts, but additional benefits include a reduction in stress by limiting the number of times an adult is handled for counting purposes.

In May 2004, a PIT tag detector/reader was installed just upstream of the fish counter. This reader allows for additional data collection including travel time and survival.

Surplus Adult Returns: Most years, more fish enter the hatchery than are needed for brood stock. Brood stock excess to hatchery needs are transferred to the Bureau of Indian Affairs for distribution to the Yakama Nation, Colville Confederated Tribes, Spokane Indian Tribe, and others for ceremonial and subsistence use. Periodically, the local Trout Unlimited group will receive excess fish via a national agreement with the Service. Surplus fish or spawned males only can be used for stream enrichment, as the females are injected with erythromycin and thus cannot be used for this purpose. Erythromycin has not been cleared for use on food fish by

the Federal Drug Administration; therefore, carcasses previously injected with erythromycin cannot be used for human consumption and must be buried on site. In accordance with the Pacific Northwest Fish Health Protection Committee draft Salmon and Steelhead Carcass Distribution Protocols pre-spawn mortalities cannot be used for stream enrichment and must be buried on site as well.

3. Adult spawning.

a) Spawning protocols.

The first spawning date is usually mid-August and most spawning is normally completed by the end of the month. The holding ponds are supplied with Icicle Creek water and tempered with well (ground) water to maintain a temperature between 45° - 50° F. The volumes of the ponds are such that density is not a concern. However, pond water flow is managed to meet or exceed one gallon of inflow per fish. The adults are injected with erythromycin, 30 days prior to spawning to control bacterial kidney disease. Adults are generally treated daily with formalin to control external parasites.

Eggs are taken each Tuesday to allow time between egg takes for fish to develop viable eggs and to coordinate sampling by the Olympia Fish Health Center. Ripe females are separated with equal amount of males the day before spawning to expedite the spawning procedure. The day of spawning, a small number of fish are crowded into a lift system and then to an anesthetic vat. Once the fish are anaesthetized they are placed on a table where males and females are separated and sacrificed via a sharp blow to the head. Ripe females are bled prior to spawning.

Fish are randomly selected and mated as close to a 1:1 male/female ratio as possible. Typically, the sex ratio for the returning adults is skewed 60/40 in favor of the females. During antibiotic injections (all fish are handled), the sex ratio is brought close to 1:1 by excessing surplus males or females. Because of the large number of total fish spawned, if needed, males may be used twice. If culling excess eggs (from non-BKD detected parents) is required, a portion from each mating is removed rather than a complete family unit. Jacks (age-3 males) are randomly included in the spawning population. Should a large number of jacks return, the number will be limited to 5% of the total number of males used (per Regional genetics guidelines).

The number of adults retained (capacity) for brood stock is based on density and flow indices, which relate to the amount of available water and space for juvenile rearing.

b) No. of males and females spawned each year over past 10 years (BY2000-BY2005 to be added).

Table 11. Number of adults used for production, eggs taken, and juveniles released, 1988 to 1999.

Year	Adults Females	Males	Jacks	Eggs Taken	Juveniles released
1988	851	852		3,811,000	3,725,211
1989	1,309	629	7	6,086,752	4,585,370
1990	1,147	863	10	5,002,287	3,055,636
1991	981	527	19	3,027,595	2,288,631
1992	493	489	4	2,075,629	1,522,846
1993	510	510		1,914,216	1,712,648
1994	460	462	10	2,361,879	1,706,060
1995	212	167	29	965,402	919,025
1996	497	465	48	2,060,619	1,701,753
1997	500	452	7	2,240,533	1,636,402
1998	495	404	5	2,263,338	1,680,904
1999	469	383	40	1,892,607	1,630,089

Data source: Hatchery records. Note: broodstock numbers vary because production numbers and protocols have changed over the years. Also, not all fish were released as smolts (some fry, etc.).

4. Fertilization.

a) Protocols.

- A 1:1 female to male spawning ratio is the objective. Due to the continuous number of fish removed, and separate male and female staging areas, there is no selectivity in mating. **(LNFHhgmp, P. 27-28)**
- Milt from the primary male is used first for fertilization. A secondary male (backup), which was the primary male in the prior mating, is used again about one minute after the primary male. Precocious males (3-year-old jacks) are used randomly throughout spawning as primary and backup males. **(LNFHhgmp, P. 27)**
- When the abdomen of a female is opened, egg's flow freely into a colander where the ovarian fluid is decanted. Eggs are transferred to a bucket where fertilization takes place. After milt

from the primary and secondary males is added to the eggs, pathogen-free well water is added. **(LNFHhgmp, P. 28)**

- All eggs and accompanying containers are disinfected with iodine solution during the water hardening process following fertilization. **(LNFHhgmp, P. 27)**
- Eggs are destroyed if the female displays gross BKD lesions. **(LNFHhgmp, P. 28)**
- The table below provides current Spring Chinook hatchery practices and performance targets for spawning-egg incubation stages for the Leavenworth Complex by hatchery, life stage, and attribute. **(LNFHComplexrpt2005, P. 10, Table 4)**

Spring Chinook production protocols and current practices for the Leavenworth Complex by hatchery, life stage, and attribute. **(LNFHComplexrpt2005, P. 10, Table 4)**

Life Stage	Attribute	Leavenworth NFH Chinook	Entiat NFH Chinook	Winthrop NFH Chinook	Winthrop NFH Steelhead	Winthrop NFH Coho
Adults	***collection***	Hatchery ladder	Hatchery ladder	Hatchery ladder	Wells Dam SFH	Hatchery ladder, Wells Dam SFH
	ladder operation	Continuous (throughout run). Pulsed during high returns	Continuous (throughout run).	Varies depending on return & stock availability	N/A	Varies depending on return & stock availability
	brood target	1,000	250	400	N/A	280
	prophylaxis	One antibiotic injection to brood females. Formalin treat AHP	Double antibiotic treatment to brood females. Formalin treat AHP	Double antibiotic treatment to brood females. Formalin treat AHP	N/A	Formalin Treatment
	stock	1. Hatchery return 2.Wenatchee	1.Hatchery return 2.Entiat	1.MetComp 2.Methow SFH 3.MetComp Cross	1.Wells Dam SFH	1.Winthrop 2.Wenatchee
	water quality monitoring	Temp.& flow rates	Temp.& flow rates	Temp.& flow rates	Temp.& flow rates	Temp.& flow rates
	spawning	Male:female = 1:1 (back up male)	Male:female = 1:1	Male:female = 1:1 (cross by stock 1st priority)	N/A	Male:female = 1:1
	health monitoring	BKD 100% females, virology/bacteriology	BKD 100% females, virology/bacteriology	BKD 100% females, virology/bacteriology	N/A	BKD 100% females, virology/bacteriology
	adult monitoring	Sex/age/length/Tag ID	Sex/age/length/Tag ID	Sex/age/length/Tag ID (prior to spawn)	N/A	Sex/age/length/Tag ID
	adult pre-spawn survival	98%	98%	98%	N/A	98%
Eggs	***green egg target***	2,000,000	500,000	750,000	110,000 eyed eggs received from Wells Dam SFH	320000
	prophylaxis	Disinfect, water harden, formalin treat	Disinfect, water harden, formalin treat	Disinfect, water harden, formalin treat	Performed at Wells SFH	Disinfect, water harden, formalin treat
	incubation units	Heath trays	Heath trays	Heath trays	Heath trays	Heath trays
	water source	Well	Well/Spring	Infiltration galleries	Infiltration galleries	Infiltration galleries
	water quality monitoring	Temp., flow rates, and gases if suspect	Temp., flow rates, and gases if suspect	Temp., flow rates, and gases if suspect	Temp., flow rates, and gases if suspect	Temp., flow rates, and gases if suspect
	culling	By ELISA rank	By ELISA rank	By ELISA rank	N/A	N/A
	shocking	Eggs pooled by rank / take and inventoried	Eggs pooled by rank / take and inventoried	Eggs kept separate by female and inventoried	Performed at Wells SFH	Eggs kept separate by female and inventoried

b) Number of eggs collected and fertilized each year over past 10 years (Table)

- The table below shows the number of eggs taken and survival rates to eye-up and/or ponding from 1988-2000. **(LNFHhgmp, P. 28-29, Table 12)**

Number of eggs taken and survival rates to eye-up and/or ponding from 1988-2000. **(LNFHhgmp, P. 28-29, Table 12)**

Year	Total eggs taken	Survival rate to eye-up
1988	3,811,000	96 %
1989	6,086,752	96 %
1990	5,002,287	96 %
1991	3,027,595	96 %
1992	2,075,629	93 %
1993	1,914,216	97 %
1994	2,361,879	93 %
1995	965,402	96 %
1996	2,060,619	97 %
1997	2,240,533	97 %
1998	2,263,338	97 %
1999	1,892,607	96 %
2000	1,917,429	97 %

- The table below shows Leavenworth NFH spring Chinook adult brood stock management, performance, and spawning practices, and eggs collected, 1994-2005. **(LNFHComplexrpt2005, P. 13, Table 5)**

Leavenworth NFH spring Chinook adult brood stock management, performance, and spawning practices, 1994-2005. **(LNFHComplexrpt2005, P. 13, Table 5)**

Return Year	Hatchery Return	Surplus	Returned to Stream[1]	Jump Outs DIP's	Kept for Propagation			Green, Bad Spent	Used for Production	Pre-spawn Survival[2]	Spawn Ratio		Green Eggs Taken	Average Fecundity
					Males	Jacks	Females				Males	Females		
1994	1,019	32	0	41	462	10	460	7	925	96.0%	1.03	1.00	2,361,879	4,746
1995	462	29	0	16	163	26	197	8	378	96.5%	0.96	1.00	965,402	4,398
1996	1,148	78	0	32	465	48	497	22	988	97.2%	1.02	1.00	2,060,619	4,104
1997	2,839	1,833	0	28	452	7	500	12	947	99.0%	0.92	1.00	2,054,509	4,680
1998	1,541	538	0	66	404	5	495	18	886	95.7%	0.83	1.00	2,263,338	4,614
1999	1,745	740	15	86	383	40	469	12	880	95.1%	0.91	1.00	1,884,538	3,953
2000	4,457	3,428	15	25	437	51	487	14	961	99.4%	1.00	1.00	1,917,429	3,857
2001	6,259	4,875	1,488	32	414	15	430	3	856	99.5%	1.00	1.00	1,814,183	4,306
2002	6,459	5,070	0	35	494	8	484	12	974	99.5%	1.03	1.00	2,098,464	4,182
2003	4,825	3,392	61	184	377	9	447	5	828	96.2%	0.86	1.00	2,360,935	5,268
2004	2,308	924	0	33	453	40	494	3	984	98.6%	1.18	1.00	1,826,216	3,691
2005	2,560	1,830	44	8	331	8	337	5	671	99.7%	1.01	1.00	1,295,015	3,843
AVE	2,969	1,897	135	49	403	22	441	10	857	97.7%	0.98	1.00	1,908,544	4,304
MAX	6,459	5,070	1,488	184	494	51	500	22	988	99.7%	1.18	1.00	2,361,879	5,268
MIN	462	29	0	8	163	5	197	3	378	95.1%	0.83	1.00	965,402	3,691
STDEV	2,050	1,857	426	47	88	18	89	6	175	1.7%	0.09	0.00	415,476	461

[1]MCRFRO records indicate all adults in 1999, 2000, and 986 of the 1,488 in 2001 were passed upstream of the returned to stream component. In 2001, 487 and in 2002-2004, 350 adults were annually live outplanted to Peshastin/Ingalls Creeks.

[2]Pre-spawn survival is the hatchery return minus the # of DIP's/Jumpouts, divided by the hatchery return.

5. Incubation.
   - From fertilization to the eyed stage, eggs are in individual bucket incubators receiving one gallon per minute of ground water.

(LNFHhgmp, P. 23)

- Each female is given a number, which corresponds to an individual incubator and a fish health tissue sample. The ELISA (Enzyme-Linked Immunosorbent Assay) method is used to detect BKD, which takes about 30 days to process. **(LNFHhgmp, P. 28)**
- Egg lots are categorized via the ELISA method, ranging from very high to no detection. Egg lots, depending on their numeric value, are segregated from others. **(LNFHhgmp, P. 28)**
- Throughout the incubation period, eggs are treated daily with 1,667 ppm of formalin for fungus control. **(LNFHhgmp, P. 23)**
- Eyed eggs are physically shocked before egg picking begins. **(LNFHhgmp, P. 28)**
- During the eyed stage, eggs are culled for BKD, mortalities picked and the remaining eggs enumerated. Deep troughs with trays are used for incubation to the buttoned-up stage. **(LNFHhgmp, P. 23)**
- Surplus eggs are taken to allow for the culling of moderate to high risk BKD infected eggs. It is common practice to cull (destroy) eggs that have a very high ELISA rating. We use historical data to determine egg collection levels. The culled eggs are disposed of in an earthen pit on station property. **(LNFHhgmp, P. 23)**
- Eggs are not combined until fish health reports are completed. **(LNFHhgmp, P. 28)**
- Goal is low density incubation, 1,500 eggs per tray, which is well below the IHOT recommendation of 5,000 eggs per single tray. Water flows in the deep troughs is 15 gallons per minute. **(LNFHhgmp, P. 29)**
- Eggs are incubated in pathogen free (well) water. Water temperature is continuously monitored and recorded via a computer. Water temperatures are converted to temperature units for each spawning day. For the Leavenworth SCS stock, it takes about 750 temperature units to reach the eyed stage and 1,700 temperature units to the button-up stage or initial feeding. **(LNFHhgmp, P. 29)**
- Well water passes through a de-gassing media prior to entering the nursery. Water oxygen levels are always near saturation. When cleaning the nursery, the effluent passes through a pollution abatement facility prior to entering Icicle Creek. **(LNFHhgmp, P. 29)**

6. Ponding.

a) Protocols.

- After the eggs hatch and reach the buttoned-up stage, they are moved from the troughs to the starter tanks and feeding commences. **(LNFHhgmp, P. 23)**
- Fry are removed from incubators when they are 99% buttoned-up. After a few days of acclimation and when all fish are on or near the surface, feeding commences. Commonly, newly

buttoned-up fish are 1,250 to 1,350 fish/pound when they are moved to nursery tanks. **(LNFHhgmp, P. 29-30)**

- As density and flow indices increase to a certain point (indices are measured), the fry are moved outside to the raceways. As the juveniles grow, they are periodically "split" into other raceways to reduce densities. Excluding the juveniles moved to the adult ponds, the fish would remain in these raceways until release. **(LNFHhgmp, P. 23)**
  - In an effort to minimize stress, prevent disease, and optimize the aquatic environment rearing parameters target density indexes of ≤0.2, flow index ≤0.6 and raceway turnover at ≤30 minutes. **(LNFHComplexrpt2005, P. 9)**
- The table below provides current Spring Chinook hatchery practices and performance targets for fry-subyearlying life stages for the Leavenworth Complex by hatchery, life stage, and attribute. **(LNFHComplexrpt2005, P. 11, Table 4)**

Spring Chinook production protocols and current practices for the Leavenworth Complex by hatchery, life stage, and attribute. **LNFHComplexrpt2005, P. 11, Table 4)**

Life Stage	Attribute	Leavenworth NFH Chinook	Entiat NFH Chinook	Winthrop NFH Chinook	Winthrop NFH Steelhead	Winthrop NFH Coho
Fry	*% green egg to fry*	≥95%	≥95%	≥95%	≥95%	≥95%
	rearing unit	Starter tanks	8X80 raceways	Starter tanks & Foster-Lucas ponds	Starter troughs & tanks	Starter tanks
	water source	Well	Well	Infiltration galleries	Infiltration galleries	Infiltration galleries
	water quality monitoring	Temp.& flow rates, dissolved gases when needed	Temp.& flow rates, dissolved gases when needed	Temp.& flow rates, dissolved gases when needed	Temp.& flow rates, dissolved gases when needed	Temp.& flow rates, dissolved gases when needed
	feed type	Bio-Starter	Bio-Starter	Bio-Starter	Bio-Starter	Bio-Starter
	feeding frequency	6-8 times/day	4-5 times/day	8 times/day	8 times/day	8 times/day
	feed amount (%BW/Day)	1.0% BW/Day	1.8%BW/Day	2%BW/Day	2%BW/Day	2%BW/Day
	feed application	Hand	Hand	Hand	Hand	Hand
	cleaning frequency	Daily	Every other day	Daily	Daily	Daily
	monitoring	Monthly biometrics	Monthly biometrics	Monthly biometrics	Monthly biometrics	Monthly biometrics
Sub-yearlings	*rearing units*	8X80 raceways	8X80 raceways	8X80's (covered), converted FL's	Foster-Lucas ponds	Converted FL's
	water source	Well/river	Well/spring/re-use	River & infiltration galleries	Infiltration galleries	River & infiltration galleries
	water quality monitoring	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates
	feed	BioMoist-Grower/LowPhos1000	BioMoist-Grower	BioMoist-Grower	BioMoist-Grower	BioMoist-Grower
	feeding frequency	4-6 times/day	1-2 Times per day	4-6 times/day	4-6 times/day	4-6 times/day
	feed amount	1% BW/Day	1.1% BW/Day	1.0% to 1.5% BW/Day	1.0% to 1.5% BW/Day	1.0% to 1.5% BW/Day
	feed application	Hand	Hand	Hand	Hand	Hand
	cleaning frequency	Every other day	Every three days	Every other day	Every day	Every other day
	marking	25%CWT, 100% Adclip, inventory, 15K PIT's	25%CWT, 100% Adclip, inventory, 3K PIT's	100%CWT, Adclip% (varies), inventory, 4.5K PIT's	100% Adclip, inventory	100% CWT, inventory
	monitoring	Monthly fish health & biometrics, CWT retentions	Monthly fish health & biometrics, CWT retentions	Monthly fish health & biometrics, CWT retentions	Monthly fish health & biometrics	Monthly fish health & biometrics, CWT retentions

b) Number of fry ponded each year, including % hatch each year.

- The current green egg target is 2,000,000 eggs with an green egg to fry rate of 98% and an expected ponding of 1.9M fry **LNFHComplexrpt2005, P. 10&11, Table 4)**

7. Rearing/feeding protocols.
   - Bird exclusion devices are used on all rearing units to minimize the spread of disease through bird predation. **(LNFHhgmp, P. 27)**
   - Density index and flow index are the criteria by which standard pond management procedures adhere. These criteria include efforts to remain below a density index of 0.2 and below a flow index of 0.6 while maintaining production goals. **(LNFHhgmp, P. 31)**

- The table below provides Spring Chinook production protocols and current practices for the Leavenworth Complex yearling fish production by hatchery, life stage, and attribute. **(LNFHComplexrpt2005, P. 12, Table 4)**

Spring Chinook production protocols and current practices for the Leavenworth Complex by hatchery, life stage, and attribute**(LNFHComplexrpt2005, P. 12, Table 4)**

Life Stage	Attribute	Leavenworth NFH Chinook	Entiat NFH Chinook	Winthrop NFH Chinook	Winthrop NFH Steelhead	Winthrop NFH Coho
Yearlings	***rearing units***	8X80's, 10X100's (covered), AHP's	8X80's, AHP's	8X80's (covered), converted FL's	Converted FL's	Converted FL's
	water source	River/well/1st pass re-use in emergency situation	Well/spring/re-use	River & Infiltration galleries	River & Infiltration galleries	River & Infiltration galleries
	water quality monitoring	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates	Temp., dissolved gases when needed, & flow rates
	feed	BioMoist-Grower	BioMoist-Grower	BioMoist-Grower	BioMoist-Grower	BioMoist-Grower
	feeding frequency	Daily	Daily	Twice daily	Four times daily	Twice daily
	feed amount (%BW/Day)	1.0% BW/Day	0.6%BW/Day	< 1.0%BW/Day	< 1.0%BW/Day	< 1.0%BW/Day
	feed application	Hand	Hand	Hand	Hand	Hand
	cleaning frequency	1-2 times/ week	Twice per week	Every other day	Every day	Every other day
	monitoring	Monthly fish health & biometrics	Monthly fish health & biometrics	Monthly fish health & biometrics	Monthly fish health & biometrics	Monthly fish health & biometrics
	rearing parameters	Temp $\leq 60^0$F	Temp $\leq 49^0$F	Temp $\leq 60^0$F	Temp $\leq 60^0$F	Temp $\leq 60^0$F
		$d0_2$ >6 ppm	$d0_2$ >6 ppm	$d0_2$ >6 ppm	$d0_2$ >6 ppm	$d0_2$ >6 ppm
		Turnover rate$\leq$ 30 min	Turnover rate$\leq$ 30 min	Turnover rate$\leq$ 30 min	Turnover rate$\leq$ 30 min	Turnover rate$\leq$ 30 min
		Density index $\leq$ 0.20	Density index $\leq$ 0.09	Density index $\leq$ 0.11	Density index $\leq$ 0.20	Density index $\leq$ 0.15
		Flow index $\leq$ 0.60	Flow index $\leq$ 0.66	Flow index $\leq$ 0.50	Flow index $\leq$ 1.00	Flow index $\leq$ 1.00
	condition factor	3.90E-04	3.50E-04	3.50E-04	3.50E-04	3.50E-04
	size	16-20 fpp	16-18 fpp	15-18 fpp	5-7 fpp	15-18 fpp
	release type	forced	forced	forced	forced & volitional	forced
	release time	3rd week of April	mid-April	mid-April	mid-April	mid-April
	release goal	1,625,000	400,000	600,000	100,000	250,000
	fry to smolt survival	$\geq$95%	$\geq$95%	$\geq$ 95%	$\geq$ 95%	$\geq$ 95%
	smolt to adult survival	0.35%-0.40%	0.27%-0.30%	0.23%-0.27%	0.5%-2.5%	0.15%

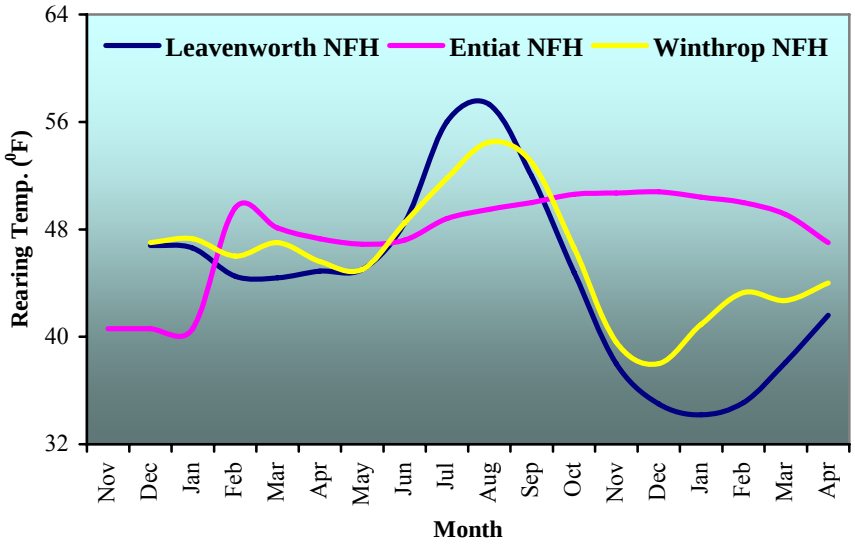
8. Fish growth profiles.
    - The table below provides monthly culture and performance averages for brood years 1997-1998 Leavenworth NFH juvenile spring Chinook. **(LNFHComplexrpt2005, P. 17)**

Leavenworth NFH juvenile spring Chinook monthly culture and performance averages for brood years 1997-1998. **(LNFHComplexrpt2005, P. 17)**

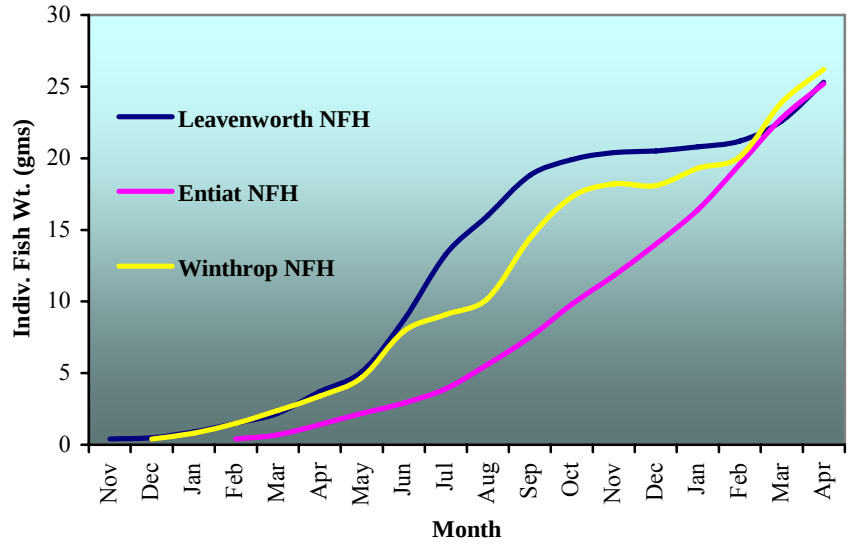
Month	Life Stage	Ave Size (#/lb)	Ave Size (gms)	Length Ave (in)	Length Ave (mm)	Condition Factor (C = lbs /in)	Feed Fed Per Day (lbs.)	Feeding Rate %BW/day[1]	Food Conversion (lbs. Fed/lb. Gain)	Comments
August		NA	NA	NA	NA	NA	NA	NA	NA	Eggs collected from broodstock
September	Egg	NA	NA	NA	NA	NA	NA	NA	NA	Fertilzed and placed in Heath stacks
October		NA	NA	NA	NA	NA	NA	NA	NA	Eyed at 750 Temperature Units (TU's)
November	Alevin	1,200.0	0.4	1.3	33	3.97E-04	NA	NA	NA	Shocked and picked, hatch @ 1,040 TU's
December		906.9	0.5	1.4	36	3.93E-04	19	1.00%	NA	Fry ponded in 91ft^3 nursery tanks
January	Fry	526.9	0.9	1.7	43	4.00E-04	22	0.68%	1.36	(~15K per tank) and on feed @ 2,067 TU's.
February		311.2	1.5	2.0	51	3.96E-04	70	1.28%	1.39	End of February ~55K per raceway placed
March		210.3	2.2	2.3	58	3.96E-04	115	1.42%	1.39	in 8'X80' raceways.
April		123.3	3.7	2.7	69	3.98E-04	129	0.94%	1.37	
May		89.5	5.1	3.0	77	3.98E-04	291	1.54%	1.39	Coded-wire tagging and adipose clipping,
June	Sub-yearling	52.5	8.7	3.6	92	3.99E-04	249	0.78%	1.36	fish split during marking into (45) 8'X80' rcwys,
July		34.1	13.3	4.2	107	3.96E-04	680	1.38%	1.39	and (14) 10'X100' rcwys.
August		28.3	16.0	4.5	113	3.98E-04	858	1.46%	1.37	
September		24.1	18.8	4.7	120	3.97E-04	456	0.66%	1.35	
October		22.8	19.9	4.8	122	3.96E-04	469	0.65%	1.35	After broodstock are removed a
November		22.3	20.4	4.8	123	3.98E-04	170	0.23%	1.40	portion of the fish in 8'X80's are moved to
December		22.1	20.5	4.9	123	3.97E-04	78	0.10%	1.52	two adult holding ponds (150' X 15'X 4'deep).
January	Yearling	21.8	20.8	4.9	124	3.97E-04	28	0.04%	3.45	
February		21.4	21.2	4.9	124	3.96E-04	54	0.07%	2.12	
March		20.1	22.6	5.0	127	3.96E-04	227	0.28%	6.86	
April		18.0	25.3	5.2	132	3.98E-04	427	0.47%	2.57	Release window is late April. Forced release.

[1]Factor utilized to determine feed aplication rates calculated as the % of body weight(BW) in total mass divided by total pounds fed.

- As with most hatcheries the quantity and quality of the water source is the primary factor determining the structure and operation of each fish culture facility. Within the many characteristics of water no other single factor affects the development and growth of fish as much as water temperature (Piper et. Al, 1982). As previously mentioned, each Leavenworth Complex facility is unique in the use of water to culture spring Chinook. The figures below provide examples of the types of rearing temperature profiles (Figure 3) and subsequent fish growth (Figure 4) resulting from primarily river water use at Leavenworth NFH, to a mix of infiltration gallery/well water at Winthrop NFH, to strict well/re-use water at Entiat NFH. **(LNFHComplexrpt2005, P. 22)**



An example of spring Chinook rearing temperature (^{0}F) profiles for Leavenworth (brood years 1997-98 average), Entiat (brood years 2001-03 average), and Winthrop (brood year 2002) NFH's. **(LNFHComplexrpt2005, P. 22, Figure 3)**



An example of juvenile spring Chinook growth (gms) profiles for Leavenworth (brood years 1997-98 average), Entiat (brood years 2001-03 average), and Winthrop (brood year 2002) NFH's. **(LNFHComplexrpt2005, P. 22, Figure 4)**

9. Fish health.
    - Fish health services are provided by staff from the USFW Services Olympia Fish Health Center (OFHC) which is a full service aquatic health facility capable of monitoring, diagnostic, and certification procedures that meet or exceed all national, international, IHOT or co-manager requirements. **(LNFHhgmp, P. 26)**

- Disease monitoring is accomplished through daily observations by hatchery staff and monthly monitoring by fish health biologists/pathologists from the OFHC. **(LNFHhgmp, P. 30)**
- Pathogen and disease monitoring start with adult testing of captured populations for all reportable aquatic viruses and bacteria at the minimum assumed pathogen prevalence level of 5% (i.e. 60 individuals). For the past 10 years, the actual sampling has been a minimum of 210 adults (60 males and 150 females) for these pathogens. In addition, all females spawned are specifically and individually tested for *Renibacterium salmoninarum*, the causative agent of BKD. This is essential to determine the pathogen levels and eliminate or segregate the resulting eggs from different risk levels. This process greatly reduces the likelihood of transmitting the disease from infected females to progeny. All eggs and accompanying containers are disinfected with iodine solution during the water hardening process following fertilization. **(LNFHhgmp, P. 26-27)**
- Juveniles are monitored throughout the rearing period by monthly visits by fish health biologists for routine purposes. More frequent diagnostics are performed if hatchery staff notices undue mortality or morbidity. Disease outbreaks are prevented or treated by legal application of appropriate chemicals or by modification of rearing parameters. During the rearing period, fish culture equipment is rinsed in disinfectant following use in each pond. Bird exclusion devices are used on all rearing units to minimize the spread of disease through bird predation. At the end of the rearing period, all production lots are again tested for reportable pathogens at the minimum assumed prevalence level of 5% prior to release. **(LNFHhgmp, P. 27)**
- In recent years, there has not been any significant loss of production fish at LNFH. Although not considered significant, the occasional disease out-break will heighten mortality. **(LNFHhgmp, P. 24)**

10. Chemotherapeutant use.
    - Administration of therapeutic drugs and chemicals to fish and eggs reared at Leavenworth NFH is performed only when necessary to effectively prevent, control, or treat disease conditions. All treatments will be administered in compliance with FDA and EPA regulations and agreements for the use of aquatic animal drugs and chemicals. **(LNFHchmp, P. 46)**
    - All females are injected with Erythromycin prior to spawning. **(LNFHhgmp, P. 27)**
    - Erythromycin injections for spring Chinook salmon female brood stock are critical to the control of bacterial kidney disease which is caused by a vertically transmitted bacterium (*R. salmoninarum*). **(LNFHchmp, P. 46)**
    - Prior to the administration of erythromycin, surplus adults may be outplanted to nearby streams and/or made available to appropriate groups. Except for fish arriving too close to the time of spawning for safe handling, all spring Chinook salmon females kept for broodstock

at Leavenworth NFH will be injected with erythromycin once, generally in mid-July. **(LNFHchmp, P. 46)**

- Formalin (167 ppm for 1 hour) treatment is administered to holding ponds and antibiotic treatment of female brood is administered one to two times prior to spawning to combat vertical transmission of bacterial kidney disease (BKD). **(LNFHComplexrpt2005, P. 8)**

11. Tagging and marking of juveniles.
    - In June, fingerlings are marked, tagged, inventoried and split to additional ponds. MCRFRO evaluates CWT retention rates a minimum of 30 days post tag and at a rate of 500 individuals checked per tag code. **(LNFHComplexrpt2005, P. 9)**
    - A significant change occurred in this program beginning with brood year 2000 compared to the previous 1994-1999 period. **(LNFHComplexrpt2005, P. 31)**
    - Since this time release size has decreased 15%, **(LNFHComplexrpt2005, P. 31)**
    - the coded-wire tagging has increased from 17% to 50%, **(LNFHComplexrpt2005, P. 31)**
    - and the percent of adipose clipped juveniles has increased from 17% to 100%. **(LNFHComplexrpt2005, P. 31)**
    - Additionally, brood years 2000-2002 were part of a lower Columbia River transportation study which increased the portion of PIT tags from ~5,000 to 260,000 (Table 21). PIT tagging in recent years (2005 @~15K) is being conducted by the Fish Passage Center. **(LNFHComplexrpt2005, P. 31)**
    - The table below shows Leavenworth NFH yearling spring Chinook releases and tag/mark status for brood years 1994-2003. **(LNFHComplexrpt2005, P. 27,Table 21).**

Leavenworth NFH yearling spring Chinook releases for brood years 1994-2003. **(LNFHComplexrpt2005, P. 27,Table 22).**

Brood Year	Release Year	Release Date	Yearlings Released	Release Size (#/LB)	# CWT Tagged	% CWT Tagged	% Adipose Clipped	# PIT Tagged	% PIT Tagged
1994	1996	15-Apr	1,706,060	16.1	287,288	17%	17%	1,196	0.1%
1995	1997	17-Apr	919,025	18.3	299,190	33%	33%	1,198	0.1%
1996	1998	20-Apr	1,701,753	16.1	301,044	18%	18%	7,468	0.4%
1997	1999	19-Apr	1,636,402	17.3	187,841	11%	11%	7,404	0.5%
1998	2000	18-Apr	1,680,904	18.0	193,411	12%	12%	7,387	0.4%
1999	2001	17-Apr	1,630,089	16.8	242,732	15%	15%	7,592	0.5%
2000	2002	22-Apr	1,554,362	22.5	444,493	29%	100%	317,278	20.4%
2001	2003	21-Apr	1,288,893	16.3	771,756	60%	100%	240,558	18.7%
2002	2004	19-Apr	1,422,100	20.3	822,002	58%	100%	216,698	15.2%
2003	2005	15-Apr	1,476,046	19.9	782,602	53%	100%	14,825	1.0%
AVE		18-Apr	1,501,563	18.2	433,236	30%	50%	82,160	5.7%
MAX		22-Apr	1,706,060	22.5	822,002	60%	100%	317,278	20.4%
MIN		15-Apr	919,025	16.1	187,841	11%	11%	1,196	0.1%
STDEV		2.4	245,649	2.1	257,917	20%	43%	124,022	8.6%

12. Fish Release.

a) Protocols.

- Prepawning adults transferred to Peshastin Creek, travel via a fish hauling truck supplied by the Yakama Nation. The 1,000 gallon capacity tank is baffled in the center, has four air-stones run by compressed air, two circulation pumps, and is double insulated. No other live fish are moved off station. Adults exit the tank via a 10 to 12 inch diameter flexible pipe, directly into the receiving waters. **(LNFHhgmp, P. 24)**
- Yearlings (smolts) are forced released directly from the raceways. A drain plug is removed, and the smolts travel through an underground pipe system, which empties at the base of the collection ladder into Icicle Creek. The juveniles holding in the adult ponds are forced out through a large flexible drainpipe, which empties into the pool (Icicle Creek) below the hatchery. **(LNFHhgmp, P. 24)**
- Smolts are mass released directly into Icicle Creek at a size of 18 fish/pound to minimize interactions with other fish populations. There are no native spring Chinook stocks in Icicle Creek. Some hatchery spring Chinook spawn in Icicle Creek annually and ESA listed steelhead also utilize Icicle Creek for spawning and rearing. Releasing fish at 18 fish/pound or larger helps ensure that the released fish are functional smolts which actively migrate through Icicle Creek and the Wenatchee River corridor. **(LNFHchmp, P. 44)**

- Smolts are released around the third week of April to coincide with normal spring migration and spill at Columbia River dams. It is likely that the fish are functional or near functional smolts at this time as evidence by their rapid migration to the Rock Island smolt trap (personal communications with Chelan PUD fish biologists). **(LNFHchmp, P. 44)**

b) Number of fish released each year (subyearlings?; yearlings?; other?)

- Prespawning adult fish are scheduled for release into Peshastin and Ingalls creeks release in June – July (n=500). Release point is rm 7.2 and 3.8 (Peshastin Cr.), rm 1.0 on Ingalls Cr. **(LNFHhgmp, P. 34)**
- Yearling Icicle Creek release is scheduled for mid-April at 15-18 fpp (n=1.625M). Release point is rm2.7. **(LNFHhgmp, P. 34)**
- Yearling releases have ranged from 919K to 1,716K between 1996-2005. **(See Table 21, LNFHComplexrpt2005, P. 31).**

D. Program benefits and performance.

1. Adult returns.

a) Numbers of adult returns (need data for the past 10-20 years).

- Leavenworth Complex adult spring Chinook returns to the Wenatchee Basin have varied considerably over the past twenty-six years (1980-2005, Figure 8 & Table 25). Annually Leavenworth NFH has averaged 5,649 (SD = 4,034, +/- 71% of average) returning adults to the Wenatchee River Basin and was unable to achieve a minimum broodstock goal of 1,000 adults in only one of twenty-six years (1995 or 1/26 years = 4%). **(LNFHComplexrpt2005, P. 37)**
- The table below shows Leavenworth Complex adult spring Chinook returns to release basin, 1980-2005. **(LNFHComplexrpt2005, P. 38, Table 25)**

Leavenworth Complex adult spring Chinook returns to release basin, 1980-2005. **(LNFHComplexrpt2005, P. 38, Table 25)**

Year	Leavenworth NFH	Entiat NFH	Winthrop NFH	Complex Total
1980	2,452	305	155	2,912
1981	2,420	247	399	3,066
1982	2,814	247	601	3,662
1983	3,090	672	755	4,517
1984	4,189	808	900	5,897
1985	7,714	912	1,201	9,827
1986	8,451	969	836	10,256
1987	6,905	913	594	8,412
1988	6,277	689	1,327	8,293
1989	5,134	669	195	5,998
1990	4,373	583	121	5,077
1991	3,858	437	92	4,387
1992	11,117	520	332	11,969
1993	13,862	730	646	15,238
1994	1,124	80	29	1,233
1995	484	121	14	619
1996	1,327	175	80	1,582
1997	4,533	275	144	4,952
1998	2,158	216	178	2,552
1999	2,073	724	118	2,915
2000	9,464	1,919	947	12,330
2001	15,082	2,666	3,695	21,443
2002	12,281	1,834	2,249	16,364
2003	8,161	884	515	9,560
2004	3,732	759	573	5,064
2005	3,793	884	464	5,141

Summary Data for 1980 - 2005				
AVE	5,649	740	660	7,049
MAX	15,082	2,666	3,695	21,443
MIN	484	80	14	619
STDEV	4,034	598	798	5,136
By %	80%	10%	9%	100%

Summary Data for 1980 - 1993				
AVE	5,904	622	582	7,108
MAX	13,862	969	1,327	15,238
MIN	2,420	247	92	2,912
STDEV	3,431	244	394	3,689
By %	83%	9%	8%	100%

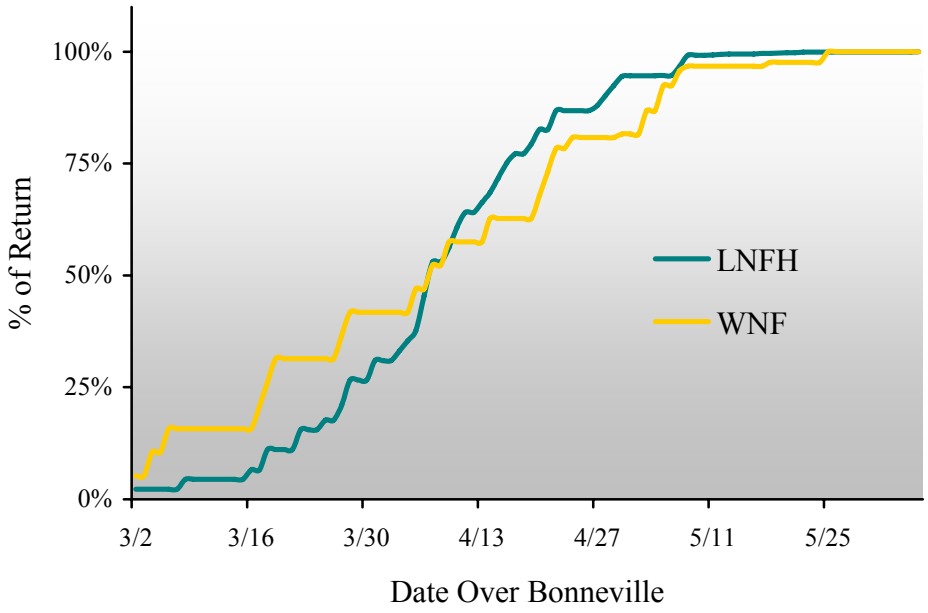
Summary Data for 1994 - 2005				
AVE	5,351	878	751	6,980
MAX	15,082	2,666	3,695	21,443
MIN	484	80	14	619
STDEV	4,786	839	1,117	6,623
By %	77%	13%	11%	100%

b) Return timing and age-class structure of adults.

- Little data is currently available to address adult return run timing. Historically, notes were kept by hatchery personnel to document the number of adults estimated by week in the holding ponds. Additionally, a mechanical lever was used at Leavenworth NFH to estimate the in ladder return (Cooper et.

al., 2002). Recently, PIT tags in returning adults combined with improved dam ladder detection systems have produced some data regarding the run timing characteristics of the adult return. Figure 9 describes the 2003 adult PIT-tag expanded ((# juveniles released/# PIT tags (by BY)*each PIT detected adult)) spring Chinook return over Bonneville Dam for Leavenworth and Winthrop NFH. From this data approximately, half the run was over Bonneville by April 7th for both hatcheries. **(LNFHComplexrpt2005, P. 35)**

Comparison of run timing between Leavenworth and Winthrop NFH adult pit-tagged spring Chinook over Bonneville Dam, 2003 **(LNFHComplexrpt2005, P. 35, Figure 9)**



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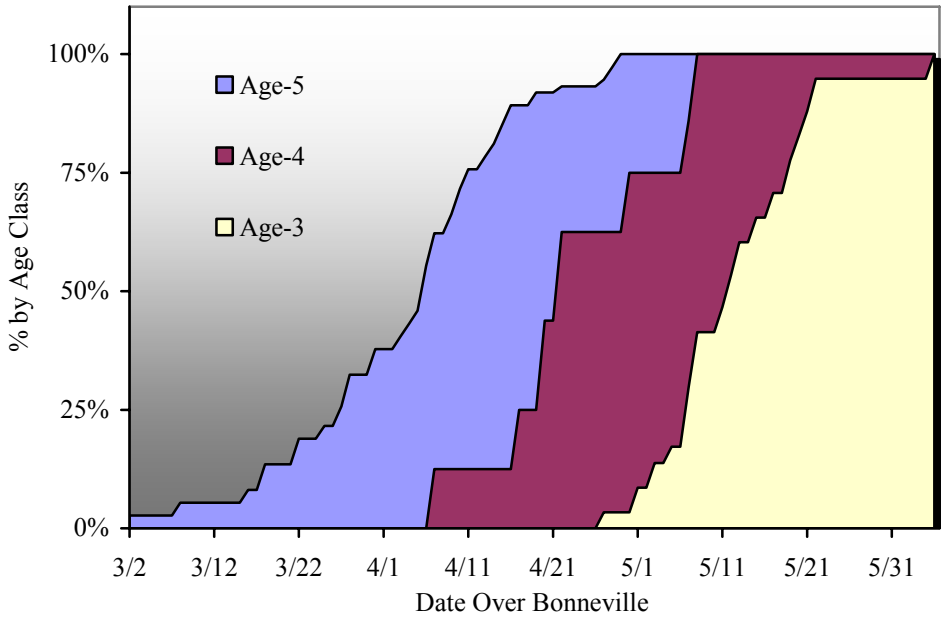
- The 2003, Leavenworth NFH return timing to Bonneville by age class is shown in figure 10. Age 5's, 4's, and 3's reached half of their age class return over Bonneville by April 6th, April 22nd, and May 12th, respectively. It took age 5's, 4's and 3's on average, 47, 35, and 21 days, respectively, to travel between Bonneville and Wells Dams for Winthrop NFH adults (not shown). **(LNFHComplexrpt2005, P. 35)**

Comparisons of age-class run timing over Bonneville Dam for Leavenworth NFH adult pit-tagged spring Chinook, 2003**.** **(LNFHComplexrpt2005, P. 36, Figure 10)**



- The majority of Leavenworth Complex adults return as age-4 adults (~65-88% on average, either by return or brood year). **(LNFHComplexrpt2005, P. 35)**

Leavenworth Complex spring Chinook age composition of adults by **return year** for each facility, 1994-2005. **(LNFHComplexrpt2005, P. 51, Table 31)**

Return	Leavenworth NFH			Entiat NFH			Winthrop NFH		
Year	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5
1994	2.4%	7.8%	89.6%	6.5%	33.9%	59.7%	3.0%	0.0%	97.0%
1995	13.1%	75.4%	10.9%	2.8%	94.4%	2.8%	14.0%	64.0%	22.0%
1996	9.9%	84.6%	5.5%	5.6%	91.2%	3.2%	9.0%	86.0%	5.0%
1997	0.5%	91.5%	7.9%	1.2%	90.1%	8.7%	0.5%	96.1%	3.4%
1998	0.9%	40.7%	58.4%	7.5%	73.6%	19.0%	0.0%	39.4%	60.6%
1999	14.8%	63.0%	22.2%	5.2%	88.4%	6.4%	53.0%	41.0%	6.0%
2000	3.5%	94.4%	2.1%	3.8%	94.5%	1.6%	7.8%	91.8%	0.4%
2001	1.7%	89.4%	8.9%	4.3%	92.0%	3.7%	4.2%	94.0%	1.8%
2002	0.7%	86.1%	13.2%	0.9%	91.4%	7.7%	0.7%	91.5%	7.8%
2003	3.1%	17.2%	79.7%	5.3%	61.9%	32.6%	12.0%	10.2%	77.8%
2004	9.6%	82.3%	8.1%	2.2%	95.7%	2.0%	11.4%	85.8%	2.8%
2005	2.4%	91.9%	5.6%	6.1%	91.2%	2.8%	14.2%	82.5%	3.3%
AVE	5.2%	68.7%	26.0%	4.3%	83.2%	12.5%	10.8%	65.2%	24.0%
MAX	14.8%	94.4%	89.6%	7.5%	95.7%	59.7%	53.0%	96.1%	97.0%
MIN	0.5%	7.8%	2.1%	0.9%	33.9%	1.6%	0.0%	0.0%	0.4%
STDEV	5.1%	30.3%	31.2%	2.1%	18.4%	17.4%	14.3%	34.2%	34.2%

Data describes the total age composition of yearling releases only and excludes were possible contributions by other hatcheries to the return (ie. MSFH recovered at WNFH). In recent years the age composition displayed for WNFH has been influenced by selective spawning to minimize the "Carson" lineage. Age-6 fish comprised 0.1% - 0.6% of the return in 1994, 1995 and 1997 & one age-7 fish was noted in 2005 @ LNFH. Only one age-6 fish was observed @ ENFH. No age-6 fish or older were observed @ WNFH.

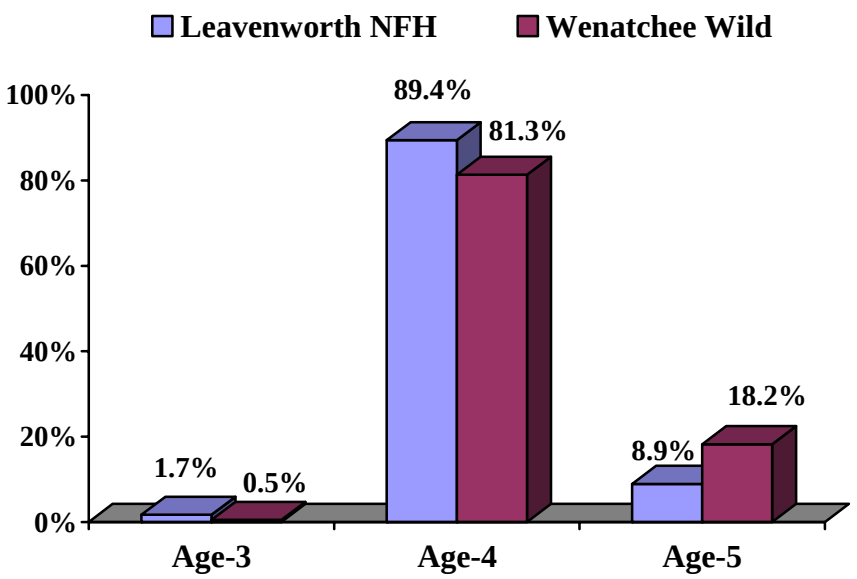
Leavenworth Complex spring Chinook age composition of adults by brood year for each facility, 1989-2000. **(LNFHComplexrpt2005, P. 52, Table 32)**

Brood Year	Leavenworth NFH			Entiat NFH			Winthrop NFH		
	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5
1989	1.7%	43.9%	54.1%	2.2%	88.8%	9.0%	2.0%	87.0%	11.0%
1990	0.0%	45.8%	54.2%	0.0%	91.3%	8.7%	0.0%	0.0%	100.0%
1991	3.0%	80.6%	16.1%	5.3%	89.3%	5.3%	4.8%	42.9%	52.4%
1992	4.9%	87.0%	8.1%	1.5%	87.0%	11.5%	1.1%	94.6%	4.3%
1993	7.1%	64.9%	28.0%	3.6%	79.5%	16.9%	5.2%	63.6%	31.2%
1994	1.1%	58.9%	40.0%	1.1%	73.6%	25.3%	1.3%	89.9%	8.9%
1995	1.1%	93.7%	5.3%	2.0%	95.6%	2.4%	5.7%	90.6%	3.8%
1996	7.7%	83.6%	8.7%	3.8%	91.9%	4.2%	8.2%	85.8%	6.0%
1997	3.0%	84.2%	12.8%	3.2%	90.9%	5.7%	2.2%	93.3%	4.5%
1998	1.1%	57.2%	41.7%	4.9%	78.2%	16.9%	6.2%	78.7%	15.1%
1999	3.6%	70.4%	26.1%	2.2%	94.7%	3.1%	19.0%	61.9%	19.0%
2000	4.3%	89.0%	6.7%	5.1%	92.9%	2.0%	10.7%	86.7%	2.6%
AVE	3.2%	71.6%	25.1%	2.9%	87.8%	9.3%	5.5%	72.9%	21.6%
MAX	7.7%	93.7%	54.2%	5.3%	95.6%	25.3%	19.0%	94.6%	100.0%
MIN	0.0%	43.9%	5.3%	0.0%	73.6%	2.0%	0.0%	0.0%	2.6%
STDEV	2.4%	17.2%	18.4%	1.7%	7.0%	7.2%	5.3%	27.8%	28.6%

Data describes the total age composition by brood year of yearling releases and attempts were possible to exclude contributions by other releases (subyearlings/fry) and hatcheries to the return (ie. MSFH recovered at WNFH). In recent years the age composition displayed for WNFH has been influenced by selective spawning to minimize the "Carson" lineage. Age-6 fish comprised 0.3% of the return in brood years 1989 and 1991 & one age-7 fish was noted in brood year 1998 @ LNFH. Only one age-6 fish from brood year 1997 was observed @ ENFH. No age-6 fish or older were observed @ WNFH.

- Similar to gender few comparisons between Leavenworth Complex hatchery and wild adults have been conducted for age-class composition. As with the gender comparisons, we data was utilized from the 2001 recovered "wild" carcasses collected on the spawning grounds on the Wenatchee (Tonseth, 2003) and Entiat River (Hamstreet & Carie, 2002) to provide age-class proportions from which to compare against the hatchery sampled Leavenworth (Figure 21) NFH returns. It is cautioned that hatchery return and spawning ground recovery data may be biased by collection method. **(LNFHComplexrpt2005, P. 53)**

Age comparison of Leavenworth NFH vs. Wenatchee River wild spring Chinook, 2001. **(LNFHComplexrpt2005, P. 53, Figure 21)**



c) Smolt-to-adult return rates.

- The table below shows the number of yearling spring Chinook released from Leavenworth NFH, 1983 to 1994. Also listed is the number of returning adults and their survival rate. **(LNFHhgmp, P. 7-8, Table 2)**

Number of yearling spring Chinook released from Leavenworth NFH and number of returning adults and their survival rate**(LNFHhgmp, P. 7-8, Table 2)**

Broodye	Yearlings releas	Adult returns (B	Smolt to adult survival (%
1983	2,190,000	6,737	0.308
1984	1,969,668	3,723	0.189
1985	2,336,868	5,496	0.235
1986	2,207,294	3,865	0.175
1987	2,239,677	6,427	0.287
1988	2,304,237	15,100	0.655
1989	2,258,034	7,435	0.329
1990	2,286,828	203	0.009
1991	1,757,931	564	0.032
1992	1,522,846	1,569	0.103
1993	1,712,648	5,456	0.319
1994	1,706,060	1,299	0.076

d) Stock productivity (e.g. recruits per spawner).

- The table below describes spring Chinook brood year survival (%) and recruits per spawned adult (RPS) for each Leavenworth Complex facility by release basin and total return. For the brood year period of 1990-1999 the total smolt-adult return has averaged 0.404%, 0.302%, and 0.267% for Leavenworth, Entiat, and Winthrop NFH's, respectively. Total recruits per spawned

adult (RPS) has averaged 7.2, 5.5, and 4.8 for Leavenworth, Entiat, and Winthrop NFH's, respectively. Often the number of spawners to produce a given brood has been estimated during years of hatchery transfers, extensive disease related culling of gametes or the planting of eggs/fry. Additionally, smolt-adult return and RPS by release basin has followed a similar pattern by facility with an approximated decrease of 0.04% survival (0.035%-0.056%) and 0.8 RPS (0.6-1.0) from total returns. **(LNFHComplexrpt2005, P. 45, Table 28)**

- All facilities have exhibited upward survival trends peaking in brood year 1997 for Entiat/Winthrop NFH's and 1998 for Leavenworth NFH. Brood year 1999 exhibited a drastic decrease over the previous trend. Potentially this drop in survival at all facilities is attributable to the poor outmigration conditions experienced in 2001 when spill at Columbia River hydro-projects was curtailed under a basin wide drought emergency. **(LNFHComplexrpt2005, P. 45, Table 28)**

Leavenworth Complex spring Chinook brood year survival and recruits per spawned adult, brood years 1990-1999. **(LNFHComplexrpt2005, P. 45, Table 28)**

Brood Year	LEAVENWORTH NFH				ENTIAT NFH				WINTHROP NFH			
	WENATCHEE		TOTAL RETURN		ENTIAT		TOTAL RETURN		METHOW		TOTAL RETURN	
	%	RPS	%	RPS	%	RPS	%	RPS	%	RPS	%	RPS
1990	0.009%	0.1	0.010%	0.1	0.009%	0.2	0.009%	0.2	0.000%	0.0	0.002%	0.0
1991	0.026%	0.3	0.027%	0.3	0.031%	0.6	0.034%	0.6	0.002%	0.0	0.002%	0.0
1992	0.103%	1.6	0.108%	1.7	0.038%	0.7	0.048%	0.9	0.033%	0.6	0.036%	0.7
1993	0.317%	5.3	0.327%	5.5	0.054%	1.0	0.062%	1.1	0.045%	0.8	0.048%	0.9
1994	0.077%	1.4	0.080%	1.5	0.063%	1.1	0.072%	1.3	0.070%	1.3	0.071%	1.3
1995	0.155%	3.5	0.161%	3.6	0.343%	5.9	0.367%	6.3	0.363%	6.5	0.376%	6.8
1996	0.615%	10.4	0.650%	11.0	0.563%	11.6	0.609%	12.5	0.358%	6.4	0.376%	6.8
1997	0.978%	16.7	1.201%	20.5	0.783%	14.1	0.889%	16.0	0.714%	12.9	0.846%	15.2
1998	1.070%	19.9	1.309%	24.3	0.560%	9.6	0.699%	12.0	0.691%	12.4	0.859%	15.5
1999	0.130%	2.4	0.168%	3.1	0.202%	3.6	0.234%	4.2	0.048%	0.9	0.057%	1.0
AVE	0.348%	6.2	0.404%	7.2	0.265%	4.8	0.302%	5.5	0.232%	4.2	0.267%	4.8
MAX	1.070%	19.9	1.309%	24.3	0.783%	14.1	0.889%	16.0	0.714%	12.9	0.859%	15.5
MIN	0.009%	0.1	0.010%	0.1	0.009%	0.2	0.009%	0.2	0.000%	0.0	0.002%	0.0
STDEV	0.398%	7.1	0.486%	8.7	0.281%	5.2	0.323%	5.9	0.282%	5.1	0.339%	6.1

*All adult return information includes all adults age-3 or older recovered throughout the Pacific Northwest (Total Return) and by release basin.

RPS = recruit per spawner ratios.

2. Contributions to harvest and utilization (e.g. food banks).
   - Leavenworth NFH is the dominant contributor of spring Chinook to the Wenatchee Basin. **(LNFHComplexrpt2005, P. 46)**
   - The table below provides cumulative summary of returning adult spring Chinook deposition for the Leavenworth Complex, 1999-2003. **(LNFHComplexrpt2005, P. 44, Table 26)**

Cumulative summary of returning adult spring Chinook deposition for the Leavenworth Complex, 1999-2003. **(LNFHComplexrpt2005, P. 44, Table 26)**

Recovery / Fishery Location	Leavenworth NFH		Entiat NFH		Winthrop NFH	
	#	%	#	%	#	%
Hatchery Brood	6,323	11.2%	1,973	20.9%	2,498	26.8%
Hatchery Donated Surplus	17,505	30.9%	6,174	65.3%	0	0.0%
Treaty Ceremonial	14,526	25.6%	78	0.8%	40	0.4%
Freshwater Sport	6,262	11.0%	9	0.1%	19	0.2%
Columbia River Gill Net	4,175	7.4%	512	5.4%	651	7.0%
Spawning Ground	4,053	7.1%	211	2.2%	5,426	58.2%
Columbia River Sport	3,686	6.5%	469	5.0%	659	7.1%
Test Fishery Net	0	0.0%	0	0.0%	1	0.0%
Freshwater Net	0	0.0%	2	0.0%	4	0.0%
Estuary Sport	0	0.0%	1	0.0%	0	0.0%
Ocean Troll	148	0.3%	19	0.2%	18	0.2%
Ocean Trawl	9	0.0%	0	0.0%	0	0.0%
Commercial Seine	0	0.0%	4	0.0%	0	0.0%
Above Rock Island	48,122	84.9%	8,464	89.5%	7,921	85.0%
Grand Total	56,685	100.0%	9,452	100.0%	9,316	100.0%

- For Leavenworth NFH the greatest single contribution of adults is through hatchery surpluses (Table 26) which are donated primarily to area tribes. **(LNFHComplexrpt2005, P. 46)**
    - **Harvest Contribution:** Spring Chinook salmon from Leavenworth NFH have, over the years, supported successful sport and tribal fisheries in the Wenatchee River and Icicle Creek, and to a lesser extent, the Columbia River. Due to the ESA listed stocks in the Wenatchee Basin above Icicle Creek, this fishery is now limited to the Icicle only. For example, in 2002, the sport catch in Icicle Creek was 1,201, with tribal harvest at 3,793, and 6,458 returned to the hatchery (WDFW 2002b). In 2003, WDFW estimated that 4,016 anglers fished a total of 29,133 hours (WDFW 2003). **LNFHchmp, P. 30)**
    - **Economic Benefit:**No specific analysis of the economic benefits of the hatchery and its fish production to the local economy has been done, but it is likely variable depending on the strength of the salmon return. When attempting to estimate the benefits of an anadromous fish hatchery, environmental conditions outside the hatchery are cyclic and beyond the control of hatchery administrators (e.g. ocean conditions and water releases from the dams). This environmental variability can subsequently affect post-release survival of juveniles and number of adult returns. During times of good ocean and river conditions that result in healthy adult returns, significant economic activity is generated through harvest of Leavenworth NFH spring Chinook salmon. For example, in 2002, WDFW estimated that 3,811 anglers fished 17,150 hours in Icicle Creek as a direct result of

Leavenworth NFH adult spring Chinook salmon. **LNFHchmp, P. 31)**

- **Cultural Values:** The Yakama Nation shares the in-river harvest of spring Chinook salmon returning to Leavenworth NFH and is also a beneficiary of surplus spring Chinook salmon which have entered the hatchery holding ponds. **LNFHchmp, P. 31)**
- Other tribes benefiting from surplus adults are the Colville Confederated Tribes, Spokane Tribe, Kalispel Tribe, and the Snoqualmie Tribe, along with a portion going to the local chapter of Trout Unlimited (TU). TU uses the proceeds from these fish for habitat improvement projects. **LNFHchmp, P. 32)**

3. Contributions to conservation

   ?

4. Other benefits.

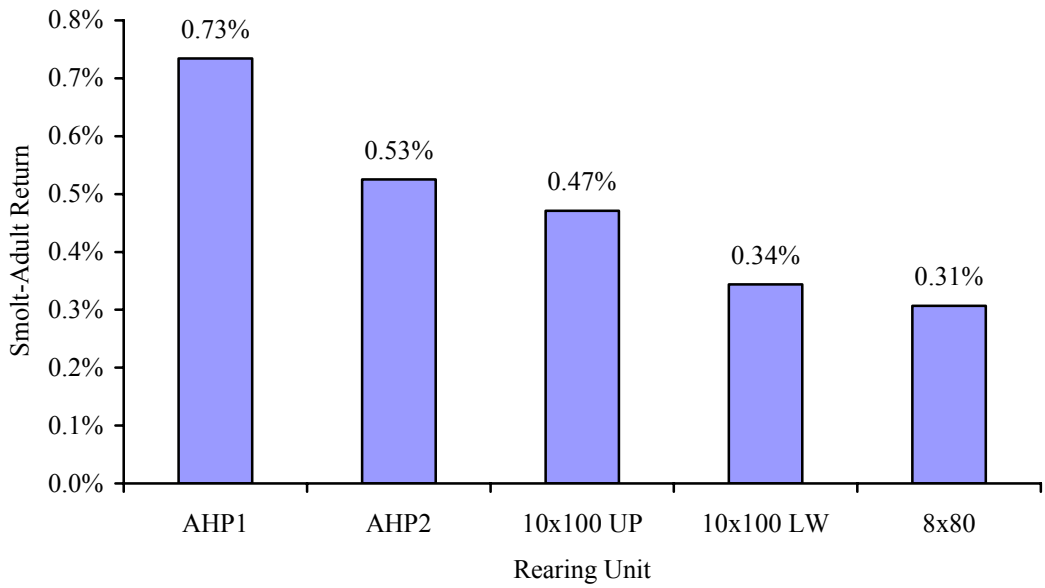
   ?

E. Research, monitoring, and evaluation programs.

- Detection of PIT tagged fish at McNary and Bonneville Dam's bypass facilities provides evidence of rapid movement of smolts released from Leavenworth NFH. The average travel time from release to McNary Dam, for release years 1998 – 2003, is 27.2 days, with a minimum travel time of 20 days in 1998 to a maximum time of 35 days in 2001. McNary Dam is approximately 204 miles from Leavenworth NFH. The average survival from release to McNary Dam is 57.1% with a minimum survival of 50% in 2001 to a high of 64% in 2003 (SURPH database, 2004). **(LNFHchmp, P. 44)**
- For the period of 2002-2005, the average passage date over McNary Dam has remained fairly consistent for all three hatcheries, with Entiat NFH generally arriving first (May 4th, SD = 3.7 days), followed by Winthrop NFH (May 11th, SD = 3.0 days), then Leavenworth NFH (May 16th, SD = 1.4 days). **(LNFHComplexrpt2005, P. 34)**
- Each year coded-wire tags are applied to various release groups of spring Chinook from Leavenworth Complex facilities. Tags are distributed in a manner to represent the entire brood year. In addition specific tag groups are often utilized to represent unique aspects within each brood year such as rearing unit, water re-use, BKD risk, stock, or specific study. Tags are recovered at each Leavenworth Complex from returning adults and decoded. Information regarding each CWT adult is then submitted to the Regional Mark Information System. This system provides online queries from which data representing a particular hatchery or tag code can be gathered. **(LNFHComplexrpt2005, P. 60)**
- Recent, (1997-2000) CWT groups at Leavenworth NFH have been applied in a manner to represent the rearing units present at this facility (ie. adult holding ponds 1&2, upper & lower 10'x100' raceways, and 8'x80' lower raceways). Although the 1997-2000 brood year average return survival (Figure 25) appears

different by rearing unit no significant difference between rearing units is currently observed (ANOVA, p = 0.441). **(LNFHComplexrpt2005, P. 61)**

Leavenworth NFH CWT recovery and subsequent average smolt-adult survival rates by rearing unit for brood years 1997-2000. **(LNFHComplexrpt2005, P. 61, Figure25)**



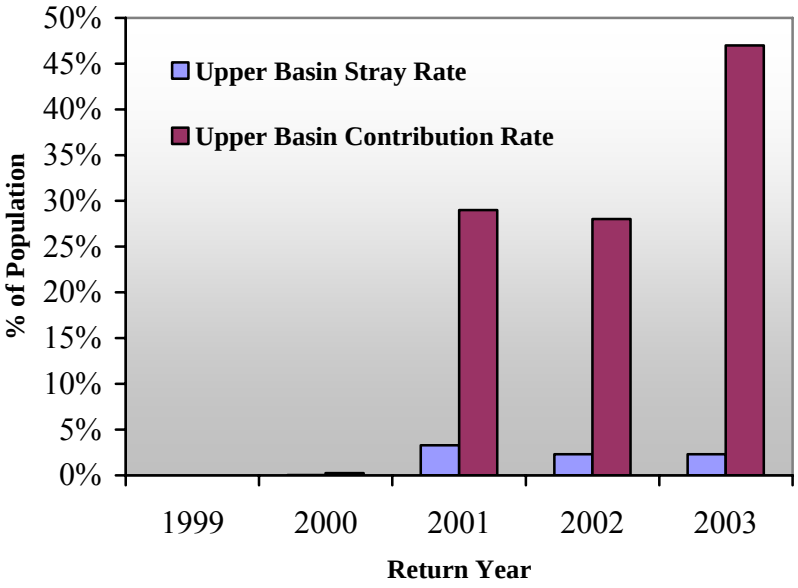
- A nutrient enhancement program was established in 2000 to outplant post-spawn spring Chinook carcasses from Leavenworth Complex hatcheries in the Wenatchee, Entiat and Methow River basins. Carcasses were sanitized through freezing and the tail was removed prior to outplanting to distinguish outplants from naturally spawned carcasses. Carcass distribution targeted known spring Chinook spawning areas in each basin. During the course of the project, decisions were made to eliminate female broodstock because they are injected with erythromycin prior to spawning to combat bacterial kidney disease. Due to the limited availability of useable carcasses for outplanting, complications with other in basin studies, and the costs associated with the use of analogs, the Leavenworth Complex nutrient enhancement program was discontinued in 2004. **(LNFHComplexrpt2005, P. 64)**
- Spring Chinook salmon at Leavenworth NFH were reared at three different loading densities during brood years 1994 – 1996. Each year, following differential coded wire tagging, fingerlings were loaded in triplicate at approximate densities of 10,000, 20,000 or 30,000 (density indexes of 0.07, 0.14, and 0.21 (#/lb/length*ft^3) or 5, 10, and 15 kg/m^3) per 8'x80'raceway. During rearing, growth, and size at release were maintained between all treatment groups. No significant differences for survival or the number of adults returned were observed from the pooled 1994-1996 data set (ANOVA, p>0.05). **(LNFHComplexrpt2005, P. 65)**

- The USFWS in conjunction with the Yakama Nation conducted a Leavenworth NFH adult spring Chinook outplant program. Beginning in 2001 and continuing each year through 2004 a portion of the adult hatchery spring Chinook salmon that returned to the hatchery were live outplanted in early-July each year to Peshastin and Ingalls Creeks within the Wenatchee River watershed (Figure 36). These adults from 2001-2004 were successful in producing redds (Figure 37) at an average annual rate of 4.6 fish/redd (SD = 1.8 fish/redd). In 2005 no adults were outplanted and surveys indicated only three redds were observed (A. Grassell, pers. comm., Chelan County PUD). **(LNFHComplexrpt2005, P. 72)**

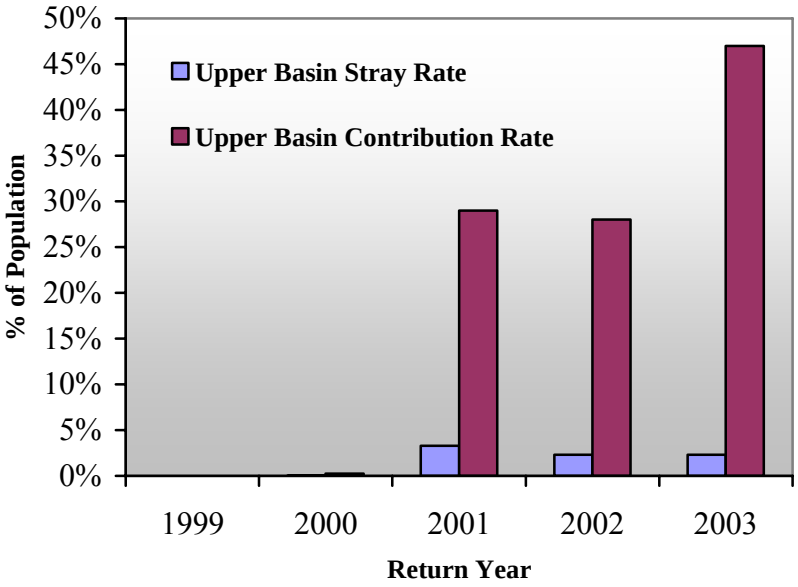
F. Program conflicts.

1. Biological conflicts (e.g. propagated stock maladapted to hatchery water source).

- Given the magnitude of this program it is not surprising that some adults contribute to the spawning populations present within the basin. Leavenworth NFH's impact on within basin spawning aggregates is focused on the upper Wenatchee. **(LNFHComplexrpt2005, P. 46-47)**
- For the period of 2001-2003 in which Leavenworth NFH recoveries were primarily discovered, the average Leavenworth NFH population Upper Basin stray rate has remained consistent and averaged 2.6% (SD = 0.6%) while the contribution this recovery rate has had upon the estimated spawning escapement has averaged 34.6% (SD = 10.5%). **(LNFHComplexrpt2005, P. 47)**
- Stray estimates for years 1990 to 2000 show that SCS adults of LNFH origin have a high fidelity to Icicle Creek. Of an estimated 62,375 surviving adults of LNFH origin, only 442 (0.71%) are considered as "strays." Of the 442, only 193 (0.31%) were estimated to have strayed into natural spawning areas. Historical data for the same years show that of 12,013 adults spawning in the upper Wenatchee Basin (Mosey and Murphy 2000), only 193. **(LNFHhgmp, P. 13)**
- Leavenworth NFH contribution rates to the Chiwawa River, Chickamin, and Rock Creeks combined has averaged 9% (SD = 13%), the Little Wenatchee River has averaged 53% (SD = 41%), Nason Creek has averaged 18% (SD = 10%), White, Napeequa, and Panther Creeks combined has averaged 3% (SD = 6%), and the remaining upper Wenatchee River mainstem has averaged 89% (SD = 18%). **(LNFHComplexrpt2005, P. 47)**



Contribution of Leavenworth NFH return to the Wenatchee Basin spring Chinook escapement, 1984-2003.



A comparison of the estimated Leavenworth NFH spring Chinook within basin stray and contribution rates to the upper Wenatchee spawning population.

2. Harvest conflicts (e.g. mixed stock fishery on hatchery and wild fish limits harvest opportunities on hatchery fish).

- For Leavenworth NFH, the Icicle Creek sport and treaty/ceremonial fisheries harvest a significant portion of the return (Table 27). However, the opportunity for harvest is limited in the short (~2.8 miles) section of Icicle Creek open for fishing and a large number of adults quickly travel this length and enter the hatchery ladder. Occasionally, the ladder is closed to increase harvest and most likely this practice improves tribal catch as the area open for treaty harvest is immediately adjacent to the ladder in the spill way pool. **(LNFHComplexrpt2005, P. 39)**

3. Conservation conflicts (e.g. competition between unlisted hatchery fish and ESA-listed wild fish).

- Potential competition/predation conflict of unlisted hatchery stock on wild listed fish. **(LNFHhgmp, P. 20)**
- When hatchery-origin Chinook are released into the Wenatchee River Basin, the potential exists for intra- and inter-specific competition with natural-origin juvenile salmonids, including listed spring Chinook salmon and steelhead. **(LNFHhgmp, P. 18)**
- By virtue of their large size compared to wild juvenile fish that they may encounter after release, and considering the areas where hatchery fish are released, hatchery spring Chinook yearlings have the potential to prey upon listed fish in the Wenatchee River Basin and mainstem Columbia River. **(LNFHhgmp, P. 18)**
- The potential for LNFH fish to transmit diseases and parasites to listed salmonids is unknown, but thought to be low.
- NMFS determined that the annual rate of population change for the UCR spring Chinook and summer steelhead ESU is less than 0.9, and decreasing in abundance at a rate of at least 10% per year. These populations are at dire risk, with only small fractions of their already depressed populations expected to persist through the next 24 years under current conditions (NMFS 2001). Therefore, UCR spring Chinook and summer steelhead are considered at a "critical population threshold." **(LNFHhgmp, P. 12)**
- Wild juvenile spring Chinook salmon originating in the upper-Columbia Basin emigrate towards the ocean during their second year. Average size at emigration (April and May) ranges from about 91.8 mm to 100.5 mm (averages from three emigration studies) (Chapman et al. 1995). From 1985 to 1993, the average 10th, 50th, and 90th percentile passage at Rock Island Dam was April 21st, May 10th, and June 3rd respectively (Chapman et al, 1995). Although these percentages are strongly influenced by releases from Leavenworth NFH, Chapman et al. (1995) believe that the naturally produced migrants have a run timing similar to the hatchery component. **(LNFHhgmp, P. 11)**
- There are no listed SCS stocks in Icicle Creek, only an unlisted hatchery

stock. The listed spring Chinook stocks utilizing the Wenatchee basin spawn over 20 river miles above Icicle Creek in the mainstem Wenatchee River and tributaries. If listed summer steelhead enter the collection ladder at Leavenworth NFH, we are required to pass them above the barrier at the hatchery. Effects of the barrier dam on listed fish are being addressed under a separate consultation process (USFWS 2002). **(LNFHhgmp, P. 12)**

- UCR steelhead and Wenatchee Basin (UCR) spring Chinook salmon. In 1995, the small steelhead program at LNFH was moved to Winthrop NFH. Remnants of this program still return to and spawn in Icicle Creek. Affects to listed steelhead and spring Chinook during the harvest of returning LNFH adults is consulted on by WDFW under a separate and annual process. Listed Snake River stocks may be affected in the migration corridor. See Ecological Interactions section for information. **(LNFHhgmp, P. 12)**
- Broodstock collection directed at unlisted adults returning to Leavenworth NFH has a low potential to "take" listed spring Chinook salmon. Since 1994, only one verified listed spring Chinook has been used for propagation. . **(LNFHhgmp, P. 14)**
- **Alternative 1:** Develop a new broodstock and eventually eliminate the unlisted Carson ancestry stock from the basin. This action would potentially eliminate concerns on the negative impacts to the listed, endemic stocks in the basin. The current status of the endemic stocks (very low numbers) negates this alternative at this time. **(LNFHhgmp, P. 9)**
- **Alternative 2:** Reduce the production goal for the unlisted stock at LNFH. This may be expected to lessen impacts to the listed stocks in the basin. Impacts could include straying, predation, competition, etc. Current mitigation responsibilities negate this alternative at this time. **(LNFHhgmp, P. 9)**

- Conservation groups are highly concerned about potential actions undertaken by the hatchery to address drought conditions and their impact to listed salmonids. **(LNFHchmp, P. 3)**
- Conservation groups are concerned about the current lack of fish passage to areas above the hatchery's barrier dam. A major project is currently underway to provide fish passage by 2006. **(LNFHchmp, P. 3)**

4. Other conflicts between the hatchery program, or fish produced by the program, and other non-hatchery issues.

- The Colville Tribes will be submitting an HGMP for comprehensive management of spring Chinook in the Okanogan River and the Columbia River below Chief Joseph Dam. This HGMP outlines an Isolated Harvest Program using Carson stock spring Chinook. This program would mitigate the effects of Federal hydroelectric development to the Colville Confederated Tribes. The Chinook would be acclimated and released in both the Okanogan and Columbia rivers to support tribal C&S and recreational fisheries. The Tribes have also initiated an Integrated Recovery Program for spring Chinook in Omak Creek

using the Carson stock (this program will shift to Methow Composite eggs when available) The egg needs for these programs will need to come, in the near term, from Leavenworth NFH. **(LNFHhgmp, P. 8-9)**

- For the Integrated Recovery Program, 50,000 smolts are provided on an ad-hoc basis from Leavenworth NFH. For the Isolated Harvest Program, rearing would occur at an existing, lower river hatchery (likely Willard NFH). Later, with anticipated construction or expansion of the Chief Joseph Dam Hatchery, these Chinook would be reared locally. The needs of these two programs could be integrated formally into the Leavenworth NFH HGMP and operations. **(LNFHhgmp, P. 9)**
- The Integrated Recovery Program using Carson stock is intended to develop information, skills, and capabilities necessary prior to the planned reintroduction of ESA-listed Upper Columbia River Spring Chinook into the Okanogan Basin. Re-introduction of the listed fish into the Okanogan would increase its abundance, distribution, and diversity, thereby aiding in its recovery. **(LNFHhgmp, P. 9)**
- The Isolated Harvest Program and accompanying live-capture, selective fisheries is being developed to provide mitigation to the Colville Tribes for development of the Federal hydroelectric system. All current spring Chinook mitigation has been located down river in waters inaccessible to the Colville Tribes. **(LNFHhgmp, P. 9)**
- The Yakama Nation has expressed an opinion that juvenile fish from the hatchery should be released throughout the watershed. **(LNFHchmp, P. 3)**

IV. Entiat National Fish Hatchery.

A. *Description of hatchery* (ET HGMP, P2,3, CHMP, P8, LPR, P3).

- The Leavenworth Complex is located in North Central Washington State on the east side of the north Cascade Mountains (Figure 1). Peaks along the North Cascades vary from 5,000 to 10,000 feet, and few major tributaries drain this area to the east. The Columbia River forms the boundary between these mountains to the west and the Columbia Plateau to the east which rises to 2,500 feet and is dry with only a few minor streams. Annual precipitation in the Columbia Plateau may be less than 8 inches, while the Cascade Mountains may receive in excess of 120 inches.
- Entiat NFH is part of the Leavenworth Complex, which also includes the Leavenworth and Winthrop NFH's. Entiat NFH is located six miles west of Entiat, WA on the Entiat River, 6.7 river miles (rm) above its confluence with the Columbia River. Site elevation is approximately 1,000 feet above sea level. Fish returning to Entiat NFH must travel a total of 790 km and negotiate passage through eight Columbia River hydroelectric dams.
- The hatchery has numerous buildings involved in fish production, three residences, adult holding ponds, thirty raceways, six wells, spring, pollution abatement pond, river intake structure, walk in freezer, generator building, screen chamber, and an aeration building (Table 1).
- Rearing units consist of 2 brood ponds, 2 earth ponds, 46 raceways, 8 incubator troughs, 21 vertical stacked incubators, and 24 starter tanks (Table 2).

Table 1. Hatchery buildings, primary use, size, and construction type.

Building	**Sq. Ft.**	**Construction Type**
Service Admin. Building (includes offices, vehicle storage, feed storage freezer, and feed prep room)	3,537	Brick, ceramic block
Nursery Building	4,141	Wood frame
Shop	2,118	Wood frame
Residence #1	192	Wood frame
Residence #2	1,500	Wood frame
Residence #3	1,500	Wood frame
Oil and paint storage	339	Brick
Pond cover	17,170	Galvanized steel
Hazardous materials storage (formalin storage)	69	Prefabricated metal

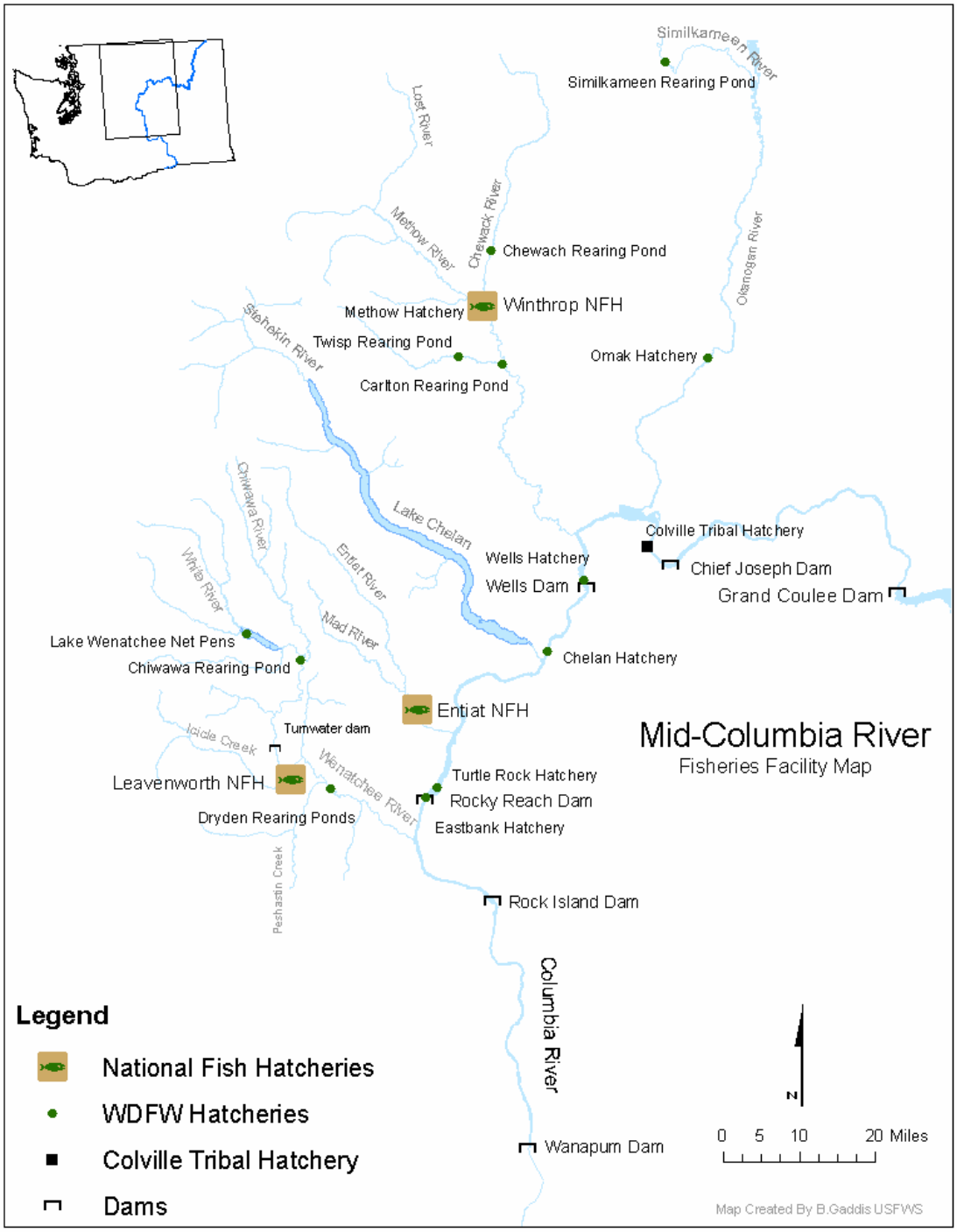


Figure 1. Map of Upper Columbia River watershed detailing major fish production facilities and hydro-system impoundments.

Table 2. Physical description of incubation and rearing facilities.

Unit Type	Size	Volume (cu ft)	Number	Material	Age	Condition
Brood pond	145'x40'x4'	23,360	2	Concrete	42	Fair
Lower earth pond	270'x78'x3'	63,180	1	Dirt	42	Good
Upper earth pond	170'x45'x2.3'	17,212	1	Dirt	42	Good
Raceways	80'x8'x2'	1,280	46	Concrete (polyurethane lined)	42	Good
Incubator troughs	20'x1.5'x1.5'	45	8	Fiberglass	20	Good
Vertical stack incubators		7	21	Fiberglass	5	Good
Starter tanks	15'x3.5'x2'	105	24	Fiberglass	20	Good

B. ***Hatchery water sources*** (ET HGMP, P21-22, CHMP, P18-19).

- The water sources for the hatchery include the Entiat River and/or six wells (22.5 cfs) and Limekiln Springs (7.0 cfs). All water rights are the property of the USFWS.
- The intake is located at river mile 7.2, approximately .33 miles upstream of the hatchery. Water is conveyed to the hatchery through a buried 36-inch pipe system. This water enters a pre-settling basin via inclined 3/32" screens. Screened debris and downstream migrants are diverted via a 18" line back to the Entiat River. The water intake structure consists of a diversion dam, intake well, and bar trash racks (3 inch spacing).
- Non-hatchery fish and other aquatic organisms that enter the system can return to the river via an 18" water line that diverts screened debris and water from the stations surface water screen chamber building. Screen chamber meets the standards for screening criteria described in the 1994 Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries developed by NMFS.
- Surface water is used on a limited basis. Currently surface water is used to supply adequate amounts of water to operate the station's fish ladder during spring Chinook adults returns. Surface water is also used in case of long-term loss of ground water supplies (emergency).
- Entiat River water contains high organic loads and detrimental parasites (*Myxobolus sp.*) which have been shown to have a negative impact on hatchery fish production. Since 1990, hatchery production has relied primarily on ground and spring water for fish production. The availability of ground water determines fish production at Entiat NFH.
- Screens are cleaned at least twice per day. Deflectors are installed in the screen chamber to divert sufficient amounts of water through and over 3/32 inch holed screens when water demand from the river is low. These deflectors simply shunt water over

the screens so that downstream migrants and debris washes off the screens. Effluent discharge is monitored, reported, and currently complies with applicable standards.

- Figure x provides a schematic of water flows at ENFH (need).

C. Adult broodstock collection facilities (ET HGMP, P23, CHMP, P20).

- All brood stock used for production are volunteers to the facility.
- Adults swim up the collection ladder and into one of two holding ponds.
- The holding ponds measure 16 x 120 feet, and are supplied with a mixture of surface and ground water for attraction and operation of the ladder.
- After the spring Chinook adults are spawned, the ponds are cleaned, disinfected, and a portion of the juveniles from the previous years brood are moved from the upper raceways into the large adult ponds.

D. Broodstock holding and spawning facilities

All brood stock used for production are volunteers to the facility. Adults swim up the collection ladder and into one of two holding ponds. The holding ponds measure 16 x 120 feet, and are supplied with a mixture of surface and ground water for attraction and operation of the ladder. The spawning building sits next to the holding ponds. This area has access to pathogen-free well water which is used in the spawning process. After the gametes are mixed, the enumerated egg buckets are taken inside the hatchery building. After the spring Chinook adults are spawned, the ponds are cleaned, disinfected, and a portion of the juveniles from the previous years brood are moved from the upper raceways into the large adult ponds. The juveniles remain there until their release the following April. .

E. Incubation Facilities

From fertilization to the eyed stage, eggs are incubated in individual tray-type incubators receiving 4 gallon per minute of ground water. Eggs from individual females are kept separate until fish health tests are completed. Eyed eggs are mixed by egg take after they are "picked". Developing eggs are treated every other day with 750 ppm of formalin for fungus control until they reach 600 temperature units. The current SCS production is incubated on 100% ground water at 47-51^{0}F until "eyed". The eggs are shocked, picked, and inventoried by egg take. Eggs are returned to incubation trays and incubated on 100% ground water at 39-41^{0}F. Emergence is delayed until late February, early March. Previous broods, 2000 and older, were incubated on 100% ground water at 48-51^{0}F until emergence, which occurred in mid-December every year

Table 11: Number of eggs taken and survival rates to eye-up. (FROM HGMP)

Year	# Eggs	Survived to Eyed	Percent(%)
1988	612,188	548,520	89.6
1989	878,245	828,185	94.3
1990	804,660	768,450	95.5
1991	896,000	876,976	98.1
1992	885,400	861,494	97.3
1993	1,196,000	1,169,688	97.8
1994	168,000	162,120	96.5
1995	232,000	222,488	95.9
1996	387,600	378,685	97.7
1997	500,400	483,887	96.7
1998	441,000	423,801	96.1
1999	1,067,800	1,029,359	96.4
2000	756,000	706,104	93.4

Surplus eggs are taken to allow for the culling of moderate to high risk BKD infected eggs. It is common practice to cull (destroy) eggs that have a very high ELISA rating. Historical data is used to determine egg collection levels. The culled eggs are disposed of in an earthen pit on station property. Typically, an additional 10% of females are taken to account for culled eggs due to moderate to high ELISA ratings.

The dry-weight method is used to enumerate eggs. Only one female per tray is incubated until the eggs reach the "eyed" stage. Following shocking and picking, each female's eggs are sampled for weight. A combined average is used for groups of 10 females. Eyed eggs are returned to incubation trays, loaded at 4000 eggs per tray. Incubation continues on chilled spring/ground water. Water flow is set at a minimum of 4 gallons per minute.

Eggs are incubated in low pathogen (spring/well) water. Water temperature is continuously monitored every thirty minutes and logged by a remote temperature sensor. Water temperatures are converted to temperature units for each spawning day. For the Entiat SCS stock, it takes about 600 temperature units to reach the eyed stage and 1750 temperature units to the button-up stage or initial feeding.

F. Indoor Rearing Facilities (Need to get attachment 6 – CHMP for rearing unit dimensions)

Rearing facilities include the 32 starter tanks. Emergence occurs in late February to early March. Fry are moved from trays directly to outside raceways.

Table 13. Survival estimates for juvenile SCS, LNFH.

Broodyear	Fry to Fingerling (%)	Fingerling to Smolt (%)
1988	98.8	98.3
1989	98.4	98.2
1990	97.5	98.4
1991	97.4	98.7
1992	98.7	97.0
1993	98.7	98.1
1994	99.1	97.9
1995	98.3	96.4
1996	98.2	98.3
1997	98.8	97.1
1998	99.0	96.8
1999	98.8	98.1

G. Outdoor Rearing Facilities

30– 8 x 80 raceways Fry are reared on first pass ground water. Ponds are loaded pending scheduled tagging. At this point fry are counted and "split" into raceways for summer and fall rearing. Once spawning in complete, fry from raceways are moved to the large adult ponds for four months until release (April).

Percent survival estimates for juvenile SCS, ENFH. (From HGMP)

Brood year	Fry to Fingerling (%)	Fingerling to Smolt (%)
1989	99.8	99.8
1990	99.6	95.4
1991	97.8	96.4
1992	89.9	96.5
1993	97.3	95.8
1994	99.8	81.9
1995	99.0	84.5
1996	98.2	98.3
1997	98.8	97.1
1998	99.0	96.8
1999	98.8	98.1
2000	96.3	95.8

Density and flow indices are the criteria by which standard pond management procedures adhere. These criteria include efforts to remain below a density index of 0.17 and below a flow index of 0.75 while maintaining production goals.

Table 13: Monthly production density and flow indexes for yearling brood years from 1990 to present.

Month	Development Stage	Temp[1] Avg. ^{0}F	Water Source[2]		Flow (GPM)	Flow Index[3] Lbs./L(in) GPM	Density Index[3,4] Lbs./L(in)cuft
			% River	% Ground			
August	EGG	48.5	0	100	40	4000/tray	Na
September.	EGG	48.8	0	100	40	4000/tray	Na
October	EGG	50.5	0	100	40	4000/tray	Na
November	EGG/Alevin	50.5	0	100	40	4000/tray	Na
December	Alevin/Fry	50.0	0	100	1800	0.23	0.05
January	Fry	48.0	0	100	1800	0.37	0.08
February	Fry	47.0	0	100	1800	0.52	0.11
March	Fry	47.0	0	100	1800	0.56	0.14
April	Fingerling	47.0	0	100	5400[5]	0.53	0.11
May	Fingerling	46.7	0	100	5400	0.32	0.06
June	Fingerling	46.7	0	100	5400	0.40	0.08
July	Fingerling	47.6	0	100	5400	0.49	0.10
August	Fingerling	48.5	0	100	5400	0.58	0.12
September	Fingerling	48.8	0	100	5400	0.60	0.09
October	Fingerling	50.5	0	100	5400	0.66	0.09
November	Fingerling	50.5	0	100	5400	0.70	0.10
December	Year;ing	50.0	0	100	5400	0.74	0.11
January	Yearling	49.0	0	100	5400	0.77	0.11
February	Yearling	48.5	0	100	5400	0.72.	0.11
March	Yearling	47.5	10	90	5940	0.70	0.12
April	Yearling/Smolt	47.0	20	80	6480	0.72	0.12

H. ***Release locations and facilities*** (ET HGMP, P23, CHMP, P40).

- Yearlings (smolts) are force released directly from the raceways.
- Dam boards are removed, and the smolts travel through an underground pipe system, which empties at the base of the collection ladder into the Entiat River.
- The juveniles holding in the adult ponds are forced out down the hatchery ladder into the Entiat River.

I. ***Outmigrant monitoring facilities.***

- NA

J. ***Additional or special facilities.***

- NA

K. ***Outreach and public education facilities/programs*** (ET CHMP, P48).

- Salmon-in-the-classroom activities with Entiat Elementary School.
- Cooperative outdoor education activities with Entiat High School students and Chelan County Soil Conservation district.
- Salmon-in-the-classroom activities with Mission View Elementary School.
- Partnership with Friends of Northwest Hatcheries.
- Cooperative outreach activities with U.S. Forest Service, Entiat Ranger District including fishing day and camp activities.
- Partnership in hosting Kid's Fishing Days and Open House events with Entiat Service Club.

L. ***Special issues or problems (e.g. water and property rights issues, law suits, etc.).*** (ET HGMP, P7, CHMP, P19, 51, 53)

- Currently, there is a hatchery/wild fish genetic study underway and tissue samples are being taken from both populations. This is a big issue and the results may have a great impact on the future of the Entiat program.
- ENFH also lacks a quality water source for the production program.
- Another key issue in the Entiat Basin is whether to keep this river as a "reference" stream. This is potentially the only basin available in the upper-Columbia River ESU where the effects of supplementation can be measured against areas without hatchery influence.
- Development of a comprehensive marking strategy.
- Funds for unmet program, maintenance, ESA, and M&E needs.
- **Lack of cover and predator exclusion over outdoor raceways - Correction** – to be addressed by BOR Listed in RAX survey of maintenance needs?
- **Pump motors at wells are single speed without remote monitoring capability. Correction -** – to be addressed by BOR Listed in RAX survey of maintenance needs?
- **Lack of redundancy in chilling – Correction –** If status quo of stock mixture (SCS/COS) remains, a backup chiller or larger reservoir capacity for chilled water should be considered. If stock mix changes (i.e. – SCS stock removed) this may no longer be a concern.
- **Water Quality –**
  Use of pesticides in orchards in close proximity to facility – Correction – consider a monitoring program which would periodically sample water for presence of pesticides or other contaminants in rearing water.
- **Add perimeter fences for security and predator exclusion**
- **Rehabilitate effluent/pollution abatement pond at all three hatcheries**.

V. Entiat River spring Chinook hatchery program, Entiat NFH.

A. ***General information*** (ET HGMP, P3, CHMP, P1).

- The hatchery was originally authorized through the Grand Coulee Fish Maintenance Project in 1937 and again by the Mitchell Act in 1938.
- Operations began in 1942. Entiat NFH is one of three mid-Columbia hatcheries constructed by the BOR as mitigation for the Grand Coulee Dam-Columbia Basin Project.

B. ***Stock/Habitat/Harvest Program Goals and Purpose.***

1. ***Purpose and justification of program*** (CHMP, P1).

- To compensate for fish losses caused by the construction of Grand Coulee Dam.
- Original production consisted of Chinook salmon trapped at Rock Island Dam, but since then has included several resident and anadromous salmonids.
- The hatchery is currently used for adult collection, egg incubation and rearing of spring Chinook salmon.
- It also provides juveniles and/or adults, for re-establishing spring Chinook runs in other Columbia River tributaries, as needed.

2. ***Goals of program*** (ET CHMP, P1).

- Produce fish species and numbers commensurate with those lost/affected by the construction of Grand Coulee Dam. Assure that hatchery operations support Columbia River Fish Management Plan (U.S. v. Oregon) production and harvest objectives.
- Minimize impacts to ESA listed and other native species, their habitat, and the environment.
- Provide the public with quality aquatic interpretation and education, customer service and comprehensive outreach to enhance public understanding, participation and support of Service and Entiat NFH programs.

3. ***Objectives of program*** (ET CHMP, P30-35).

- Successfully maintain a brood stock of spring Chinook salmon at Entiat NFH without the need for out-of-basin egg or fish transfers to the hatchery (achieve a minimum 0.1% smolt to adult return back to the hatchery).
- Collect sufficient brood stock to produce 0.4 million smolts for on-station release into the Entiat River.
- Contribute to a meaningful harvest for sport, tribal and commercial fisheries from March through July of each year in the Columbia and Entiat Rivers (achieve a 10-year average of 0.5% smolt to adult survival, harvest plus escapement)
- Meet tribal trust responsibilities
- Communicate and coordinate effectively with co-managers in the Columbia River Basin.
- Minimize interactions with other fish populations by implementing state-of-the-art fish culture technology.

- Increase visibility of Entiat NFH.
- Provide information and education about the Service programs and Entiat NFH to internal and external audiences.
- Develop forums for public participation (or input) into Entiat NFH issues.
- Conduct monitoring and evaluation to ensure goals and objectives are achieved.

4. ***Type of program*** (ET HGMP, P2, CHMP, P13-14, 17, 50).

- Mitigation

5. ***Alignment of program with ESU-wide plans*** (ET HGMP P16, CHMP, P.

- Anadromous salmonid populations in the Entiat sub-basin are influenced by the following out-of-sub-basin impacts; degraded estuarine habitat, fish harvest, unfavorable ocean conditions, and the effects of eight Columbia River reservoirs and hydroelectric dams on smolt and adult migration.
- BA (1994) covered potential hatchery impacts to listed Snake River sockeye and spring, summer, and fall Chinook salmon.
- BA's to cover listed upper-Columbia River summer steelhead (1997), listed and unlisted spring Chinook salmon (1999), and bull trout (1999).
- Recently replaced with the HGMP's to better describe the programs and their potential impacts. NOAA Fisheries determination to date is that "the federal artificial propagation programs proposed for operation of funding by the USFWS and BPA in the UCR basin are not likely to jeopardize the continued existence of these listed ESU's or to destroy or adversely modify their habitat."
- Several federal, state, local, and tribal entities share responsibilities for development of sub basin plans, hatchery production, harvest management, and ESA considerations.

6. ***Habitat description and status*** (ET HGMP, P16-17, CHMP, P11).

- The ability of the Entiat watershed to fully sustain salmon populations is most limited by a lack of over-wintering juvenile habitat and water quality. Losses in floodplain and riparian zone connectivity and function have dramatically altered natural hydrological and geomorphic processes essential to juvenile survival.
- Historically, moderate to heavy sheep grazing in the uplands modified the under story grassy communities, and the removal of beaver diminished water storage capacity and altered flow regimes.
- Timber harvest, fire suppression, and the conversion of floodplains to crops, pasture, roads, and urban uses has contributed to losses of important salmonid rearing habitat through compacted soils, simplification and destruction of vegetative communities, accelerated sediment and water delivery to stream channels, and increases in the frequency, intensity and duration of flood and mass wasting events.

7. ***Size of program and production goals (No. of spawners and smolt release goals)*** (ET HGMP, P6-7, CHMP, P16).

- Approximately 300 adults are needed for production target of 400K smolts (Table 3).

- Up to 100 adults are secured (when possible) for transfer to Omak Creek in Okanogan County. This upper Columbia River tributary has been void of salmonids for years. This re-introduction effort began through a cooperative agreement between USFWS, NMFS, WDFW, Colville Federated Tribe, and Columbia River Inter-tribal Fish Commission (CRITFC). Consultation will be conducted by the Colville Tribe.

Table 3. Current proposed annual fish releases from the Entiat NFH.

Life Stage	Release Location	Annual Release Level
Eyed Eggs	0	0
Unfed Fry	0	0
Fry	0	0
Fingerling	0	0
Yearling (smolts)	Entiat River	400,000 (goal)
Adults	Omak Creek	Up to 100

C. Description of program and operations.

1. *Broodstock goal and source.*

Table 9: History of Egg Source for the Entiat NFH

Egg Source	Brood	Stock Origin
Rock Island Dam	1942 and 1944	Commingled Upriver Stocks
McKenzie River, OR	1941	McKenzie River
Cowlitz River Hatchery	1974	Cowlitz River
Carson NFH	1975-1981	Carson (Bonneville)
Little White Salmon NFH	1976,1978,1979,1981	Little White Salmon River
Leavenworth NFH	1979-81,1994	Commingled Hatchery Stock
Winthrop NFH	1988	Commingled Hatchery Stock
Entiat NFH	1980, 1983-present	ENFH rack returns

- The original brood stock used to start the program was commingled, and destined for the upper Columbia Basin. These adults were trapped at Rock Island Dam and brought to the Entiat NFH facility.
- No spring Chinook releases were made from the facility from 1945 to 1975. Spring Chinook production resumed in 1974, with releases in 1976. Since 1974, eggs sources and subsequent yearling releases have been from several lower river sources as well as from Leavenworth and Winthrop NFHs. The history of their egg source has been incorporated into the yearling fish production at ENFH.
- The Little White Salmon (LWS) stock started in 1967, when fish of unknown origin returned to the LWS River. These adults were probably descendants of several different stocks.

- The following performance measures have been established at the hatchery for spring Chinook salmon:

Performance Measure	Hatchery Goal	5-Year Average	Range
Spawning Population[1]	350	350	
Fish release (millions)[2]		400K	
Egg transfers (thousands)[2]	0	0	N/A
Fish transfers (thousands)[2]	0	0	N/A
Adults passed upstream[3]	0	Unknown	Unknown
Percent survival juvenile to adult[4]		0.50	
Smolt size at release (fish/lb)[2]	19	19	18-20

[1]females plus males (including jacks) spawned, five year average and range from calendar years 1997-2001
[2]five year average and range from calendar years 1998-2002
[3]volitional passage upstream and into hatchery
[4]includes all adult recoveries (fisheries plus hatchery), five year average and range from completed brood years 1992-1996

2. ***Adult collection procedures and holding.***

- Brood stock is obtained entirely from adults volunteering to the hatchery's collection ladder. The ladder operates from mid-May to mid-July, which covers the full spectrum of the run. Excess adults are periodically donated to various tribes and non-profit groups. This occurs when large numbers of adults enter the ladder in a short period of time. All adults enter one holding pond, and those retained for brood are moved to a separate unit.
- Program goal (assuming 1:1 sex ratio for adults): Approximately 300 adults are needed to secure production needs. An additional 100 adults may be held for the Omak Creek re-introduction effort.
- Disposition of hatchery-origin fish collected in surplus of brood stock needs: Under an agreement with Bureau of Indian Affairs, adults collected in excess of brood stock needs are donated to various tribes for ceremonial and subsistence purposes. A small portion may also go to non-profit groups. Also, up to 100 adults may be transferred to Omak Creek in Okanogan County.
- All adults used for brood stock are volunteers to the hatchery. No adults are transported to the facility. Adults swim into two 16' X 120' adult holding ponds. Adults may be held up to three months before spawning. A flow-through formalin treatment is administered every other day to help control parasites and fungus. Treatment procedures are consistent with the protocols outlined in INAD permit #9013.

- The fish ladder operates and adult trapping is conducted throughout the entire run. If run size is large, excess fish are periodically removed and brood stock moved to a separate holding pond in proportion to the run size. This enables us to retain adults from the entire run spectrum. All ripe females are spawned weekly. No other selection occurs.
- Returning adult Spring Chinook salmon begin to appear as early as the first week in May of every year. Surface water combined with groundwater is fed through the adult holding ponds to provide the necessary attraction and to operate the fish ladder. Adults enter the facility voluntarily via the fish ladder directly from the Entiat River. Adults enter a V-trap which has a one way swing gate that traps the fish in the holding ponds. This station has the capacity to hold 2000 Spring Chinook adults. This number is limited to available ground water in July and August. Only 300 adults of equal gender are needed for the current program. There is no barrier in the river that prohibits adults from passing by the facility.
- Adult spring Chinook return to the hatchery from May through July. The ladder is kept open throughout the return, typically until the 1st of August. In the 2003 Biological Opinion NOAA Fisheries requests the USFWS maintain the Entiat NFH ladder and trapping facility open through the entire duration of the Carson-lineage spring Chinook salmon adult return period to maximize removal of the fish from critical habitat for listed spring Chinook salmon.
- The adult brood stock remains in the east holding pond (HP1) until removed for spawning. The first spawn date is usually scheduled for late-August and all spawning is usually completed by the second week in September. The holding ponds are supplied with ground water so the temperature remains at 49- 50°F. The volume of the pond is such that density is not a concern. However, pond loading is managed to meet or exceed one gallon of inflow per fish and a minimum 8 ft3 per adult in HP1. Holding capacity for each holding pond is about 950 adults, 350 are needed for brood stock. The adults are injected with erythromycin 60 days prior to spawning and again 30 days prior to spawning to control bacterial kidney disease. The adults are also treated three times weekly with formalin to control external parasites.
- To achieve a spawning population of 300 fish, up to 350 spring Chinook brood stock are retained based on the following assumptions:
  - 400,000 smolt release
  - 15% green egg to smolt mortality
  - 10-20% BKD cull
  - 4000 green eggs per female
  - 5% pre-spawn mortality
  - 60:40; female to male return ratio

3. Adult spawning.

a) *Spawning protocols.*

- Partitions are set up in the holding pond to separate ripe females and males. Unripe fish are returned to the holding pond and held there until the following week. Ripe fish are killed with a club and are not bled prior to spawning.
- Milt from the primary male is used first for fertilization. A secondary male (backup), which was the primary male in the prior mating, is used again about one minute after the primary male. Precocious males (3-year-old jacks) are used randomly throughout spawning at a rate relative to the total return.
- A 1:1 female to male spawning ratio is the objective. Due to the continuous number of fish removed, and separate male and female staging areas, there is no selectivity in mating. The abdomen of a female is opened, egg's flow freely into a colander where the ovarian fluid is decanted. Eggs are transferred to a bucket where fertilization takes place.

b) ***No. of males and females spawned each year over past 10 years***

Brood Year	**Females**	**Males**	**Jacks**	**Egg Take(e)**	**Smolts Released**
1988	132	68	0	612,188	585,800
1989	240	174	0	878,245	818,707
1990	197	183	0	804,660	721,096[1]
1991	216	180	2	896,000	738,052[1]
1992	233	152	8	885,400	710,907[1]
1993	299	299	0	1,196,000	791,440[1]
1994	42	27	4	168,000	335,593
1995	58	55	3	232,000	200,486
1996	102	62	7	387,600	350,784
1997	139	102	2	500,400	519,237[1]
1998	126	69	14	441,000	359,667
1999	281	144	34	1,067,800	818,981[1]
2000	210	168	24	756,000	533,720
2001	135	98	11	635,250	400,000[2]

(e) estimated; [1]Includes Sub-yearling releases; [2]Program release

- **Disposition of carcasses:** More fish enter the hatchery than are needed for brood stock. Brood stock excess to hatchery needs are transferred to the Bureau of Indian Affairs for distribution to either the Yakama Nation or the Colville Confederated Tribes for Ceremonial and Subsistence (C&S) use, other tribes for C&S use, or the Bureau of Federal Prisons for inmate rations. Surplus fish or spawned carcasses may also be available for stream enrichment. Since all females are injected with Erythromycin prior to spawning, they cannot be placed into basin tributaries for nutrient enhancement. These adults are buried on-site in an earthen pit. All post-spawn adult male carcasses are scatter planted in several basin tributaries for nutrient replacement under permits obtained from WDFW and FWS.

4. Fertilization.

a) ***Protocols.***

- After milt from the primary and secondary male is added to the eggs, pathogen-free well water is added.
- Eggs are destroyed if the female displays gross BKD lesions.
- Each female is given a number, which corresponds to an individual incubator and a fish health tissue sample. The ELISA (Enzyme-Linked Immunosorbent Assay) method is used to detect BKD, which takes about 30 days to process. Eggs are not combined until fish health reports are complete.
- Egg lots are categorized via the ELISA method, ranging from very high to no detection. Egg lots, depending on their numeric value, are segregated from others.
- The culled eggs are disposed of in an earthen pit on station property. Typically, an additional 10% of females are taken to account for culled eggs due to moderate to high ELISA ratings.
- Eyed eggs are physically shocked before egg picking begins. The undeveloped or infertile eggs remain tender and will rupture when shocked. Within a few hours, these eggs turn white and are easily identified.
- Due to the large number of fish returning, cryopreserved gametes and pooled and factorial mating is felt to be unnecessary.
- Fish are randomly selected and randomly mated as close to a 1:1 male/female spawning ratio as possible. It is nearly impossible to attain a strict 1:1 ratio, however, because the sex ratio of returning adults is typically skewed 60/40 in favor of the females. There are times when, simply by chance, insufficient numbers of males come across the spawning table to exactly match the desired 1:1 spawning ratio. The actual ratio attained is usually 1.0 male: 1.1 females (i.e. some males are used more than once). Jack size fish (age 3 males) are randomly included in the spawning population. Should an extraordinary number of jacks return, the number included in the spawning population will be limited to 5% of the total number of males used per our Regional genetics guidelines.

b) ***Number of eggs collected and fertilized each year over past 10 years***
(See previous table)

5. ***Incubation*** (ET HGMP, P23, 29-30, CHMP, P39).

- Only one female per tray is incubated until the eggs reach the "eyed" stage.
- Following shocking and picking, each female's eggs are sampled for weight.
- A combined average is used for groups of 10 females.
- Eyed eggs are returned to incubation trays, loaded at 4000 eggs per tray.
- Incubation continues on chilled 40-500 F spring/ground water.
- Water flow is set at a minimum of 4 gallons per minute. Eggs are incubated in low pathogen (spring/well) water. Water temperature is continuously monitored every thirty minutes and logged by a remote temperature sensor. Water temperatures are converted to temperature units for each spawning day. For the Entiat SCS stock, it takes about 600 temperature units to reach the eyed stage and 1750 temperature units to the button-up stage or initial feeding.
- Well water passes through an aeration chamber prior to entering the nursery. Water oxygen levels are always at saturation.

- Eggs from individual females are kept separate until fish health tests are completed.
- Eggs from females with moderate to high levels of Bacterial Kidney Disease are discarded.
- Eyed eggs are mixed by egg take after they are "picked".
- Developing eggs are treated every other day with 750 ppm of formalin for fungus control until they reach 600 temperature units.
- The current SCS production is incubated on 100% ground water at 47-510F until "eyed".
- The eggs are shocked, picked, and inventoried by egg take.
- Eggs are returned to incubation trays and incubated on 100% ground water at 39-410F. Emergence is delayed until late February, early March.
- Previous broods, 2000 and older, were incubated on 100% ground water at 48-510F until emergence, which occurred in mid-December every year. This program change had to occur in order to hold Coho adults in our holding ponds. In the past, yearling Chinook needed the holding ponds for rearing space due to growth and because raceways were needed for the new brood. Chilling incubation water delays growth and the need for space so there is a brief window where the holding ponds can be used to hold Coho adults. All takes are incubated at variable temperature so that "ponding" can occur at the same time for all takes.

Table 4. Number of eggs taken and survival rates to eye-up.

Year	# Eggs	Survived to Eyed	Percent(%)
1988	612,188	548,520	89.6
1989	878,245	828,185	94.3
1990	804,660	768,450	95.5
1991	896,000	876,976	98.1
1992	885,400	861,494	97.3
1993	1,196,000	1,169,688	97.8
1994	168,000	162,120	96.5
1995	232,000	222,488	95.9
1996	387,600	378,685	97.7
1997	500,400	483,887	96.7
1998	441,000	423,801	96.1
1999	1,067,800	1,029,359	96.4
2000	756,000	706,104	93.4

6. Ponding.

a) ***Protocols*** (ET HGMP, P23, 29- CHMP, P39-40)

- Rearing facilities include 2 adult holding ponds, 30– 8 x 80 raceways, and 32 starter tanks, emergence occurs in late February to early March.
- Fry are moved from trays directly to the upper bank of 6 raceways for first feeding in early March. The remaining 12 raceways and two holding ponds contain yearling fish at this time.

- Percent survival to eyed egg stage has varied from 89.6% to 98.1% from 1988 through 2000 (Table 4).
-

b) ***Number of fry ponded each year, including % hatch each year*** (ET HGMP, P29).

7. ***Rearing/feeding protocols*** (ET HGMP, P23, 33, CHMP, P39-40).

- All fish are fed moist feed from BioOregon (Table 5). Dry feeds have been tried in the past with anecdotal evidence that dry feeds amplify losses due to BKD. Fish are fed several times a day when first on feed to once a day when they reach fingerling size. Need to balance growth with limited space and water to ensure the best possible fish health.
- Fry are reared on first pass ground water.
- Ponds are loaded pending scheduled tagging.
- In July, fish are marked/tagged and a total count of the fish on hand is made.
- Marked fish are loaded directly into one of the 18 raceways where most will remain until release in April; the exception is fish from A-bank are moved to the holding ponds in December where they will remain until release in April.
- The number of fish per pond is: A-bank, six ponds at 29,000; B-bank, six ponds at 20,000; C-bank, six ponds at 18,000; and, holding ponds, two ponds at 87,000 each.
- Entiat NFH does not have enough water of adequate quality to supply each rearing unit with first pass water therefore water is reused. The current water management scheme is to provide first pass water to A-bank; B-bank receives water from A-bank (second pass); and C-bank receives water from B-bank (third pass). The holding ponds generally receive water from C-bank. When fish are not in A-bank first pass water is provided to B-bank and is then reused by lower banks. Pond loading considers water reuse; ponds on reuse water have lower pond densities.
- Beginning with brood year 1997, rearing space has been managed so that density indices (the ratio of weight of fish to rearing unit volume and fish length) at no time exceed 0.15 In order to achieve the low indices, total production was reduced from 800 thousand to 400 thousand smolts.
- The raceways are brushed every other day from first “ponding” until the fish are “split” in July. Then raceways are then brushed once every three days until the fish are released. The adult pond is also vacuumed once every three days until release.

Table 5. Typical Entiat NFH feed type, application rates, and food/length conversion rates

MONTH	Feed Type	Feed Fed Per Day (lbs.)	Total Feed (lbs./mo)	Feeding Rate % BW/day [1]	Food Conversion (lbs. Fed/lbs. Gain)	Conversion Temp. Units Per in. growth[2]
December	BioMoist Starter #2	14	209	2.6	1.07	35
January	BioMoist Starter #3	21	534	1.9	0.91	37
February	BioMoist Grower 1.0mm	28	710	1.5	0.97	42
March	BioMoist Grower 1.3mm	49	1078	1.8	1.15	41
April	BioMoist Grower 1.5mm	70	1408	1.8	1.20	42
May	BioMoist Grower 1.5mm	87	1738	1.5	1.01	37
June	BioMoist Grower 2.0mm	100	2000	1.2	0.83	35
July	BioMoist Grower 2.0mm	163	2612	1.5	0.96	41
August	BioMoist Feed 2.5mm	190	3035	1.4	1.02	47
September	BioMoist Feed 2.5mm	197	3149	1.2	1.34	70
October	BioMoist Feed 2.5mm	181	2892	1.0	1.15	68
November	BioMoist Feed 2.5mm	204	2647	1.0	1.66	113
December	BioMoist Feed 3.0mm	201	2610	0.9	1.57	96
January	BioMoist Feed 3.0mm	168	2187	0.7	1.17	82
February	BioMoist Feed 3.0mm	149	2382	0.6	1.95	111
March	BioMoist Feed 3.0mm	155	3411	0.6	1.44	73

1- Factor utilized to determine feed application rates calculated as the % of body weight (BW) in total mass divided by total pounds fed.
2- temperature units per inch of growth are calculated by subtracting 32^0F from the average monthly temperature and length gain.

8. ***Fish growth profiles*** (ET HGMP, P30-32).

- Predominant growth (Figure 2) occurs the first spring and summer, from May through September. Minimal growth occurs during the fall and winter followed by a secondary period of increased growth just prior to release in April. Additional measures of fish performance are described in Table 6 and Table 7.
- Energy reserve data through routine monitoring of body fat content is not conducted on a routine basis. On a quarterly basis fish health profiles are conducted through the collection of a Goede Index that ascribes qualitative values to external and internal observations of fish health.

Table 6. Percent survival estimates for juvenile SCS, ENFH.

Brood year	Fry to Fingerling (%)	Fingerling to Smolt (%)
1989	99.8	99.8
1990	99.6	95.4
1991	97.8	96.4
1992	89.9	96.5
1993	97.3	95.8
1994	99.8	81.9
1995	99.0	84.5
1996	98.2	98.3
1997	98.8	97.1
1998	99.0	96.8

Table 7. Entiat NFH number, size, growth and condition values. These are average values for broods reared since 1990. Fish began feeding the end of the second week in December.

MONTH	Inventory (#fish)	Weight (lbs.)	Size (#/lb)	Size (gms)	Length (mm)	Length (in)	Condition Factors K= g/mm^3	Growth Rate (mm/mth)	Growth Rate (gms/mth)
Start	**410,000**	**342**	**1200**	**0.38**	**33.9**	**1.33**			
Dec	396,681	537	738.5	0.62	39.9	1.57	0.922	12.2	0.46
Jan	393,586	1,126	349.5	1.30	51.0	2.01	0.949	11.1	0.69
Feb	390,266	1,861	209.7	2.16	60.7	2.39	0.966	9.7	0.86
Mar	382,818	2,796	136.9	3.33	70.1	2.76	0.967	9.4	1.17
Apr	379,062	3,969	95.5	4.78	78.9	3.11	0.970	8.9	1.45
May	376,810	5,683	66.3	6.82	88.9	3.50	0.971	9.9	2.04
Jun	379,829	8,081	47.0	9.70	99.8	3.93	0.941	10.9	2.80
Jul	379,579	10,814	35.1	12.9	109.9	4.33	1.010	10.2	3.20
Aug	379,119	13,786	27.5	16.5	119.4	4.70	1.013	9.4	3.6
Sept	377,685	16,140	23.4	19.4	125.9	4.96	1.060	6.6	2.9
Oct	376,945	18,661	20.2	22.6	132.6	5.22	1.020	6.6	3.2
Nov	374,664	20,252	18.5	24.5	136.1	5.36	1.002	3.5	1.9
Dec	372,534	21,914	17.0	26.7	140.2	5.52	0.988	4.1	2.2
Jan	368,733	23,789	15.5	29.2	144.5	5.69	0.988	4.3	2.5
Feb	365,130	25,009	14.6	31.1	147.6	5.81	0.991	3.1	1.9
Mar	361,306	27,372	13.2	34.4	152.4	6.00	0.955	4.8	3.3
Apr	Fish released 1st week in April								

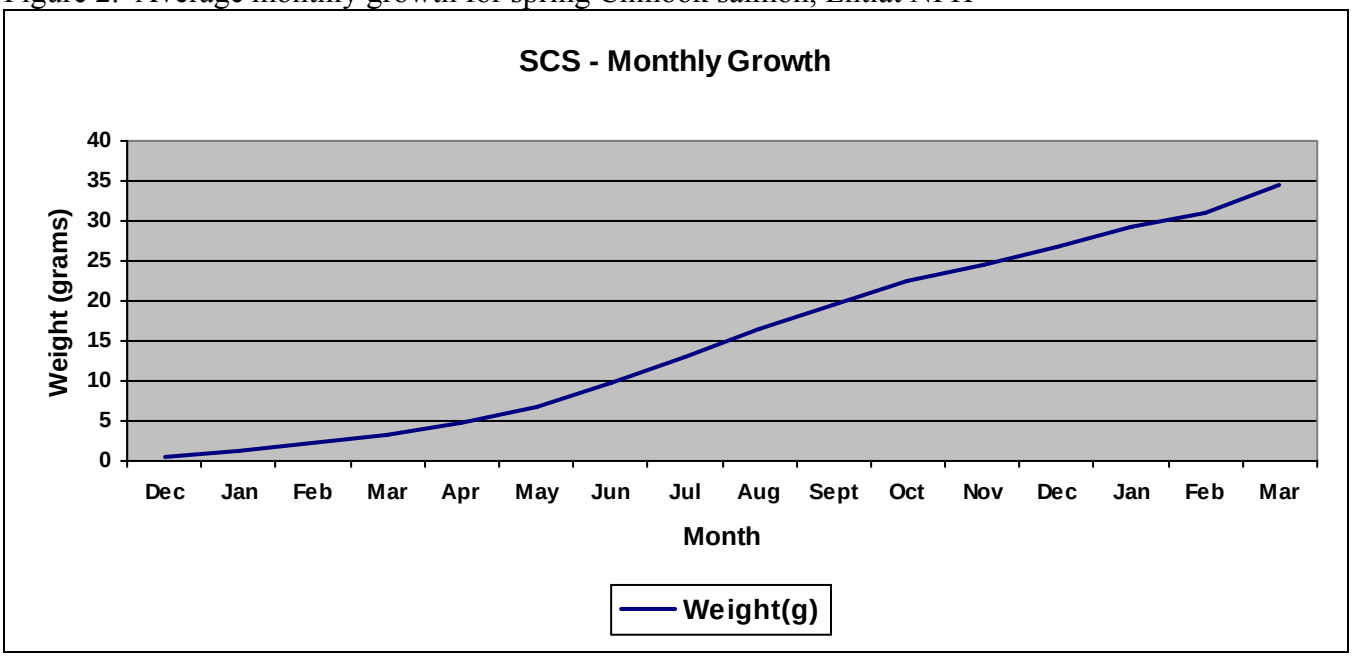
- Density and flow indices are the criteria by which standard pond management procedures adhere. These criteria include efforts to remain below a density index of 0.17 and below a flow index of 0.75 while maintaining production goals (Table 8).

Table 8. Monthly production density and flow indexes for yearling brood years from 1990 to present.

Month	Development Stage	Temp[1] Avg. ^{0}F	Water Source[2]		Flow (GPM)	Flow Index[3] Lbs./L(in) GPM	Density Index[3,4] Lbs./L(in)cuft
			% River	% Ground			
August	EGG	48.5	0	100	40	4000/tray	Na
September.	EGG	48.8	0	100	40	4000/tray	Na
October	EGG	50.5	0	100	40	4000/tray	Na
November	EGG/Alevin	50.5	0	100	40	4000/tray	Na
December	Alevin/Fry	50.0	0	100	1800	0.23	0.05
January	Fry	48.0	0	100	1800	0.37	0.08
February	Fry	47.0	0	100	1800	0.52	0.11
March	Fry	47.0	0	100	1800	0.56	0.14
April	Fingerling	47.0	0	100	5400[5]	0.53	0.11
May	Fingerling	46.7	0	100	5400	0.32	0.06
June	Fingerling	46.7	0	100	5400	0.40	0.08
July	Fingerling	47.6	0	100	5400	0.49	0.10
August	Fingerling	48.5	0	100	5400	0.58	0.12
September	Fingerling	48.8	0	100	5400	0.60	0.09
October	Fingerling	50.5	0	100	5400	0.66	0.09
November	Fingerling	50.5	0	100	5400	0.70	0.10
December	Year;ing	50.0	0	100	5400	0.74	0.11
January	Yearling	49.0	0	100	5400	0.77	0.11
February	Yearling	48.5	0	100	5400	0.72.	0.11
March	Yearling	47.5	10	90	5940	0.70	0.12
April	Yearling/Smolt	47.0	20	80	6480	0.72	0.12

Unless otherwise indicated all values are for end of the month totals or values obtained for the last ten days of the month.
Dissolved oxygen is measured during critical periods of disease, elevated temperatures, restricted flows, or fouled water. Minimum $d0_2$ standards for salmonids are 5 mg/L (Piper et al 1982)*. [1]Temperature data is electronically measured every .5 hours and averaged for the month.
[2]Data indicates approximate water source usage. Actual usage depends on a variety of factors including disease and maintaining water temperatures (through well /river mixing) to minimize the formation of slush ice in winter and not to exceed 68^{0}F in summer.
[3]Estimated GPM used by brood including re-use. Calculated by dividing total weight (lbs.) by the average length (in.) X FI.
[4]Index averaged from Entiat NFH lot history records from brood years 1997 and 1998.
*Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, & J.R. Leonard. 1982. Fish Hatchery Management. US Department of Interior. Pp. 503. Washington DC. [5] Serial Re-use; water is re-used twice; 1stpass, 2nd pass and 3rd pass rearing.

Figure 2. Average monthly growth for spring Chinook salmon, Entiat NFH



9. ***Fish health*** (ET HGMP, P30, 36).
   - Disease monitoring is accomplished through daily observations by hatchery staff and monthly monitoring by fish health biologists/pathologists from the OFHC.
   - Any abnormal situations observed by hatchery personnel are called to the attention of the OFHC, which performs diagnostic and confirmatory clinical tests before recommending appropriate treatments.
   - Treatment procedures may include environmental manipulation to control stresses and enhance the fish's ability to recover from infectious agents and/or appropriate chemicals or antibiotics.
   - Pre-release certification procedures are selective grab samples of moribund fish in the population followed by non-selective grab samples to make up a minimum of 60 fish (to statistically satisfy the assumed pathogen prevalence level of 5%) of each production group of fish. Kidney and spleen samples are tested for the presence of reportable viruses and bacteria.

10. ***Chemotherapeutant use*** (ET HGMP, P30).
   - Antibiotics and chemicals that are registered for fish disease treatments are applied as per labeled instructions. Other therapeutic drugs and chemicals may be applied through appropriate INAD permits or by allowable extra-label prescription by staff Veterinary Medical Officer or local veterinarian.

11. Tagging and marking of juveniles (ET HGMP, P36).
   - Current production is marked at 50% CWT and ad-clip combination with the remainder having an ad-clip only (total is 100%).
   - This marking scenario is covered under the 2001 Draft Biological Opinion (BiOp) issued by NMFS covering unlisted hatchery production in the upper Columbia Basin.

12. Fish Release.

a) ***Protocols*** (ET HGMP, P34-36).

- Proposed release levels include 400,000 yearlings at 18 to 20 fish per pound into the Entiat River and 100 adults into OmaK Creek annually (Table 9).
- From 1990 to 2001, release dates ranged from April 1 to April 19.
- All juveniles were yearlings and were forced out of the ponds.
- Historically, smolts from ENFH have shown early signs of smolt stress.
- April 1st, is the earliest date at which fish can be released.
- River conditions and by-pass operations at Rocky Reach and Rock Island Dams are also considered prior to release.
- The sub-yearling program was terminated after 2000.
-

Table 9: Proposed fish release levels.

Age Class	Maximum Number	Size (fpp)	Release Date	Location
Eggs				
Unfed Fry				
Fry				
Fingerling				
Yearling	400,000	18 – 20	April 1-15	Entiat River
Adults	100	NA	June - July	Omak Creek

b) ***Number of fish released each year (subyearlings?; yearlings?; other?)*** (ET HGMP, P34-36).

- Numbers released and size at release has varied from 1988 through 2000 (Table 10)

Table 10. Numbers and size of fish released through the program. (data source: hatchery records).

Release year	Eggs/ Unfed Fry	Avg size	Fry/Fingerling	Avg size (fpp)	Sub-yearling	Avg size (fpp)	Yearling	Avg size (fpp)
1988			263,018 24,942 10,800	541.0 320.0 101			838,940 56,493	21.026.0
1989							2,109,923	20.6
							129,754	18.5
1990							2,251,503	18.1
							52,734	17.9
1991					377,946	79.4	819,764	20.2
1992					361,590	52.6	347,500	15.0
1993					332,178	42.0	376,462	14.4
1994					399,429	38.7	378,729	13.5
1995					186,817	50.8	392,011	13.5
1996							332,593	13.3
1997							200,486	9.7
1998					164,999	41.3	350,784	10.8
1999							354,238	11.3
2000					421,126	43.8	397,855	12.7

Release year	Eggs/ Unfed Fry	Avg size	Fry/Fingerling	Avg size (fpp)	Sub-yearling	Avg size (fpp)	Yearling	Avg size (fpp)
Average			22981	504				

D. **Program benefits and performance.**

1. **Adult returns.**

a) ***Numbers of adult returns (need data for the past 10-20 years)*** (ET FPR, P14).

- Adult returns to the hatchery have ranged from 80 to 2,666 from 1994 through 2005 (Table 11).

Table 11. Entiat NFH spring Chinook adult brood stock management, performance, and spawning practices, 1994-2005.

Return Year	Hatchery Return	Surplus	Returned to Stream	Jump Outs DIP's	Kept for Propagation			Green, Bad Spent	Used for Production	Pre-spawn Survival[1]	Spawn Ratio		Green Eggs Taken	Average Fecundity
					Males	Jacks	Females				Males	Females		
1994	80	0	0	7	27	4	42	0	73	91.3%	1.0	1.40	168,000	4,000
1995	121	0	0	4	55	3	58	1	116	96.7%	1.0	1.00	232,000	4,000
1996	175	0	0	4	62	7	102	0	171	97.7%	1.0	1.50	387,600	3,800
1997	275	0	0	19	102	2	139	13	243	93.1%	1.0	1.30	500,400	3,762
1998	216	0	0	5	69	14	126	0	209	97.7%	1.0	1.50	441,000	3,500
1999	724	246	0	15	144	34	281	3	456	97.9%	1.0	1.60	1,067,800	3,840
2000	1,919	1,478	0	7	115	17	150	2	280	99.6%	1.0	1.10	540,000	3,650
2001	2,666	2,350	0	9	128	11	165	0	304	99.7%	1.0	1.20	635,250	3,850
2002	1,834	1,558	0	5	130	5	135	0	270	99.7%	1.0	1.00	508,101	3,763
2003	884	542	0	31	126	25	143	4	293	96.5%	1.1	1.00	607,750	4,250
2004	759	452	0	5	118	12	150	2	278	99.3%	1.0	1.20	600,000	4,054
2005	763	466	0	1	127	17	144	6	282	99.9%	1.0	1.00	504,000	3,500
AVE	868	591	0	9	100	13	136	3	248	97.4%	1.0	1.2	515,992	3,831
MAX	2,666	2,350	0	31	144	34	281	13	456	99.9%	1.1	1.6	1,067,800	4,250
MIN	80	0	0	1	27	2	42	0	73	91.3%	1.0	1.0	168,000	3,500
STDEV	839	782	0	8	37	10	59	4	99	2.8%	0.0	0.2	225,444	223

[1]Pre-spawn survival is the hatchery return minus the # of DIP's/Jumpouts, divided by the hatchery return.

b) ***Return timing and age-class structure of adults*** (ET FPR, P39, 56).

- Little data is currently available to address adult return run timing.
- Recently, PIT tags in returning adults combined with improved dam ladder detection systems have produced some data regarding the run timing characteristics of the adult return (only 5 age-3 adults were represented with PIT-tags in 2003) (Figure 3 and Table 12).

Figure 3. A comparison of run timing between Leavenworth and Winthrop NFH adult pit-tagged spring Chinook over Bonneville Dam, 2003.

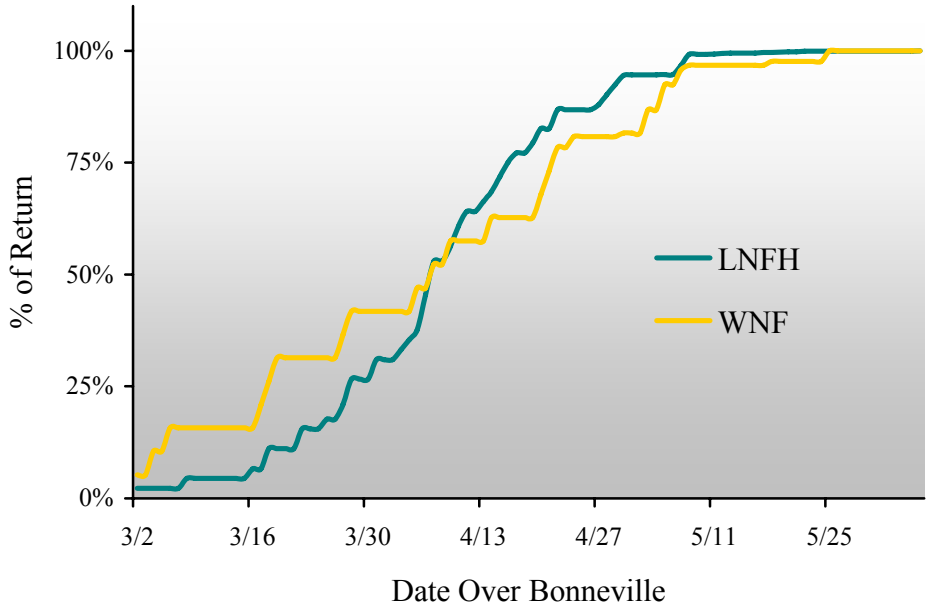


Table 12. Leavenworth Complex spring Chinook age composition of adults by brood year for each facility, 1989-2000.

c) ***Smolt-to-adult return rates*** (ET FPR, P65-66, HGMP, P7).

- Smolt to adult survival rates have varied from 0.009% to 0.129% for 1983 through 1994 brood year releases (Table 13).

Table 13. Number of yearling spring Chinook released, adult returns by brood year and corresponding smolt to adult survival (%) from Entiat NFH, 1980 to 1994 (USFWS 2002).

Brood year	Smolts Released	Adult returns (BY)	Smolt to Adult Survival (%)
1983	894,631	1,155	0.129
1984	835,090	216	0.026
1985	925,000	929	0.100
1986	838,940	449	0.054
1987	791,263	490	0.062
1988	585,800	742	0.127
1989	818,707	450	0.055
1990	343,150	30	0.009
1991	376,462	127	0.032
1992	378,729	182	0.048
1993	391,211	244	0.062
1994	335,593	240	0.072

d) ***Stock productivity*** (e.g. recruits per spawner).

2. Contributions to harvest and utilization (e.g. food banks) (ET HGMP, P16, 26).

- The average adult return to Entiat NFH for the past 25 years has been just over 600 adults which prohibits any significant harvest (Table 14).
- When returns can be become more predictable and with 100% marking of hatchery stock, a limited sport harvest combined with an on station tribal surplus may occur. (Production numbers are derived from the *U.S. v. Oregon* court decision.)

Table 14. Number of ENFH SCS adults harvest, 1988 to 1999.

Year	1988	1989	1990	1991	1992	1993
Entiat Basin Harvest	0	0	0	0	0	0
Outside Basin Harvest	64	8	0	9	13	52

Year	1994	1995	1996	1997	1998	1999
Entiat Basin Harvest	0	0	0	0	0	0
Outside Basin Harvest	8	12	7	0	16	25

- Under an agreement with Bureau of Indian Affairs, adults collected in excess of brood stock needs are donated to various tribes for ceremonial and subsistence purposes. A small portion may also go to non-profit groups. Also, up to 100 adults may be transferred to Omak Creek in Okanogan County.

3. Contributions to conservation (ET HGMP, P3).

- There is no primary intent for returning adults to be used for any purpose other than harvest, brood stock, and stream nutrient enhancement.

4. ***Other benefits*** (ET HGMP, P27).

- All females are injected with Erythromycin prior to spawning, and cannot be placed into basin tributaries for nutrient enhancement. These adults are buried on-site in an earthen pit. All post-spawn adult male carcasses are scatter planted in several basin tributaries for nutrient replacement under permits obtained from WDFW and FWS.

E. ***Research, monitoring, and evaluation programs***.

- The Mid-Columbia Fisheries Resource Office (MCFRO) provides monitoring, evaluation, and coordination services concerning Entiat NFH production. The MCFRO staff monitors hatchery returns, biological characteristics of the hatchery stock, fish marking, tag recovery, and other aspects of the hatchery program. They maintain the database that stores this information and serve as a link to databases maintained by other entities. The MCFRO also cooperates with the hatchery, fish health center, Abernathy Fish Technology Center, and co-managers to evaluate fish culture practices, assess impacts to native species, and coordinate hatchery programs both locally and regionally. These activities are described in the following section.
- Database Management.—The Fisheries Information System (FIS) is a national database system for the Service's Fisheries Program. Each Service field office contributes to this database. The FIS consists of five different databases, two of which, Fish and Egg Distribution databases document production accomplishments from all National Fish Hatcheries. This database is discussed further in Chapter 4.
- Information from and about Entiat NFH is connected to the broader fisheries community of the West Coast of the North American Continent through the U.S. Fish & Wildlife Service Columbia River (information) System (CRiS). The following information is recorded in files that are components of the CRiS database: adult, jack and mini-jack returns to the hatchery; age, sex, length, mark and coded-wire tag information for returning fish that are sampled; egg development and disposition; the origin of fish raised at the hatchery; and fish transfers and releases. Entiat NFH maintains files containing information generated at the hatchery (brood stock management, incubation, rearing, and release). Staff from MCFRO maintains files containing information on marked juvenile fish and on sampled adult fish (adult bio-samples).
- Use of CRiS database files and programs achieves the following multiple purposes: 1) reduces the amount of effort expended to meet reporting requirements, 2) increases the quality and consistency of data, 3) facilitates development of software usable at all stations, 4) provides a platform on which to build effective evaluation tools which can be used by hatcheries, fisheries management and regional offices, and 5) facilitates the exchange of information with other agencies. For example, release and recovery information is reported to both the Regional Mark Information Center and the StreamNet databases.
- Computer programs that are components of the CRiS database are used to transform data into formats required by other agencies. These formats can be either electronic or printed. Other CRiS programs combine data from the hatchery, CRFPO, and from databases maintained by other agencies into other formats to accomplish reporting, monitoring, and evaluation.
- **Marking/Tagging Program**.—Juvenile fish are fin clipped, coded-wire tagged and/or PIT tagged at Entiat NFH by CRFPO to monitor and evaluate fish cultural techniques, survival and fishery contribution. Presently all spring Chinook salmon are fin clipped at Entiat NFH to identify hatchery fish in selective fisheries and to measure the impact on wild anadromous and resident stocks of fish in Entiat River. This action is in compliance with recommendations of the Biological Opinions of NMFS's 1999 Artificial Propagation in the Columbia River Basin and the 2000 Reinitiating of

Consultation on Operation of the Federal Columbia River Power System, under the Endangered Species Act-Section 7 Consultation.

- **Bio-sampling and Reporting**.—State and tribal coast-wide sampling of sport, tribal, and commercial fisheries and hatchery rack return sampling, by MCFRO and the hatchery staff, provides total recovery and survival estimates for each brood year released.
- Coded-wire tag recovery information is used to evaluate the relative success of individual brood stocks and compare performance between years and hatcheries. This information is used by salmon harvest managers to develop plans to allow the harvest of excess hatchery fish while protecting threatened, endangered, or other stocks of concern.
- Until 2001, snouts were removed from all adipose fin-clipped fish to recover coded-wire tags. A percentage of unmarked fish were sampled for length, sex, and scales (age). The percentage of fish sampled was set high enough that at least 500 fish were sampled. These samples, and a subset of fish sampled for coded-wire tags, were used to determine the age composition of fish returning to the hatchery (Attachment 15). Starting with brood year 2000 all production fish were adipose fin clipped. All returning fish are now checked for coded-wire tags by passing them through a tag detection unit. Mass marking will allow selective fisheries and will help us determine production of wild or feral spring Chinook salmon in the Entiat River.
- **Hatchery Evaluation Studies**.—Hatchery evaluation is the use of replicable, statistically defensible studies to guide management decisions. The hatchery evaluation vision action plan developed in 1993 for Region 1 Fisheries describes hatchery evaluation in greater detail (USFWS 1993). The purpose of hatchery evaluation is to simply determine what works and doesn't work through planning, implementing, documenting, monitoring, analyzing, and reporting.
- Past studies include National Marine Fisheries Service's (NOAA Fisheries) coded-wire tagging of Willard stock coho and Carson stock spring Chinook salmon reared at Carson NFH in the late 1970's and early 80's. This study evaluated imprinting and homing mechanisms of fish released at various locations in the Columbia River basin (Slatick 1988). Abernathy Fish Technology Center has also conducted hatchery evaluation studies at the hatchery. For example, brood years 1982 to 1985 spring Chinook from Carson were marked and coded-wire tagged for a rearing density study (Banks 1994). As a result of this study, rearing densities in hatchery raceways were reduced. The guidelines being implemented as a result of the density study are to keep the rearing density index at 0.25 or lower with a flow index greater than 1.0. The present production goal at Carson NFH is 1.42 million smolts.
- A study to evaluate survival of spring Chinook from the effects of fin clipping and coded-wire tagging was completed as part of a three brood year (1989-91), three hatchery investigation (Carson NFH, Oregon's South Santiam, and Washington's Cowlitz hatcheries). The results and conclusions of this study are forthcoming.

F. **Program conflicts (Need to document proportion of natural spawners composed of hatchery-origin fish).**

1. ***Biological conflicts*** (e.g. propagated stock maladapted to hatchery water source) (ET HGMP, P8).
    - ENFH lacks a quality water source for the production program.

2. ***Harvest conflicts*** (e.g. mixed stock fishery on hatchery and wild fish limits harvest opportunities on hatchery fish) (ET HGMP, P26).
    - The average adult return to Entiat NFH for the past 25 years has been just over 600 adults which prohibits any significant harvest.
    - When returns can be become more predictable and with 100% marking of hatchery stock, a limited sport harvest combined with an on station tribal surplus may occur. (Production numbers are derived from the *U.S. v. Oregon* court decision.)

3. ***Conservation conflicts*** (e.g. competition between unlisted hatchery fish and ESA-listed wild fish) (ET HGMP, P8-9).
    - NOAA Fisheries asked for the elimination of the sub-yearling program (400k annually) and this was accomplished.
    - Currently, there is a hatchery/wild fish genetic study underway and tissue samples are being taken from both populations. The results may have a great impact on the future of the Entiat program.
    - The USFWS has been collecting genetic samples from naturally spawning and hatchery populations for 2 or 3 years. NOAA Fisheries has published a preliminary report on their initial findings; **Population genetics of Entiat River spring Chinook salmon: a preliminary analysis** (Ford, 2002). Though this report is very preliminary in the overall analysis, it states "the similarity of the Entiat River wild samples and the Entiat NFH samples suggests that Entiat NFH salmon have successfully spawned and introgressed into or replaced the natural Entiat River population."
    - Another key issue in the Entiat Basin is whether to keep this river as a "reference" stream. This is potentially the only basin available in the upper-Columbia River ESU where the effects of supplementation can be measured against areas without hatchery influence.

4. ***Other conflicts between the hatchery program, or fish produced by the program, and other non-hatchery issues (ET HGMP, P 16-17).***

- Anadromous salmonid populations in the Entiat sub-basin are influenced by the following out-of-sub-basin impacts; degraded estuarine habitat, fish harvest, unfavorable ocean conditions, and the effects of eight Columbia River reservoirs and hydroelectric dams on smolt and adult migration.
- The ability of the Entiat watershed to fully sustain salmon populations is most limited by a lack of over-wintering juvenile habitat. Losses in floodplain and riparian zone connectivity and function have dramatically altered natural hydrological and geomorphic processes essential to juvenile survival (CBFWA 2002).
- Other factors have also contributed to the simplification of fish habitat. Historically, moderate to heavy sheep grazing in the uplands modified the under story grassy communities, and the removal of beaver diminished water storage

capacity and altered flow regimes. Timber harvest, fire suppression, and the conversion of floodplains to crops, pasture, roads, and urban uses has contributed to losses of important salmonid rearing habitat through compacted soils, simplification and destruction of vegetative communities, accelerated sediment and water delivery to stream channels, and increases in the frequency, intensity and duration of flood and mass wasting events. These conditions can hinder salmon productivity and/or lead to mortality of eggs, juveniles and adults (Andonaegui 1999).

VI. Winthrop National Fish Hatchery.

A. Description.

The Winthrop NFH is located in north central Washington state, in Okanogan County. The 42-acre hatchery site lies 100 miles north of Wenatchee. The hatchery boundaries border on the city limits of the community of Winthrop. The Methow River flows through the northern edge of the property, directly above its confluence with the Chewuch River. The hatchery sits on developed river-bottom at river mile (RM) 50 on the Methow River which enters the Columbia River 524 miles upstream from the Pacific Ocean and 8 miles upstream from Wells Dam. Nine Columbia River dams lie in the migration corridor. Elevation of the facility is at 1755 ft. mean sea level (MSL), however the Methow drainage originates in the north Cascade Mountain Range, containing peaks within the Methow basin which reach elevations to nearly 9,000 ft. at Mt. Gardner , fourteen miles to the northwest. The hatchery has five buildings involved in fish production, three residences, and two large pond covers. Currently, there are no plans for new buildings; however, the hatchery would like to replace two severely deteriorated banks of raceways and include large roof structures. The hatchery's outdoor rearing units include 46 raceways, 16 Foster-Lucas ponds, and 2 adult holding ponds.

B. Water Supply.

Winthrop NFH's water supply is a mix of Methow river, infiltration chambers (Spring Branch Spring) and two wells (of 6000 GPM capacity). Water rights from all supplies total 30,483GPM (115,980 L/min) and water use ranges from 8731 GPM to 28343 GPM (33,050 L/min to 107,280 L/min). The main water source for the Winthrop NFH is the Methow River, from which the hatchery has the right to 50 cubic feet per second (cfs). Spring Branch Springs and a system of infiltration galleries provide a lesser amount of water (approximately 17 cfs combined water flow). The infiltration galleries are of great importance to the success of the hatchery because they provide a warmer flow essential for fish production during the cold winter months, and they also provide a relatively pathogen free water source, which is beneficial to egg incubation and early rearing.

In 1989, a change in the Methow River Water Right was negotiated with the Washington Department of Ecology. The negotiation allows the Washington Department of Fish and Wildlife hatchery to use up to 7 cfs of water in the event of an emergency water shortage at the State facility, provided the flow is <u>not</u> required at the Winthrop NFH.

Ground water temperatures in the nursery range between 47-52 degrees F. Spring Branch Spring also provides water in the same temperature range which is used as a direct source only as a last resort in the outside rearing units. However, this water does mix with the Foghorn Ditch water above the Winthrop NFH intake. Therefore, the river source does include a small percentage of Spring Branch Spring water. The Methow River source is the main supply for the outside rearing units during the winter months, and is very susceptible to temperature swings with seasonal fluctuations from as low as 32-33 degrees F in December to as high as 67 degrees F in August. Since the river water contains the most pathogens, use of this source is usually avoided during early rearing of all salmonids. Gallery #2 is often

utilized in the winter to help alleviate ice and slush build-up, and to attempt to maintain a temperature at which salmon can actively metabolize feed.

The Foghorn diversion dam on the Methow River is a rock and boulder structure which backs up the river in order to divert multi-purpose water to the Foghorn Ditch. The structure has existed in some form for irrigation purposes long before the construction of the hatchery in 1938. Adjacent to the dam on the south shoreline a diversion structure serves to collect water for the Foghorn Ditch and provides fish passage around the dam by means of a fish ladder. The structure also has an adult salmon trap built in for the purpose of collecting wild adult salmon, however this trap has proven to be ineffective since the dam is really not a fish barrier during most of the year.

All users of surface water in the Methow subbasin are required to have fish screening devices built in to protect threatened, endangered, and unlisted wild fishes. The hatchery owns and operates two such structures on the Foghorn Ditch. The Foghorn Irrigation screen is located just below the hatchery intake and has recently been reconstructed to meet strict requirements developed by NOAA Fisheries and the Washington Department of Ecology. The Winthrop NFH fish screen has also been recently reconstructed to meet these requirements. Both screens are rotary type drum screens which guide fish into a bypass channel which runs behind the hatchery and returns wild fish to the Methow River.

C. Adult Broodstock collection facility.

1. Spring Chinook.

- *In recent years, the phase out of the Carson stock spring Chinook salmon at Winthrop NFH has resulted in some modified approaches to collecting spring Chinook for the hatchery's broodstock.*
- *Early in the phase out, collection plans included racking off the hatchery discharge channel to block entrance of the Carson stock to the facility and collecting localized, Methow Composite, stock from the outfall channel at the Methow SFH.*
- *Only since 2003, has the hatchery been able to return to operating its fish ladder and collect fish returning to the hatchery as the pure Carson stock were no longer in the river system. (From CHMP)*
- *Adult fish are held in upper end of fish ladder in pathogen-free water – large concrete 50'X 100' adult holding ponds are not used. They are too deep and too wide to easily collect fish.*
- *Current need: Either demolish current structure and rebuild to a more useable design or modify present structure to be more user-friendly.*

2. Coho.

- Winthrop NFH is the only Leavenworth Complex facility currently providing a complete coho production program.
- Adults return to the hatchery ladder and are spawned, incubated, reared, and released as yearlings for the most part back to the Methow River.

3. Steelhead

- Broodstock is collected at Wells Dam/Hatchery. Broodstock are collected from the West Fish Ladder at Wells Dam, and from volunteer returns to the Wells Hatchery.

- Broodstock are held and spawned at the Wells Hatchery facilities. Eggs are incubated to the eyed-egg stage at Wells Hatchery and then transferred to WNFH.

D. Broodstock holding and Spawning Facilities

Returning adults come back to the hatchery via the bypass/discharge channel which flows into the Methow River approximately 1/4 mile below the hatchery. The trap and the holding pond now being used is the unfinished adult facility built in 1985 and modified for safety and efficiency in 1998. Pathogen-free well water supplies the pond. The spawning shed sits next to the holding pond.

Adults are held in a 50' x 100' pond and at a density of one fish per eight cubic-feet of rearing space and a flow of 1 gpm per adult. Pathogen-free well water supplies the pond. The spawning shed sits next to the holding pond. Gametes are placed in "zip-lock" bags (not mixed yet), oxygenated, and placed into coolers with ice. The gametes are then taken inside where they are mixed. No mixing occurs until all coded-wire-tags are de-coded.

E. Incubation Facilities

1. Spring Chinook Salmon

- Isolation buckets are used from fertilization to the eyed stage. The eggs remain in the iso-buckets until eye-up, approximately one-month (450-540 TU's) after spawning.
- All incubation takes place in 100% 48°-50° F ground water. Fry from females with high levels of Bacterial Kidney Disease are released unfed to the back channel unless needed to meet production goals.
- After the eggs are eyed, they are shocked and hand-picked. From the incubation buckets, fish are transferred to the Heath trays at a loading of one isolation bucket (progeny of one female) per tray (3000 to 6000 eggs/tray). Flows in isolation buckets are 1 to 2 gpm to the eyed stage and 3 to 6 gpm in the Heath trays from the eyed to button-up fry stage.
- Dissolved oxygen is relatively constant at 9ppm on the inflow and not less than 8ppm at the outflow. It is not necessary to use formalin during incubation since *saprolegnia* fungus or silt have not been a problem.

2. Coho Salmon.

- Eggs from two females are incubated together in each Heath tray. At the eyed stage, dead eggs are removed. Viable eggs are counted and placed back into Heath trays for hatching and larval development.
- Eggs are incubated on 100% ground water until hatching, at which time river water(36°-42°) is introduced to slow the development process. The first take of eggs hatch in min-November.

3. Steelhead.

- Eggs are received from Wells SFH in February and are placed in Heath trays at approximately 5000 eggs per tray.
- All incubation takes place in 48°-50° F ground water. The first take of eggs hatch in mid-March.

F. Indoor Rearing Facilities.

Emergence occurs in December and January when fry are moved from the trays to the starter tanks. Total rearing space for the starter tanks is 89 cubic feet and flows are at 15 to 20 gpm. Spring Chinook are fully buttoned up at 1800 DTU and are ponded-out at this time. Swim-up fry average 1.3 - 1.4 inches (1200 to 1500 fish per pound). Ponding is forced as trays are removed from the Heath stacks and transferred to a tub of water and moved to the appropriate start tanks. Density indices are kept below 0.15 lbs/cu.ft./inch during early rearing. The following May or June, the fry are moved to the raceways and the goal is to not exceed a DI of 0.11.

G. Outdoor Rearing Facilities.

Rearing units include 30 – 8' x 80' raceways, 16 – 12' x 100' raceways and 16 – Foster-Lucas ponds. All spring Chinook salmon are reared on 100% ground water for the first year of rearing, if possible.

1. Spring Chinook Salmon.

- Fry are moved to inside nursery tanks and outside Foster-Lucas ponds for their initial feeding. Fry are fed BioOregon's starter feed and BioMoist feeds throughout rearing. During late January, all spring Chinook fry are moved outside to occupy 8 Foster-Lucas ponds and remain there until after the previous broodyear is released and other raceways are cleaned and disinfected.
- The fish marking staff from Columbia River Fishery Program Office (CRFPO) tags, inventories and moves all fish in May. May is the optimal time to mark fish at this facility for two reasons: 1) The fingerlings are about 100 fish/pound, a good size for marking and handling; 2) fingerlings are near their maximum pond density and need to be moved.

2. Coho Salmon.

- Fry are moved to inside nursery tanks in February for their initial feeding. Feed type remains the same as for spring Chinook fry.
- Coho are generally marked immediately following the spring Chinook in May at which time they are moved to their final rearing ponds.

3. Steelhead.

- Fry are moved to inside shallow troughs in April. After all fry have started feeding and growing readily, they are moved to the inside nursery tanks (within 3 weeks). Fry are fed BioOregon's starter feed and BioMoist feeds throughout rearing.
- Steelhead are marked in July or August and moved outside to the Foster-Lucas ponds where they can be isolated on ground water for steady growth through November. When the fish are greater than 15 fish per pound, usually early December, they are moved to 4 – 12' x 100' raceways, their final rearing location.
- Beginning with brood year 2000, rearing space has been managed so that density indices at no time exceed 0.11 for spring Chinook salmon and 0.20 for steelhead and coho salmon. Reduced production numbers and reduced densities appear to have led to a decline in a number of disease problems. (from CHMP)

H. Release Locations and Facilities.

Spring Chinook Salmon - Smolts are mass released directly into the outfall channel (leading to the Methow River) at a size of 16 to 18 fish per pound to minimize interactions with other fish populations.

Coho Salmon – Smolts are volitionally released directly into the outfall channel at a size of 16 to 18 fish per pound to minimize interactions with other fish populations. Releasing fish at 18 fish/pound or larger helps ensure that the released fish are functional smolts which actively migrate through the Methow River corridor.

Steelhead - Smolts are volitionally released directly into the outfall channel at a size of 6 to 8 fish per pound to minimize interactions with other fish populations. Releasing fish at 8 fish/pound or larger helps ensure that the released fish are functional smolts which actively migrate through the Methow River corridor.

I. Outmigrant monitoring facilities.

There are no FWS-operated outmigrant monitoring facilities below the Winthrop NFH. The Mid-Columbia FRO receives reports on outmigrant movement from the dams as the fish pass. There are both state and tribally (Yakama) operated traps but they are targeting species other than those released by the hatchery. They do report their findings to Mid-Columbia FRO.

J. Additional or Special Facilities.

The hatchery outfall channel has been enhanced for natural spawning adult steelhead which return to Winthrop NFH. Spawning surveys and redd counts are conducted each spring on the channel as part of the WDFW annual steelhead spawning surveys.

K. Outreach and public education facilities/programs.

An estimated 3,000 guests visit Winthrop NFH annually. These visitors come from all walks of life, diverse backgrounds and ages and are documented from hatchery tour records, tour bus companies, guest book registrations, special events and walk-ins. Our visiting public has become much more educated about natural resources. Many visitors and tour groups want an in-depth visit to the hatcheries in our Complex. The challenge faced by the I&E Department is to maintain quality interpretive and educational messages that stimulate thinking and conversation on all aspects of salmon issues. Hatchery tours are custom-made per group and include natural resource interactive games, interpretive trail walks, fish viewing, hands-on projects and more.

On Station: I&E activities held on station include guided and self-guided tours. The facility serves schools from throughout north central Washington, primarily from the Methow Valley. Many tours are conducted for adult groups including Elderhostel, tour bus companies, community school and several special interest groups. Hundreds of individuals and families, business groups and hotel/motel visitors enjoy the self-guided approach that the hatchery offers by way of a brochure and on-the-ground signing. Primarily, these audiences are seeking answers to questions concerning water use, history of Winthrop NFH, hatchery operations, Native American fishing, and other contemporary salmon issues.

The hatchery hosts both a Kid's Fishing Day and a fishing day for the physically challenged. They also host a Watershed Watchers event for the local 7th grade class.

The Winthrop NFH Kid's Fishing Day is the largest special event which Winthrop NFH hosts annually during National Fishing Week (a Saturday in June). This multi-partnered event also includes environmental education activities.

Another significant event held at Winthrop NFH is the Watershed Watchers event developed for the local 7th grade science classes. This is also a one-day event which involves a number of watershed related educational activities for the students.

Off station: Outreach efforts include an array of activities that occur throughout north central Washington State. The Outreach program provides counsel and fills requests for environmental education curriculum, interpretive materials and partnership building for all hatcheries in the region. The Winthrop NFH staff travels to other special festivals and events throughout eastern Washington assisting the Leavenworth National Fish Hatchery, the Wenatchee and Okanogan National Forests, Chelan County Conservation District and Chelan PUD.

L. Special Issues and Problems

1. **Adult Spawning area-**
   A. **as presently used is inadequate in size and awkward to use – Correction –** Either demolish current structure and rebuild to a more useable design or modify present structure to be more user-friendly
2. **Foster-Lucas ponds should be replaced –** F-L ponds A,B, C should be replaced with covered raceways and predator exclusion.
3. **Predator exclusion should installed over all outdoor rearing units**
4. **Expand capacity of infiltration gallery – Correction –** Presently on-going with extension of gallery laterals.
5. **Replace infiltration gallery single speed pump motor with variable speed motor. –** Identified by BOR as a need.
6. **Add perimeter fences for security and predator exclusion.**
7. **Rehabilitate effluent/pollution abatement pond at all three hatcheries**

VII. Methow Composite spring Chinook hatchery program, Winthrop NFH.

A. General information.

- Two salmon hatcheries operate in the Methow Basin, Methow State Fish Hatchery (SFH) and Winthrop NFH. Both were built for mitigation purposes, but with different objectives.
- The Winthrop NFH is intended to provide harvest mitigation whereas the Methow SFH is intended to provide conservation and harvest benefits for indigenous natural populations of spring Chinook.
- The two hatcheries are working collaboratively to propagate one "Methow Composite" stock. In addition, the Methow SFH maintains a separate, native spring Chinook broodstock program for the Twisp River and, in some brood years, a separate broodstock for the Chewuch River derived from natural and hatchery-origin adults trapped there.
- A critical limitation to achieving conservation goals for both hatcheries has been difficulties trapping wild adults for broodstock, particularly in the mainstem Methow River.

B. Stock/Habitat/Harvest Program Goals and Purpose.

1. Purpose and justification of program.

- *The original purpose of this program was to mitigate for Grand Coulee Dam.*

2. Goals of program.

- Since the ESA listing of spring Chinook salmon in 1999, the goals/objectives of this program have changed.
- *The initial goal was to provide harvest, while the current goal is to aid in the recovery of listed spring Chinook in this ESU.*
- *Prior to 1999, the spring Chinook salmon stock propagated at this hatchery was derived from the Carson NFH ("Winthrop-Carson stock"). This stock was not listed under the ESA; therefore, when upper Columbia River spring Chinook salmon were listed in 1999, the decision was made to switch from the unlisted Winthrop-Carson stock to the listed Methow Composite stock.*
- The last release of "pure" Carson NFH stock was in 2000 (BY 1998).
- The current goal of the program is the restoration of the listed Methow River stock, while maintaining mitigation responsibilities.

3. Objectives of program.

- Winthrop NFH currently has an annual yearling production goal of 600,000.
- Due to poor returns and the transition of brood stock at this facility, production goals are only recently being realized. **(MC-008)**

4. Type of program.

- Integrated.
- Conservation and harvest.

5. **Alignment of program with ESU-wide plans.**
   - The Leavenworth Complex must comply with the Endangered Species Act (ESA) of 1973. Section 7 requires that actions of federal agencies not be likely to jeopardize the continued existence of listed species or modify their critical habitat. **(WT-002)**
   - Steelhead and spring Chinook raised at Winthrop NFH are included the Upper Columbia River (UCR) Evolutionary Significant Units for these species and are currently ESA-listed for protection.
   - ESA consultations under Section 7 and 10 have been completed. A Biological Opinion (Permit # 1300) has been issued to the facility.

6. **Habitat description and status (see Winthrop NFH summer steelhead program).**

7. **Size of program and production goals (No. of spawners and smolt release goals).**
   - 370 adult spawners.
   - 600,000 yearling smolts.

C. Description of program and operations.

1. **Broodstock goal and source.**
   - Winthrop NFH spring Chinook salmon originated from commingled upriver stocks intercepted at Rock Island Dam (1940-1943) and imports from other Columbia River drainage hatcheries, primarily Carson NFH stock. **(MC-008, P.)**
   - Chinook salmon have been reared and released at Winthrop from 1942-1961 and from 1974 to the present. The last non-local stock introduction occurred in 1994.
   - Historically, Winthrop NFH has operated as a segregated harvest augmentation program and Winthrop NFH stock was not included in the ESA-listed UCR spring Chinook salmon ESU.
   - From 1974 through 2000, Winthrop National Fish Hatchery propagated a segregated, Carson NFH-derived hatchery stock, referred to as the Winthrop-Carson stock.

Table 7-1. History of egg source for the SCS program at WNFH, 1974-present. **(WT-002)**

Egg Source	Broodyear	Stock Origin
Cowlitz River Hatchery	1974	Cowlitz River
Little White Salmon NFH	1974, 75, 78	Little White Salmon River
Carson NFH	1976, 77, 79, 81, 85, 86	Commingled-Bonneville Dam
Winthrop NFH (Methow R.)	1978, 80 to present	Commingled hatchery stock
Leavenworth NFH	79, 80, 84, 89 - 92	Commingled hatchery stock
Klickitat SFH	1989	Klickitat River
Methow SFH	1997-2002	Methow River
Methow Composite	2001-present	Methow, Chewuch, W-C

   - The Little White Salmon stock started in 1967, when fish of unknown origin returned to the Little White Salmon River. These adults were probably descendants of several different stocks.
   - The Carson NFH stock originated from a collection of commingled adults captured at Bonneville Dam.
   - Beginning in 2001, Winthrop NFH began phasing out the Winthrop-Carson stock and replacing it with the Methow Composite stock.

- The Methow Composite stock was initiated at the Methow SFH in 1978. Prior to 1978, separate broodstocks for the Chewuch River and Methow River were maintained at the Methow SFH. However, the two programs were combined because of extremely low numbers of returning adults upstream of Wells Dam in the mid-1990's. In addition, significant numbers of unmarked Winthrop-Carson fish had strayed into the Methow SFH during the early years of operation (1993-1997), and a Winthrop-Carson genetic influence has continued in subsequent brood years for the Methow Composite stock.
- The last complete release of Carson stock occurred in 2000 (brood year 1998) and some "mixed" (Carson stock crossed with Methow Composite stock, known as MetComp 2, treated as non-listed w/ 100% adipose clipped) has occurred since BY 2001.
- In 2001, the progeny of all W-C x W-C (i.e., Carson) stock on station at Winthrop NFH (brood years 1999 and 2000) were transferred out of basin as part of an interagency agreement. During the summer of 2001, the adult access channel to the Winthrop NFH was blocked off, and the majority of returning Winthrop-Carson adults were forced to spawn naturally in the Methow River. **(MC-008)**
- The broodstock histories of the Methow Composite stock, and separate Methow, Chewuch, and Twisp River broodstocks, have been documented and are summarized in the following table (Table 7-2). Methow Comp 2 fish are the progeny of Methow Comp 1 (or Methow River) and Winthrop-Carson fish to meet mitigation production requirements. **(WT-007)**

Table 7-2. Summary of Methow SFH broodstock records and predicted percent (%) Winthrop-Carson ancestry of each release group and the Methow Composite broodstock based on state and Winthrop NFH records. **(WT-007)**

Brood Year	Stock	Number of Parents Females	Males	Predicted % Carson ancestry	Number released
1992	Chewuch River	11	9	0%	41,000
	Twisp River	9	9	0%	36,000
1993	Methow River	47	49	75%	211,156
	Chewuch River	58	45	8.2%	284,461
	Twisp River	23	16	0%	116,749
1994	Methow River	1	1	100%	4,477
	Chewuch River	6	4	0%	11,854
	Twisp River	4	1	0%	19,835
1995	Methow River	7	5	100%	14,238
1996	Methow River	51	51	18.6%	194,017
	Chewuch River	32	32	0%	91,672
	Twisp River	22	22	0%	76,687
1997	Methow River	132	70	70.6%	332,484
	(released from Winthrop NFH)			70.6%	81,077

	Chewuch River	40	27	7.8%	132,759
	Twisp River	11	4	0%	26,714
Brood Year	Stock	Number of parents Females	Males	Predicted % Carson ancestry	Number released
1998	Methow Composite	122	122	27.1%	435,000
	(released from Winthrop NFH)			27.1%	71,265
	Twisp River	6	6	0%	16,000
1999	Methow Composite	89	72	51.4%	360,000
	(released from Winthrop NFH)			51.4%	175,869
	Twisp River	15	15	0%	67,000
2000	Methow Composite	132	100	18.9%	?
	(released from Winthrop NFH)			18.9%	201,604
	Twisp River	41	26	0%	?
2001	Winthrop NFH				
	Methow Composite 1 (CWT)	94	73	38.3%	196,639
	Methow Comp 2 (CWT+AD)	81	40	62.3%	265,039
	Methow SFH				
	Methow Composite 1 (CWT)	69	81	54.3%	130,887
	Methow Comp 2 (CWT+AD)	82	166	≈70%	?
	Chewuch River	31	46	3.6%	261,284
	Twisp River	31	48	0%	57,471
2002	Winthrop NFH				
	Methow Composite 1 (CWT)	150	?	28.3%	537,360
	Methow Comp 2 (CWT+AD)	12	?	68.2%	40,773
	Methow SFH				
	Methow Composite 1 (CWT)	152	?	29.1%	181,235
	Methow Comp 2 (CWT+AD)	152	?	88.9%	?
	Chewuch River	0	0		254,238
	Twisp River	5	7	0%	58,074
2003	Winthrop NFH				
	Methow Comp1 ('98, CWT)	62	?	23.0%	243,285
	Methow Comp 1 ('99, CWT)	45	?	35.5%	141,318
	Methow Comp 2 (CWT+AD)	44	?	59.5%	165,611
	Methow SFH				
	Methow Composite 1	17	?	36.4%	91,083
	Methow Composite 2	30	?	64.0%	?
	Chewuch River	31	?	22.9%	127,614
	Twisp River	12	?	0%	103,576
2004	Winthrop NFH				
	Methow Composite 1 (CWT)	179	?	20.7%	484,090
	Methow SFH				
	Methow Composite 1 (CWT)	?	?	?	65,146
	Chewuch River	?	?	?	204,906
	Twisp River	?	?	?	96,617

2005	Winthrop NFH				
	Methow Composite 1 (CWT)	143	?	33.3%	
	Methow Comp 2 (CWT+AD)	77	?	46.5%	
	Methow SFH				
	Methow Composite 1	?	?	?	
	Chewuch River	?	?	?	
	Twisp River	?	?	?	

2. Adult collection procedures and holding.

- The minimum broodstock collection goal is 400 adults. **(MC-008)**
- Approximately 360 adults are needed to produce 600,000 yearling progeny for release.
- Broodstock is obtained from adults volunteering to the hatchery's collection ladder. The ladder operates from mid-May to mid-July, which covers the full spectrum of the run. Adults in excess of brood needs will be returned to the river for natural spawning.
- Collected adults are retained in holding ponds through early September. Through out the return broodstock is randomly collected so that a representative portion of the entire run contributes to egg collection.
- Formalin (167 ppm for 1 hour) treatment is administered to holding ponds and antibiotic treatment of female brood is administered one to two times prior to spawning to combat vertical transmission of bacterial kidney disease (BKD). Excess Winthrop NFH adults are primarily forced to spawn naturally in the Methow River. **(MC-008)**

3. Adult spawning.

a) Spawning protocols.

- Spawning occurs from mid-August until early September.
- Winthrop NFH prioritizes crosses of preferred ESA-listed stock over random run spawning and a male to female ratio of 1:1. In this manner gametes are held separate and spawned after individual brood has been identified or transfers have occurred to and from the adjacent Methow State Fish Hatchery.
- Run is consistently comprised of 60% females and 40% males. Therefore, all males are used at least once including jacks. Some adult males are used twice, but no more than twice, to compensate for the differing sex ratio. Backup males are only used when a problem is noticed with the milt (blood, water, etc.).
- Broodstock collection and spawning plans still need to be organized with the Methow SFH program in order to maintain a wild broodstock component in the Methow Composite stock at both facilities (i.e., most Methow Composite crosses have been Hatchery X Hatchery).

Table 7-3. Winthrop NFH spring Chinook adult brood stock management, performance, and spawning practices, 1994-2005. (MC-008)

Return Year	Hatchery Return	Surplus	Returned to Stream	Hatchery Transfers	Jump Outs DIP's	Brood Kept for Propagation	Green, Bad Spent	Used for Production	Pre-spawn Survival[1]	Male:Female Ratio	Green Eggs Taken	Average Fecundity
1994	29	0	0	0	0	29	0	29	100.0%	1.0 : 1.2	67,900	4,244
1995	14	0	0	0	1	14	0	13	92.9%	1.0 : 1.1	31,500	4,500
1996	205	3	0	0	4	203	2	196	98.0%	1.0 : 1.1	367,500	3,500
1997	231	4	0	0	10	231	0	217	95.7%	1.0 : 1.7	556,000	4,000
1998	110	0	0	0	34	110	2	74	69.1%	1.0 : 1.4	198,000	4,500
1999	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	224,430	n/a
2000	1,092	0	0	0	33	1,091	1	1,058	97.0%	1.0 : 1.2	2,219,200	3,800
2001	385	0	2	0	53	383	0	330	86.2%	1.0 : 1.5	804,000	3,799
2002	388	0	0	0	11	385	3	374	97.2%	1.0 : 2.1	943,500	3,809
2003	904	0	471	0	35	433	0	398	96.1%	1.0 : 1.5	972,000	4,000
2004	452	24	0	84	10	368	0	334	97.8%	1.0 : 1.9	832,200	3,800
2005	499	75	0	20	4	479	0	400	99.2%	1.0 : 1.3	855,000	3,672
AVE	392	10	43	9	18	339	1	311	93.6%	1.0 : 1.5	672,603	3,966
MAX	1,092	75	471	84	53	1,091	3	1,058	100.0%	1.0 : 2.1	2,219,200	4,500
MIN	14	0	0	0	0	14	0	13	70.0%	1.0 : 1.1	31,500	3,500
STDEV	344	23	142	25	18	297	1	287	8.9%	1.0 : 0.3	598,518	326

[1]Pre-spawn survival is the hatchery return minus the # of DIP's/Jumpouts, divided by the hatchery return.

b) No. of males and females spawned each year over past 10 years

Table 7-4. Broodstock collection levels for the last twelve years (e.g. 1988-99), or for most recent years available:

Year	Adults Females	Males	Jacks	Eggs	Juveniles
1988	849	471	7	2,114,503	1,121,395
1989	120	71	4	254,413	187,982
1990	75	45	1	144,500	135,123
1991	48	25	19	113,043	89,333
1992	236	85	11	872,814	478,941
1993	383	263	0	1,146,524	770,847
1994	16	12	1	119,642	112,695
1995	8	5	1	15,000	14,520
1996	107	79	19	345,893	324,851
1997	144	139	1	590,657	545,000
1998	103	77	0	437,837	377,696
1999	60	50	56	224,430	216,641

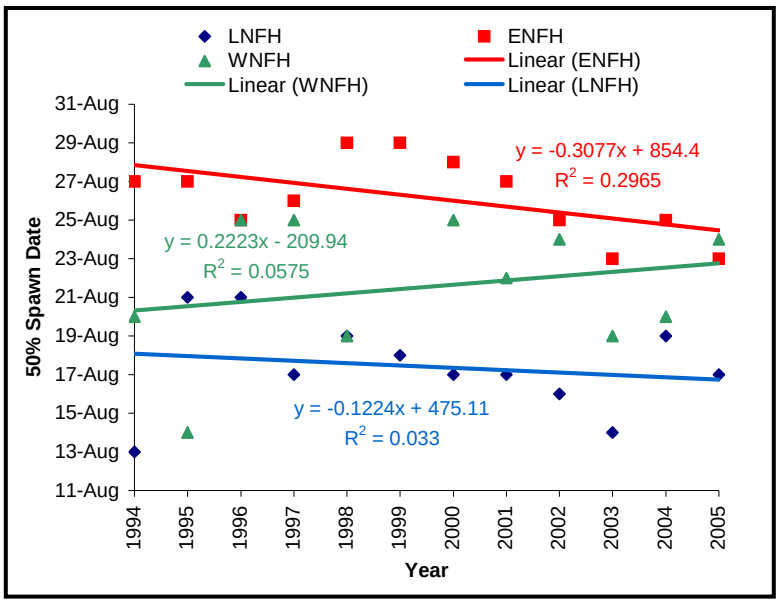


Figure 7-1. Scatter plot with linear comparisons of 50% spawn date of spring Chinook by Leavenworth Complex hatchery, 1994-2005. **(MC-008)**

4. Fertilization.

a) Protocols.

- Gametes are fertilized as 1:1 individual matings. Factorial matings have occurred in the past when returning adult numbers dropped below 50 individuals in order to maximize the effective population size.
- Gametes are placed in "zip-lock" bags (not mixed yet), oxygenated, and placed into coolers with ice. The gametes are then taken inside where they are mixed. No mixing occurs until all coded-wire-tags are de-coded. This practice has been necessary because of the high variation in percent Carson ancestry among different brood years of the Methow Composite stock and the desire to minimize this ancestry in future brood years.
- Following spawning, fertilized eggs are water hardened in disinfectant and kept separated by female until ELISA results are available (generally within one month). If possible the higher ELISA ranked eggs are culled from the production lots.
- All eggs are water hardened in a 75ppm iodophore solution.

b) Number of eggs collected and fertilized each year.

Table 7-5. Number of eggs taken and survival rates to eye-up, 1988 to 1999.

Brood Year	# Eggs Taken	% Eye-up
1988	2,279,773	93
1989	276,510	92
1990	149,000	96
1991	117,778	96
1992	916,000	95
1993	1,174,000	98
1994	120,000	97
1995	31,000	97
1996	445,000	93
1997	608,896	97
1998	376,848	95
1999	234,515	96

5. Incubation.

- Isolation incubation buckets are used to prevent horizontal transmission of diseases until virology and ELISA results are obtained.
- From the incubation buckets, fish are transferred to the Heath trays at a loading of one isolation bucket (progeny of one female) per tray (3000 to 6000 eggs/tray). Flows in isolation buckets are 1 to 2 gpm to the eyed stage and 3 to 6 gpm in the Heath trays from the eyed to button-up fry stage.
- All spring chinook salmon eggs are incubated on 100% ground water. This water source is free of silt, does not create fungus problems, and provides constant temperatures in the 47 to 50F range during incubation. Dissolved oxygen is also relatively constant at 9ppm on the inflow and not less than 8ppm at the outflow. It is not necessary to use formalin during incubation since *saprolegnia* fungus or silt have not been a problem.

6. Ponding.

a) Protocols.

- Spring Chinook are fully buttoned up at 1800 DTU and are ponded-out at this time. Swim-up fry average 1.3 - 1.4 inches (1200 to 1500 fish per pound).
- Ponding is forced as trays are removed from the Heath stacks and transferred to a tub of water and moved to the appropriate start tanks. Density indices are kept below 0.15 lbs/cu.ft./inch during early rearing.

b) Number of fry ponded each year, including % hatch each year.

Table 7-6. Winthrop NFH juvenile spring Chinook monthly brood production inventory and rearing environment parameters for brood year 2002 Methow Composite-1 stock only. **(MC-008)**

Month	Life Stage	Temp ^{0}F Ave	Water Source % Well	Water Source % River	Flow GPM	Flow Index (lbs./in.* GPM)	Density Index (lbs./in.*ft^3)	Number on Hand	Total Weight (lbs.)
August	Egg	NA	100%	0%	NA	NA	NA	NA	NA
September		NA	100%	0%	NA	NA	NA	NA	NA
October		NA	100%	0%	NA	NA	NA	NA	NA
November	Alevin	NA	100%	0%	NA	NA	NA	NA	NA
December	Fry	47.0	100%	0%	1,029	0.36	0.06	557,595	511
January		47.3	100%	0%	1,673	0.36	0.05	566,027	1,048
February		46.0	100%	0%	2,460	0.36	0.05	565,228	1,874
March	Sub-yearling	47.0	100%	0%	2,441	0.49	0.06	565,043	2,941
April		45.6	100%	0%	4,567	0.33	0.06	559,413	4,182
May		45.0	100%	0%	6,565	0.28	0.03	547,144	5,695
June		48.5	90%	10%	6,618	0.39	0.05	544,957	9,495
July		51.8	90%	10%	6,552	0.43	0.05	542,614	10,852
August		54.5	90%	10%	6,588	0.46	0.05	541,555	12,115
September		53.0	100%	0%	11,238	0.34	0.07	541,209	17,164
October		46.6	50%	50%	11,058	0.39	0.08	540,684	20,589
November	Yearling	39.6	50%	50%	11,150	0.40	0.08	540,267	21,662
December		38.0	50%	50%	11,099	0.40	0.08	539,932	21,519
January		40.9	50%	50%	11,040	0.42	0.08	539,384	22,981
February		43.3	30%	70%	11,071	0.43	0.08	538,997	23,912
March		42.7	0%	100%	11,108	0.48	0.09	538,191	28,370
April		44.0	0%	100%	NA	NA	NA	537,360	31,042

7. Rearing/feeding protocols.

- With the exception of occasional studies, most juveniles are hand fed throughout rearing.
- Density indices have been successful at or below the goal of 0.12 lbs/cu.ft./inch (DI) since the implementation of this goal in 1994. During early rearing, the maximum goal for DI's in the start tanks, has been 0.17. Once the fish are moved outside, after 2 to 3 months in the start tanks, the goal is to not exceed a DI of 0.11.
- At this time, all acclimation occurs at Winthrop NFH. Fish are reared on 100% ground water for the first 12 months of the 18-month rearing cycle, if possible. River water is gradually introduced during the 13th or 14th month of rearing. The percentage of river water is gradually increased each month to a final mixture of about 80% river water and 20% ground water for at least the last two months of rearing.

- Dissolved oxygen (DO) is periodically measured with a calibrated YSI digital meter and probe. DO is normally 9 to 10ppm at the inflow and 8 to 9ppm at the outflow of all rearing units.

Table 7-7. Percent survival estimates for juvenile SCS, WNFH, 1988 to 1999.

Brood Year	Fry to Fingerling (%)	Fingerling to Smolt (%)
1988	na	na
1989	92	57
1990	96	65
1991	93	97
1992	77	78
1993	92	92
1994	96	98
1995	100	99
1996	97	99
1997	99	99
1998	96	95
1999	98	100

Table 7-8. Winthrop NFH juvenile spring Chinook monthly brood production inventory and rearing environment parameters for brood year 2002 Methow Composite-1 stock only. **(MC-008)**

Month	Life Stage	Temp ^{0}F Ave	Water Source % Well	Water Source % River	Flow GPM	Flow Index (lbs./in.* GPM)	Density Index (lbs./in.*ft^3)	Number on Hand	Total Weight (lbs.)
August	Egg	NA	100%	0%	NA	NA	NA	NA	NA
September		NA	100%	0%	NA	NA	NA	NA	NA
October		NA	100%	0%	NA	NA	NA	NA	NA
November	Alevin	NA	100%	0%	NA	NA	NA	NA	NA
December	Fry	47.0	100%	0%	1,029	0.36	0.06	557,595	511
January		47.3	100%	0%	1,673	0.36	0.05	566,027	1,048
February		46.0	100%	0%	2,460	0.36	0.05	565,228	1,874
March	Sub-yearling	47.0	100%	0%	2,441	0.49	0.06	565,043	2,941
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July		51.8	90%	10%	6,552	0.43	0.05	542,614	10,852
August		54.5	90%	10%	6,588	0.46	0.05	541,555	12,115
September		53.0	100%	0%	11,238	0.34	0.07	541,209	17,164
October		46.6	50%	50%	11,058	0.39	0.08	540,684	20,589
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February		43.3	30%	70%	11,071	0.43	0.08	538,997	23,912
March		42.7	0%	100%	11,108	0.48	0.09	538,191	28,370
April		44.0	0%	100%	NA	NA	NA	537,360	31,042

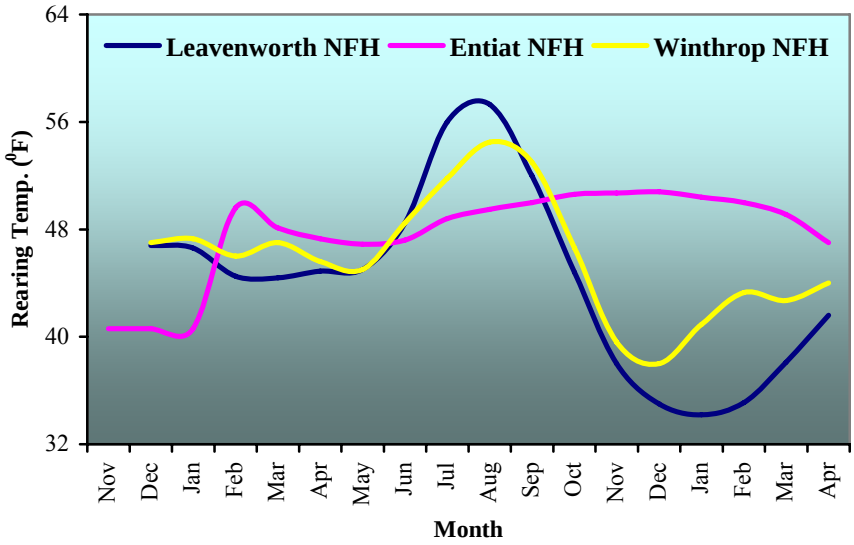

Figure 7-2. Spring Chinook rearing temperature (^{0}F) profiles for Leavenworth (brood years 1997-98 average), Entiat (brood years 2001-03 average), and Winthrop (brood year 2002) NFH's. **(MC-008)**

8. Fish growth profiles.

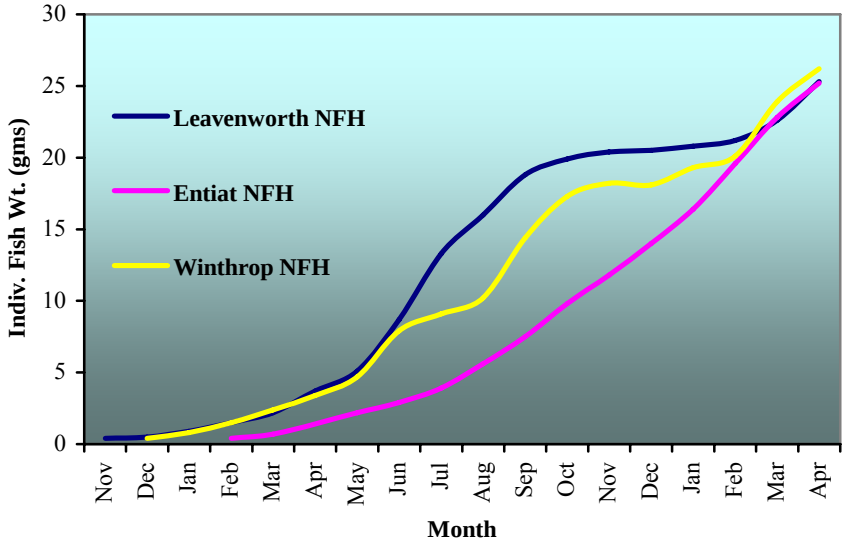

Figure 7-1. An example of juvenile spring Chinook growth (gms) profiles for Leavenworth (brood years 1997-98 average), Entiat (brood years 2001-03 average), and Winthrop (brood year 2002) NFH's. **(MC-008)**

Table 7-9. Winthrop NFH juvenile spring Chinook monthly culture and performance brood year 2002 Methow Composite-1 stock only **(MC-008)**

Month	Life Stage	Ave Size (#/lb)	Ave Size (gms)	Length Ave (in)	Length Ave (mm)	Condition Factor (C = lbs /in)	Feed Fed Per Day (lbs.)	Feeding Rate %BW/day	Food Conversion (lbs. Fed/lb. Gain)	Comments
August	Egg	NA	NA	NA	NA	NA	NA	NA	NA	Eggs collected from broodstock
September		NA	NA	NA	NA	NA	NA	NA	NA	fertilzed and placed in Heath trays
October		NA	NA	NA	NA	NA	NA	NA	NA	
November	Alevin	NA	NA	NA	NA	NA	NA	NA	NA	
December	Fry	1,091.2	0.4	1.38	35	3.49E-04	2.7	0.54%	1.18	Trasferred to starter tanks
January		540.1	0.8	1.74	44	3.51E-04	14.5	1.39%	0.84	Trasferred to Foster-Lucas ponds
February		301.6	1.5	2.12	54	3.50E-04	20.5	1.09%	1.07	
March	Sub-yearling	192.1	2.4	2.46	62	3.50E-04	30.8	1.05%	1.15	
April		133.8	3.4	2.78	70	3.50E-04	42.1	1.01%	1.18	
May		96.1	4.7	3.10	79	3.50E-04	57.9	1.02%	1.45	Coded Wire Tagging and adipose clipping,
June		57.4	7.9	3.68	93	3.50E-04	79.5	0.84%	1.58	Transferred to 8x80's and converted FL's
July		50.0	9.1	3.85	98	3.50E-04	105.9	0.98%	0.86	
August		44.7	10.2	4.00	102	3.50E-04	153.7	1.27%	3.51	
September		31.5	14.4	4.49	114	3.50E-04	153.0	0.89%	3.63	
October		26.3	17.3	4.77	121	3.50E-04	137.9	0.67%	0.85	
November	Yearling	24.9	18.2	4.86	123	3.50E-04	58.1	0.27%	0.51	
December		25.1	18.1	4.85	123	3.50E-04	60.9	0.28%	1.76	
January		23.5	19.3	4.96	126	3.50E-04	41.2	0.18%	-8.92	
February		22.5	20.1	5.02	128	3.50E-04	71.9	0.30%	1.38	
March		19.0	23.9	5.32	135	3.50E-04	164.5	0.58%	5.48	Release window is
April		17.3	26.2	5.49	139	3.50E-04	163.1	0.53%	0.55	mid-April. Forced release.

9. Fish health.

- After adult collection and sorting, adult females held for spawning are injected with 20mg per kg fish weight of Erythromycin under supervision of an attending Veterinary Medical Officer. Injections are done at approximately 30-day intervals to control levels of *R. salmoninarum*.
- As part of the fish health program at the Leavenworth Complex, portions of the returning adults are tested for viruses and specific pathogens. The focus is on the detection of BKD, Infectious Pancreatic Necrosis Virus (IPNV), and Infectious Hematopoietic Necrosis Virus (IHNV). **(MC-008)**
- The USFWS-Olympia Fish Health Center (OFHC) provides health profiles of broodstock utilized for production. Sampling protocol includes testing all females for the presence and extent of BKD. The Enzyme-Linked Immunosorbent Assay (ELISA) is used to test for BKD from females used for propagation.
- Additionally, bacteriology (kidney/spleen) is conducted on a minimum of sixty males and virology (ovarian fluid) on a minimum of 150 females. **(MC-008)**
- Disease monitoring is accomplished by daily visual observations by hatchery staff and twice monthly monitoring by fish health biologists/pathologists from the OFHC.
- Throughout the rearing cycle, routine (i.e. monthly) health examinations are conducted on a minimum of 60 fish per lot. Basic biometric (length, weight, Fulton condition factor) data is collected by hatchery staff and OFHC personnel conduct fish health examinations. **(MC-008)**

Table 7-10. Winthrop NFH adult female Chinook BKD risk profiles, 1995- 2005. **(MC-008)**

Rank / Year	No Detection	Very Low	Low	Moderate	High	Very High
1995	0.0%	11.1%	33.3%	22.2%	33.3%	0.0%
1996	16.0%	59.4%	9.4%	5.7%	5.7%	3.8%
1997	0.0%	12.3%	48.6%	26.8%	10.1%	2.2%
1998	15.2%	56.5%	17.4%	2.2%	2.2%	6.5%
1999	All Broodstock collected by WDFW					
2000	20.6%	53.1%	24.1%	1.3%	0.4%	0.4%
2001	1.5%	30.3%	14.9%	8.5%	13.9%	30.8%
2002	0.0%	73.2%	18.7%	2.4%	5.7%	0.0%
2003	2.9%	56.4%	22.6%	2.9%	1.2%	14.0%
2004	38.4%	41.6%	2.3%	0.9%	2.7%	14.2%
2005	1.3%	92.4%	4.0%	0.9%	0.4%	0.9%
AVE	9.6%	48.6%	19.5%	7.4%	7.6%	7.3%
MAX	38.4%	92.4%	48.6%	26.8%	33.3%	30.8%
MIN	0.0%	11.1%	2.3%	0.9%	0.4%	0.0%
STDEV	12.8%	25.6%	13.9%	9.4%	10.1%	9.9%

10. Chemotherapeutant use.

- Any abnormal situations observed by hatchery personnel are called to the attention of the Olympia Fish Health Center, which performs diagnostic and confirmatory clinical tests before recommending appropriate treatments.
- Treatment procedures may include environmental manipulation to control stresses and enhance the fish's natural ability to recovery from infectious agents and/or appropriate chemicals or antibiotics. Antibiotics and chemicals that are registered for fish disease treatments are applied as per labeled instructions.

11. Tagging and marking of juveniles.

- All (100%) listed spring Chinook salmon have been coded-wire tagged (CWT), and will continue to be 100% marked with CWT's in the future. Broods previous to 2000 were also adipose fin clipped. Starting with brood year 2000, listed stocks will not receive a fin clip along with the CWT, while unlisted stocks will continue to receive fin clips in order to help differentiate listed and unlisted stocks
- Coded-wire tagging has consistently remained near 100% with the percent adipose clipped varying depending on portion of brood in ESA-listed status (see Table 7-2).
- Additionally, brood years 2000-2002 were part of a lower Columbia River transportation study which increased the annual use of PIT tags from essentially 5,500 to 22,000 (Table 23). Currently no PIT tags are anticipated for this program after the 2007 release year.

12. Fish Release.

a) Protocols.

- Smolts are mass released directly into the outfall channel (leading to the Methow River) at a size of 16 to 18 fish per pound to minimize interactions with other fish populations.

- Smolts are released around the third week of April to coincide with normal spring migration and spill at Columbia River dams. It is likely that the fish are functional or near functional smolts at this time as evidence by their rapid migration to the Rock Island smolt trap (personal communications with Chelan PUD fish biologists).
- Detection of PIT tagged fish at McNary and Bonneville Dam's bypass facilities provides evidence of rapid movement of smolts released from Winthrop NFH. The average travel time from release to McNary Dam, for release years 1993 – 2005, is 28.4 days with a minimum travel time of 23 days in 2003 to a maximum time of 36 days in 2001. McNary Dam is approximately 276 miles from Winthrop NFH. The average survival from release to McNary Dam is 49% with a minimum survival of 43% in 2001 to a high of 56% in 1999 (SURPH database, 2004).

b) Number of fish released each year (subyearlings?; yearlings?; other?)

Table 7-11. Winthrop NFH yearling spring Chinook releases for brood years 1994-2003. **(MC-008)**

Brood Year	Release Year	Release Date	Yearlings Released	Release Size (#/LB)	# CWT Tagged	% CWT Tagged	% Adipose Clipped	# PIT Tagged	% PIT Tagged
1994	1996	11-Apr	112,395	11.8	110,878	99%	99%	1,493	1.3%
1995	1997	9-Apr	14,620	12.8	14,620	100%	100%	0	0.0%
1996	1998	14-Apr	324,851	13.9	324,851	100%	100%	9,542	2.9%
1997	1999	15-Apr	545,062	13.2	513,724	94%	94%	7,490	1.4%
1998	2000	10-Apr	377,696	13.8	364,632	97%	97%	7,490	2.0%
1999	2001	17-Apr	175,869	14.0	171,496	98%	98%	7,422	4.2%
2000	2002	15-Apr	201,604	17.5	201,604	100%	0%	27,459	13.6%
2001	2003	15-Apr	461,678	20.3	439,785	95%	57%	19,962	4.3%
2002	2004	13-Apr	578,307	17.7	513,687	89%	7%	19,887	3.4%
2003	2005	15-Apr	550,214	16.1	527,836	96%	18%	3,600	0.7%
AVE		13-Apr	334,230	15.1	318,311	97%	67%	10,435	3.4%
MAX		17-Apr	578,307	20.3	527,836	100%	100%	27,459	13.6%
MIN		9-Apr	14,620	11.8	14,620	89%	0%	0	0.0%
STDEV		2.6	200,810	2.7	184,883	3%	43%	9,023	3.9%

Table 7-12. Winthrop NFH spring Chinook releases into the Methow River, brood years 1989-2003. **(MC-008)**

Brood Year	Release Year	Yearlings	Sub-Yearlings (SY)	Fry	TOTAL	CWT # Tagged	% Adipose Clipped	# PIT Tagged
1989	1990		203,471		203,471			
1989	1991	1,055,056			1,055,056	107,670	10%	
1990	1991		417,864	164,900	582,764			
1990	1992	624,771			624,771	90,620	15%	
1991	1993	950,624			950,624	189,187	20%	1,489
1992	1994	556,313			556,313	140,873	25%	1,398
1993	1995	770,847			770,847	164,456	21%	1,496
1994	1996	112,395			112,395	110,878	99%	1,493
1995	1997	14,620			14,620	14,620	100%	
1996	1998	324,851			324,851	324,851	100%	9,542
1997	1999	545,062			545,062	513,724	94%	7,490
1998	2000	377,696			377,696	364,632	97%	7,490
1999	2001	175,869			175,869	171,496	98%	7,422
2000	2002	201,604			201,604	201,604	0%	27,459
2001	2002		64,683		64,683	59,474	0%	
2001	2003	461,678			461,678	439,785	57%	19,962
2002	2004	578,307			578,307	513,687	7%	19,887
2003	2005	550,214			550,214	527,836	18%	3,600

- For the period of 2002-2005, survival over McNary Dam has exhibited a consistent trend for all three hatcheries which appears to reflect the distance and number of impoundments between release station to McNary Dam. For the period of 2002-2005 Entiat NFH exhibits the current highest average survival (58.8%, SD = 4.9%), followed by Leavenworth NFH (54.8%, SD = 6.4%), then Winthrop NFH (49.9%, SD = 3.9%). **(MC-008)**

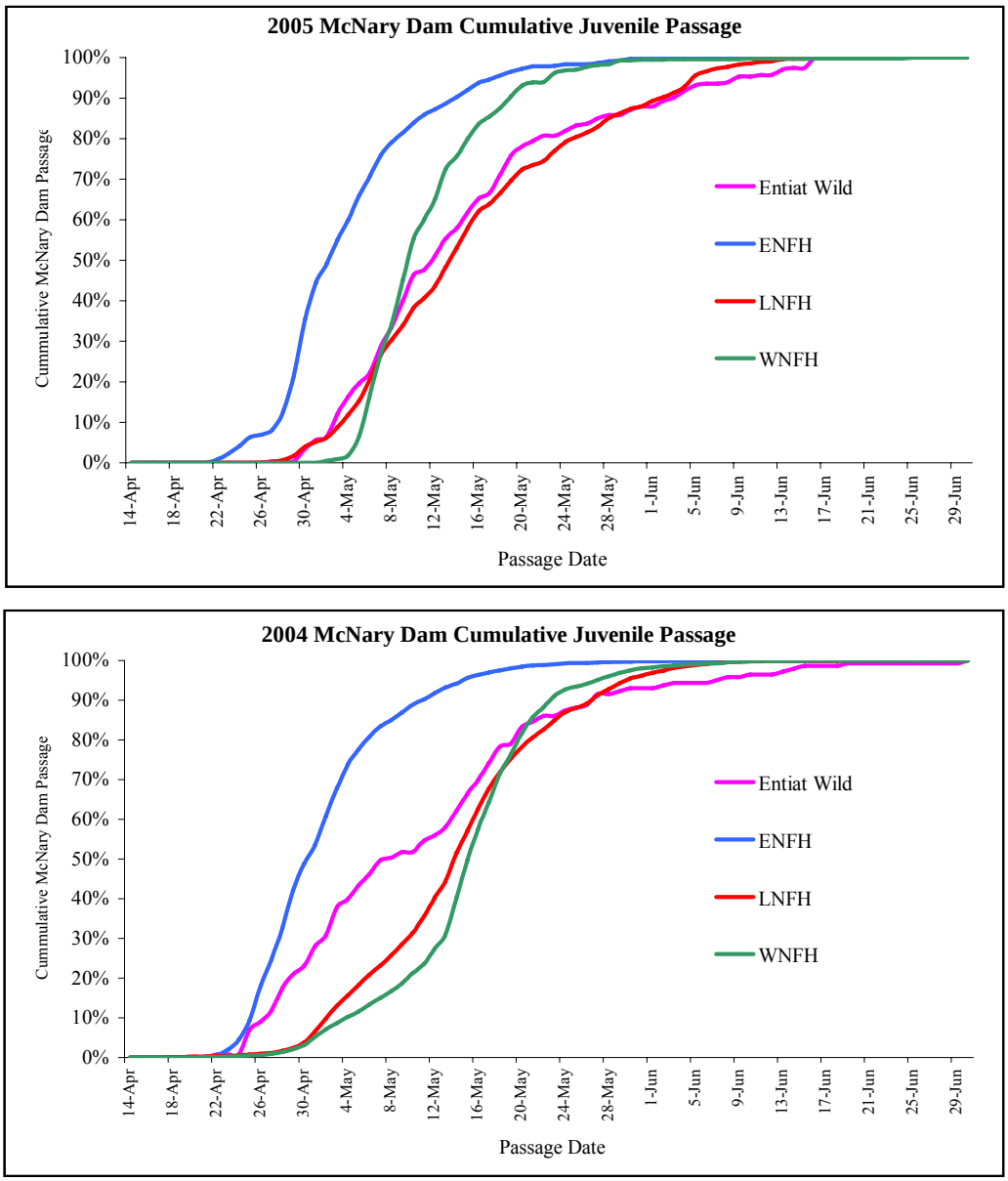

Figure 7-4. Cumulative passage of PIT-detected Leavenworth Complex and Entiat River wild spring Chinook passage over McNary Dam, 2004 (bottom) & 2005 (top). **(MC-008)**

D. Program benefits and performance.

1. Adult returns.

a) Numbers of adult returns (need data for the past 10-20 years).

- Winthrop NFH has annually averaged 660 (SD = 798, +/- 120% of average) returning adults to the Methow River Basin and failed to meet the minimum broodstock goal of 400 adults in twelve of twenty-six years (1980-81, 1989-1992, 1994-1998 or 12/26 = 46%). **(MC-008)**
- For the period of 1980 – 2005 the Leavenworth Complex has returned on average to the upper Columbia Basin approximately 7,049 (stdev = 5,136) adults annually. Leavenworth NFH has contributed approximately 80% of this return with Entiat and Winthrop NFH splitting the remaining 20%. **(MC-008)**

Table 7-13. Leavenworth Complex adult spring Chinook returns to release basin, 1980-2005. **(MC-008)**

Year	Leavenworth NFH	Entiat NFH	Winthrop NFH	Complex Total
1980	2,452	305	155	2,912
1981	2,420	247	399	3,066
1982	2,814	247	601	3,662
1983	3,090	672	755	4,517
1984	4,189	808	900	5,897
1985	7,714	912	1,201	9,827
1986	8,451	969	836	10,256
1987	6,905	913	594	8,412
1988	6,277	689	1,327	8,293
1989	5,134	669	195	5,998
1990	4,373	583	121	5,077
1991	3,858	437	92	4,387
1992	11,117	520	332	11,969
1993	13,862	730	646	15,238
1994	1,124	80	29	1,233
1995	484	121	14	619
1996	1,327	175	80	1,582
1997	4,533	275	144	4,952
1998	2,158	216	178	2,552
1999	2,073	724	118	2,915
2000	9,464	1,919	947	12,330
2001	15,082	2,666	3,695	21,443
2002	12,281	1,834	2,249	16,364
2003	8,161	884	515	9,560
2004	3,732	759	573	5,064
2005	3,793	884	464	5,141

Summary Data for 1980 - 2005				
AVE	5,649	740	660	7,049
MAX	15,082	2,666	3,695	21,443
MIN	484	80	14	619
STDEV	4,034	598	798	5,136
By %	80%	10%	9%	100%

Summary Data for 1980 - 1993				
AVE	5,904	622	582	7,108
MAX	13,862	969	1,327	15,238
MIN	2,420	247	92	2,912
STDEV	3,431	244	394	3,689
By %	83%	9%	8%	100%

Summary Data for 1994 - 2005				
AVE	5,351	878	751	6,980
MAX	15,082	2,666	3,695	21,443
MIN	484	80	14	619
STDEV	4,786	839	1,117	6,623
By %	77%	13%	11%	100%

Table 7-14. Winthrop NFH spring Chinook adult return and survival both within and outside the Methow River Basin, brood years 1979-1999. **(MC-008)**

Brood Year	Adults Spawned	Yearlings Released	Methow Basin Return	% to Basin	Methow Basin Return/Spawner	Out of Basin Recoveries	Total Return	% Total Return	Total Return/Spawner
1979	*537*	966,300	402	0.042%	0.7	NA	NA	NA	NA
1980	*396*	712,700	1,175	0.165%	3.0	NA	NA	NA	NA
1981	*530*	953,508	1,028	0.108%	1.9	NA	NA	NA	NA
1982	*547*	985,081	877	0.089%	1.6	NA	NA	NA	NA
1983	*649*	1,167,625	1,031	0.088%	1.6	NA	NA	NA	NA
1984	*590*	1,062,794	736	0.069%	1.2	NA	NA	NA	NA
1985	*594*	1,069,293	163	0.015%	0.3	NA	NA	NA	NA
1986	*606*	1,090,200	90	0.008%	0.1	NA	NA	NA	NA
1987	*481*	865,734	117	0.014%	0.2	NA	NA	NA	NA
1988	*623*	1,121,395	703	0.063%	1.1	NA	NA	NA	NA
1989	*586*	1,055,056	254	0.024%	0.4	34	288	0.027%	0.5
1990	*347*	624,771	3	0.000%	0.0	8	11	0.002%	0.0
1991	*528*	950,624	21	0.002%	0.0	0	21	0.002%	0.0
1992	*309*	556,313	186	0.033%	0.6	16	202	0.036%	0.7
1993	*428*	770,847	349	0.045%	0.8	21	370	0.048%	0.9
1994	*62*	112,395	79	0.070%	1.3	1	80	0.071%	1.3
1995*	8	14,620	53	0.363%	6.5	2	55	0.376%	6.8
1996	180	324,851	1,162	0.358%	6.4	61	1,223	0.376%	6.8
1997	*303*	545,062	3,892	0.714%	12.9	719	4,611	0.846%	15.2
1998	210	377,696	2,609	0.691%	12.4	634	3,243	0.859%	15.5
1999	*98*	175,869	84	0.048%	0.9	16	100	0.057%	1.0

Italicized values are dervied using spawner estimates based on a back calculation from the number of yearlings released using 90% survival to yearling from green egg, a fecundity of 4,000 and a spawn ratio of 1:1. NA - Not Available, spring Chinook were not tagged these years. Therefore, total contribution was probably higher than stated. Fry and/or subyearlings were also released in brood years 1983, 1988 - 1990, and 2001. Most probably contributed little, if any, therefore are not included in the return rate. *BY 95 release included an approximate 50% split of identically marked release groups from both Methow State Fish Hatchery and Winthrop NFH. Therefore, similar survival between the two facilities was assumed and tag recoveries were split to approximate brood year returns by facility. Non-CWT data is apportioned by hatchery brood age composition. Out of Basin recoveries are derived annually through CWT data in the regional mark information system (RMIS) database. # of adults are estimated by expanding expected CWT recoveries by the % marked for each tag code group.

- During the brood transition period only select brood (when possible by adipose clip or through age/length criteria) was allowed into the hatchery for spawning. All other non-prioritized stock was blocked from the facility and encouraged to spawn naturally.
- This programmatic shift is evident in figure 18 from return year 2000/2001 onward. The vast majority of spring Chinook spawning in the Methow Basin are of hatchery origin and few wild adults are available for incorporation into the Winthrop NFH broodstock.
- In 2003 it was estimated that 96.2%, 93.1%, and 40.0% of the Methow, Chewuch, and Twisp River spawning populations were composed of hatchery adults (Humling and Snow, 2004).
- In 2003 it was estimated that 96.2%, 93.1%, and 40.0% of the Methow, Chewuch, and Twisp River spawning populations were composed of hatchery adults (Humling and Snow, 2004). From 2001-2005 the average CWT expanded proportion of the Winthrop NFH origin spawners recovered during the Methow Basin spawning ground surveys has averaged 50.3% (SD = 29.3%).

Table 7-15. Winthrop NFH adult spring Chinook deposition by fishery and location using currently available data for 1999-2005. **(MC-008)**

Type of recovery and specific location		RETURN YEAR #'s							RETURN YEAR %'s						
FISHERY	**SITE NAME**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
OCEAN	AK M 1 NW 113-45		3						0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
TROLL	COOS BAY TROLL 5			1					0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
(NON-	GARIBALDI TROLL 3			2					0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TREATY)	MARINE AREA 2					6			0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%
	SWTR 023-056					5			0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%
OCEAN TROLL (NON-TREATY)		**0**	**3**	**3**	**0**	**11**	**0**	**0**	**0.0%**	**0.3%**	**0.1%**	**0.0%**	**1.8%**	**0.0%**	**0.0%**
COLUMBIA	1I MCNARY-PRIEST RAP		3						0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
RIVER	1J PRIEST RA-WANAPUM		2						0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
GILL NET	BLIND SL (LWR COL R)			4					0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
	BONNEVILLE POOL NET			70	78	12	9		0.0%	0.0%	1.5%	2.8%	2.0%	1.5%	0.0%
	COL R TONGUE POINT				2				0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	COL R ZONE 1 NET			4	38	4			0.0%	0.0%	0.1%	1.3%	0.7%	0.0%	0.0%
	COL R ZONE 2 NET			9	97	21			0.0%	0.0%	0.2%	3.5%	3.4%	0.0%	0.0%
	COL R ZONE 3 NET			2	14	2			0.0%	0.0%	0.0%	0.5%	0.3%	0.0%	0.0%
	COL R ZONE 5 NET			3					0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
	JOHN DAY POOL NET			136	30	3	2		0.0%	0.0%	3.0%	1.1%	0.5%	0.3%	0.0%
	THE DALLES POOL NET			34	66	6			0.0%	0.0%	0.7%	2.4%	1.0%	0.0%	0.0%
	YOUNGS BAY			3	2	3	3		0.0%	0.0%	0.1%	0.1%	0.5%	0.5%	0.0%
COLUMBIA RIVER GILL NET		**0**	**5**	**267**	**327**	**52**	**14**	**0**	**0.0%**	**0.5%**	**5.8%**	**11.7%**	**8.4%**	**2.3%**	**0.0%**
FRESHWATER	PRIEST RAPIDS -E LAD				1				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NET	VERNITA BAR (36)				3				0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
FRESHWATER NET TOTAL		**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0.0%**	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.0%**	**0.0%**
COLUMBIA	COL R OR SPORT SEC 1			83	12	5			0.0%	0.0%	1.8%	0.4%	0.8%	0.0%	0.0%
RIVER	COL R OR SPORT SEC 2			64	19	10			0.0%	0.0%	1.4%	0.7%	1.7%	0.0%	0.0%
SPORT	COL R OR SPORT SEC 3						6		0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%
	COL R OR SPORT SEC 4				30				0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%
	COL R OR SPORT SEC 5			19	6	10			0.0%	0.0%	0.4%	0.2%	1.7%	0.0%	0.0%
	COL R OR SPORT SEC 7				7				0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
	COL R OR SPORT SEC 8			9	11				0.0%	0.0%	0.2%	0.4%	0.0%	0.0%	0.0%
	COL R OR SPORT SEC 9				6				0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
	COL R OR SPT SEC 10			28			6		0.0%	0.0%	0.6%	0.0%	0.0%	1.0%	0.0%
	COL R WA SEC 10			37	23				0.0%	0.0%	0.8%	0.8%	0.0%	0.0%	0.0%
	COL R WA SEC 4			19	13	5			0.0%	0.0%	0.4%	0.4%	0.8%	0.0%	0.0%
	COL R WA SEC 6			17	12	5			0.0%	0.0%	0.4%	0.4%	0.8%	0.0%	0.0%
	COL R WA SEC 7			10	6				0.0%	0.0%	0.2%	0.2%	0.0%	0.0%	0.0%
	COL R WA SPORT SEC 2			10	6				0.0%	0.0%	0.2%	0.2%	0.0%	0.0%	0.0%
	COL R WA SPORT SEC 5				11				0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%
	COL R WA SPORT SEC 8			19	19				0.0%	0.0%	0.4%	0.7%	0.0%	0.0%	0.0%
	COL R WN SPORT SEC 1			96	25	5			0.0%	0.0%	2.1%	0.9%	0.8%	0.0%	0.0%
COLUMBIA RIVER SPORT TOTAL		**0**	**0**	**411**	**207**	**42**	**12**	**0**	**0.0%**	**0.0%**	**9.0%**	**7.4%**	**6.7%**	**2.0%**	**0.0%**
FRESHWATER	BONNEVILLE POOL UPR				1				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SPORT	COLUMBIA NEAR WELLS			2	1				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	LEWIS R 27.0168	2							1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	MCNARY -CHIEF JOSEPH			4	6				0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%
	THE DALLES POOL UPR				1	1			0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
FRESHWATER SPORT TOTAL		**2**	**0**	**6**	**9**	**1**	**0**	**0**	**1.1%**	**0.0%**	**0.1%**	**0.3%**	**0.2%**	**0.0%**	**0.0%**
HATCHERY	COWLITZ SALMON HATCH		2						0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
	DRYDEN DAM FCF	1							0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	ENTIAT NFH	1							0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	LTL WHITE SALMON NFH	2	1						1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	METHOW HATCHERY			377	293	57	103	4	0.0%	0.0%	8.2%	10.5%	9.2%	17.1%	0.9%
	WARM SPRINGS NFH		1						0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	WELLS HATCHERY	3							1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	WELLS W LADDE+METHOW		155						0.0%	13.6%	0.0%	0.0%	0.0%	0.0%	0.0%
	WELLS W LADDER TRAP	173							92.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	WINTHROP NFH		792	176	185	279	317	337	0.0%	69.8%	3.9%	6.6%	45.2%	52.6%	72.6%
HATCHERY TOTAL		**180**	**951**	**553**	**478**	**336**	**420**	**341**	**96.7%**	**83.8%**	**12.1%**	**17.1%**	**54.4%**	**69.7%**	**73.5%**
SPAWNING	CHEWUCH R 48.0728		4	268	153	11	10	14	0.0%	0.4%	5.9%	5.5%	1.8%	1.7%	3.0%
GROUND	METHOW R 48.0002	4	130	2,999	1,543	151	122	109	2.2%	11.4%	65.5%	55.1%	24.4%	20.3%	23.5%
	WINTHROP NFH OUTFALL			37	26	8	20		0.0%	0.0%	0.8%	0.9%	1.3%	3.3%	0.0%
	TWISP R 48.0374		5	6	34		4	0	0.0%	0.5%	0.1%	1.2%	0.0%	0.7%	0.0%
	SIMILKAMEEN R 490325				10				0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%
	ENTIAT R 46.0042		12	15		6			0.0%	1.1%	0.3%	0.0%	1.0%	0.0%	0.0%
	WHITE R 45.1116				3				0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
SPAWNING GROUND TOTAL		**4**	**151**	**3,325**	**1,769**	**176**	**156**	**123**	**2.2%**	**13.3%**	**72.6%**	**63.2%**	**28.6%**	**25.9%**	**26.5%**
TREATY	BONNEVILLE POOL CERE		6						0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%
CEREMONIAL	BVILLE POOL UM TRIBE		17	9	4				0.0%	1.5%	0.2%	0.1%	0.0%	0.0%	0.0%
	BVILLE POOL WS TRIBE			2					0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	DALLES POOL		1						0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
TREATY CEREMONIAL TOTAL		**0**	**24**	**12**	**4**	**0**	**0**	**0**	**0.0%**	**2.1%**	**0.3%**	**0.1%**	**0.0%**	**0.0%**	**0.0%**
TEST FISHERY NET	COL R (WOODY IS TEST)				1				0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TEST FISHERY NET TOTAL		**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Grand Total		**186**	**1,134**	**4,578**	**2,800**	**618**	**602**	**464**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
ABOVE ROCK ISLAND Total		**182**	**1,098**	**3,881**	**2,248**	**512**	**576**	**464**	**97.7%**	**96.8%**	**84.8%**	**80.3%**	**82.9%**	**95.6%**	**100%**

CWT data acquired from RMIS. Population census by tag group created by dividing estimated_number by the % tagged in each CWT group.
Total returns of WNFH origin fish are indicated. Estimates by both CWT expansion and actual WNFH/MSFH hatchery rack return, have been combined in place of sole CWT expanded data based on assumed improved validity.

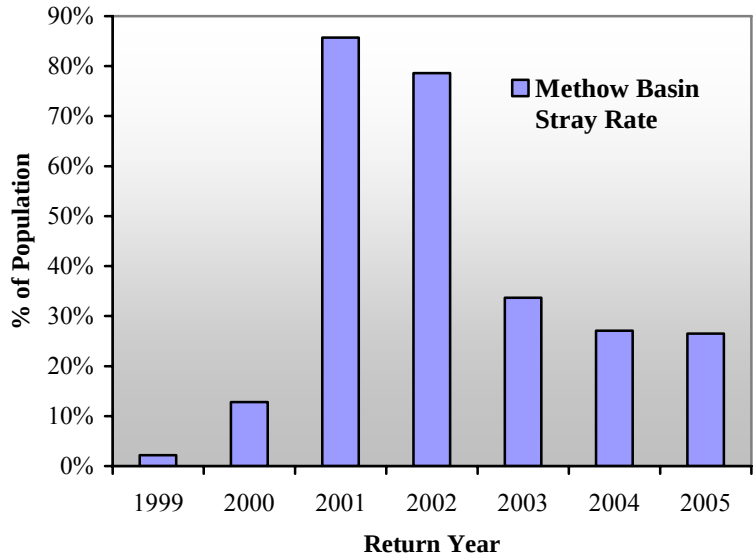

Figure 7-5. The estimated return proportion of Winthrop NFH origin spring Chinook attempting to spawn in the Methow River Basin. (MC-008)

b) Return timing and age-class structure of adults.

- The majority of Leavenworth Complex adults return as females (~54-62% on average, either by return or brood year). It has been speculated that high growth rates and the large release size of hatchery smolts compared to natural origin cohorts induces precocity potentially skewing the adult return to favor females (Mullan et al. 1992).

Table 7-16. Leavenworth Complex spring Chinook age composition of adults by return year for each facility, 1994-2005 **(MC-008)**

Return	Leavenworth NFH			Entiat NFH			Winthrop NFH		
Year	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5
1994	2.4%	7.8%	89.6%	6.5%	33.9%	59.7%	3.0%	0.0%	97.0%
1995	13.1%	75.4%	10.9%	2.8%	94.4%	2.8%	14.0%	64.0%	22.0%
1996	9.9%	84.6%	5.5%	5.6%	91.2%	3.2%	9.0%	86.0%	5.0%
1997	0.5%	91.5%	7.9%	1.2%	90.1%	8.7%	0.5%	96.1%	3.4%
1998	0.9%	40.7%	58.4%	7.5%	73.6%	19.0%	0.0%	39.4%	60.6%
1999	14.8%	63.0%	22.2%	5.2%	88.4%	6.4%	53.0%	41.0%	6.0%
2000	3.5%	94.4%	2.1%	3.8%	94.5%	1.6%	7.8%	91.8%	0.4%
2001	1.7%	89.4%	8.9%	4.3%	92.0%	3.7%	4.2%	94.0%	1.8%
2002	0.7%	86.1%	13.2%	0.9%	91.4%	7.7%	0.7%	91.5%	7.8%
2003	3.1%	17.2%	79.7%	5.3%	61.9%	32.6%	12.0%	10.2%	77.8%
2004	9.6%	82.3%	8.1%	2.2%	95.7%	2.0%	11.4%	85.8%	2.8%
2005	2.4%	91.9%	5.6%	6.1%	91.2%	2.8%	14.2%	82.5%	3.3%
AVE	5.2%	68.7%	26.0%	4.3%	83.2%	12.5%	10.8%	65.2%	24.0%
MAX	14.8%	94.4%	89.6%	7.5%	95.7%	59.7%	53.0%	96.1%	97.0%
MIN	0.5%	7.8%	2.1%	0.9%	33.9%	1.6%	0.0%	0.0%	0.4%
STDEV	5.1%	30.3%	31.2%	2.1%	18.4%	17.4%	14.3%	34.2%	34.2%

Data describes the total age composition of yearling releases only and excludes were possible contributions by other hatcheries to the return (ie. MSFH recovered at WNFH). In recent years the age composition displayed for WNFH has been influenced by selective spawning to minimize the "Carson" lineage. Age-6 fish comprised 0.1% - 0.6% of the return in 1994, 1995 and 1997 & one age-7 fish was noted in 2005 @ LNFH. Only one age-6 fish was observed @ ENFH. No age-6 fish or older were observed @ WNFH.

Table 7-17. Leavenworth Complex spring Chinook age composition of adults by brood year for each facility, 1989-2000 **(MC-008)**

Brood Year	Leavenworth NFH			Entiat NFH			Winthrop NFH		
	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5	Age-3	Age-4	Age-5
1989	1.7%	43.9%	54.1%	2.2%	88.8%	9.0%	2.0%	87.0%	11.0%
1990	0.0%	45.8%	54.2%	0.0%	91.3%	8.7%	0.0%	0.0%	100.0%
1991	3.0%	80.6%	16.1%	5.3%	89.3%	5.3%	4.8%	42.9%	52.4%
1992	4.9%	87.0%	8.1%	1.5%	87.0%	11.5%	1.1%	94.6%	4.3%
1993	7.1%	64.9%	28.0%	3.6%	79.5%	16.9%	5.2%	63.6%	31.2%
1994	1.1%	58.9%	40.0%	1.1%	73.6%	25.3%	1.3%	89.9%	8.9%
1995	1.1%	93.7%	5.3%	2.0%	95.6%	2.4%	5.7%	90.6%	3.8%
1996	7.7%	83.6%	8.7%	3.8%	91.9%	4.2%	8.2%	85.8%	6.0%
1997	3.0%	84.2%	12.8%	3.2%	90.9%	5.7%	2.2%	93.3%	4.5%
1998	1.1%	57.2%	41.7%	4.9%	78.2%	16.9%	6.2%	78.7%	15.1%
1999	3.6%	70.4%	26.1%	2.2%	94.7%	3.1%	19.0%	61.9%	19.0%
2000	4.3%	89.0%	6.7%	5.1%	92.9%	2.0%	10.7%	86.7%	2.6%
AVE	3.2%	71.6%	25.1%	2.9%	87.8%	9.3%	5.5%	72.9%	21.6%
MAX	7.7%	93.7%	54.2%	5.3%	95.6%	25.3%	19.0%	94.6%	100.0%
MIN	0.0%	43.9%	5.3%	0.0%	73.6%	2.0%	0.0%	0.0%	2.6%
STDEV	2.4%	17.2%	18.4%	1.7%	7.0%	7.2%	5.3%	27.8%	28.6%

Data describes the total age composition by brood year of yearling releases and attempts were possible to exclude contributions by other releases (subyearlings/fry) and hatcheries to the return (ie. MSFH recovered at WNFH). In recent years the age composition displayed for WNFH has been influenced by selective spawning to minimize the "Carson" lineage. Age-6 fish comprised 0.3% of the return in brood years 1989 and 1991 & one age-7 fish was noted in brood year 1998 @ LNFH. Only one age-6 fish from brood year 1997 was observed @ ENFH. No age-6 fish or older were observed @ WNFH.

Table 7-18. Winthrop NFH spring Chinook average adult fork length (cm) by return year (left table) and brood year (right table). **(MC-008)**

Sex/Age	Males			Females	
Return Yr.	Age-3	Age-4	Age-5	Age-4	Age-5
1994	55.0		90.5		87.0
1995	54.0	70.0	93.0	77.7	
1996	52.1	75.3	91.7	73.5	90.0
1997	45.0	78.2	91.5	74.7	85.7
1998		74.1	92.0	73.0	86.7
1999					
2000	49.6	76.3	101.0	73.1	84.0
2001	51.6	79..2		74.8	85.0
2002		76.4	90.5	73.0	84.3
2003	47.4	74.0	87.0	74.3	86.1
2004	47.8	72.8		72.1	77.0
2005	50.4	72.1	93.5	72.3	83.8
AVE	50.3	74.4	92.3	73.9	85.0
MAX	55.0	78.2	101.0	77.7	90.0
MIN	45.0	70.0	87.0	72.1	77.0
STDEV	3.2	2.5	3.8	1.6	3.3

Sex/Age	Males			Females	
Brood Yr.	Age-3	Age-4	Age-5	Age-4	Age-5
1991	55.0	70.0	91.7	77.7	90.0
1992	54.0	75.3	91.5	73.5	85.7
1993	52.1	78.2	92.0	74.7	86.7
1994	45.0	74.1		73.0	
1995			101.0		84.0
1996		76.3		73.1	85.0
1997	49.6	79..2	90.5	74.8	84.3
1998	51.6	76.4	87.0	73.0	86.1
1999		74.0		74.3	77.0
2000	47.4	72.8	93.5	72.1	83.8
AVE	50.7	74.6	92.5	74.0	84.7
MAX	55.0	78.2	101.0	77.7	90.0
MIN	45.0	70.0	87.0	72.1	77.0
STDEV	3.6	2.5	4.3	1.6	3.5

c) Smolt-to-adult return rates.

- For the brood year period of 1990-1999 the total smolt-adult return has averaged 0.404%, 0.302%, and 0.267% for Leavenworth, Entiat, and Winthrop NFH's, respectively. **(MC-008)**

d) Stock productivity (e.g. recruits per spawner).

- Total recruits per spawned adult (RPS) has averaged 7.2, 5.5, and 4.8 for Leavenworth, Entiat, and Winthrop NFH's, respectively. **(MC-008)**

Table 7-19. Leavenworth Complex spring Chinook brood year survival and recruits per spawned adult, brood years 1990-1999. **(MC-008)**

Brood Year	LEAVENWORTH NFH				ENTIAT NFH				WINTHROP NFH			
	WENATCHEE		TOTAL RETURN		ENTIAT		TOTAL RETURN		METHOW		TOTAL RETURN	
	%	RPS	%	RPS	%	RPS	%	RPS	%	RPS	%	RPS
1990	0.009%	0.1	0.010%	0.1	0.009%	0.2	0.009%	0.2	0.000%	0.0	0.002%	0.0
1991	0.026%	0.3	0.027%	0.3	0.031%	0.6	0.034%	0.6	0.002%	0.0	0.002%	0.0
1992	0.103%	1.6	0.108%	1.7	0.038%	0.7	0.048%	0.9	0.033%	0.6	0.036%	0.7
1993	0.317%	5.3	0.327%	5.5	0.054%	1.0	0.062%	1.1	0.045%	0.8	0.048%	0.9
1994	0.077%	1.4	0.080%	1.5	0.063%	1.1	0.072%	1.3	0.070%	1.3	0.071%	1.3
1995	0.155%	3.5	0.161%	3.6	0.343%	5.9	0.367%	6.3	0.363%	6.5	0.376%	6.8
1996	0.615%	10.4	0.650%	11.0	0.563%	11.6	0.609%	12.5	0.358%	6.4	0.376%	6.8
1997	0.978%	16.7	1.201%	20.5	0.783%	14.1	0.889%	16.0	0.714%	12.9	0.846%	15.2
1998	1.070%	19.9	1.309%	24.3	0.560%	9.6	0.699%	12.0	0.691%	12.4	0.859%	15.5
1999	0.130%	2.4	0.168%	3.1	0.202%	3.6	0.234%	4.2	0.048%	0.9	0.057%	1.0
AVE	0.348%	6.2	0.404%	7.2	0.265%	4.8	0.302%	5.5	0.232%	4.2	0.267%	4.8
MAX	1.070%	19.9	1.309%	24.3	0.783%	14.1	0.889%	16.0	0.714%	12.9	0.859%	15.5
MIN	0.009%	0.1	0.010%	0.1	0.009%	0.2	0.009%	0.2	0.000%	0.0	0.002%	0.0
STDEV	0.398%	7.1	0.486%	8.7	0.281%	5.2	0.323%	5.9	0.282%	5.1	0.339%	6.1

*All adult return information includes all adults age-3 or older recovered throughout the Pacific Northwest (Total Return) and by release basin.

RPS = recruit per spawner ratios.

2. Contributions to harvest and utilization (e.g. food banks).

   ?

3. Contributions to conservation.

   ?

4. Other benefits.

E. Research, monitoring, and evaluation programs.

1. Conventional vs. "NATURES" rearing. (MC-008)

- A study was conducted in which "natures" rearing was investigated by treating raceways with automatic feeders, structure and/or covers compared to standard or conventional rearing practices.
- A complete evaluation of this study has not been conducted, however, a brief review of the recent brood year return averages by treatment group is displayed in the following figure.

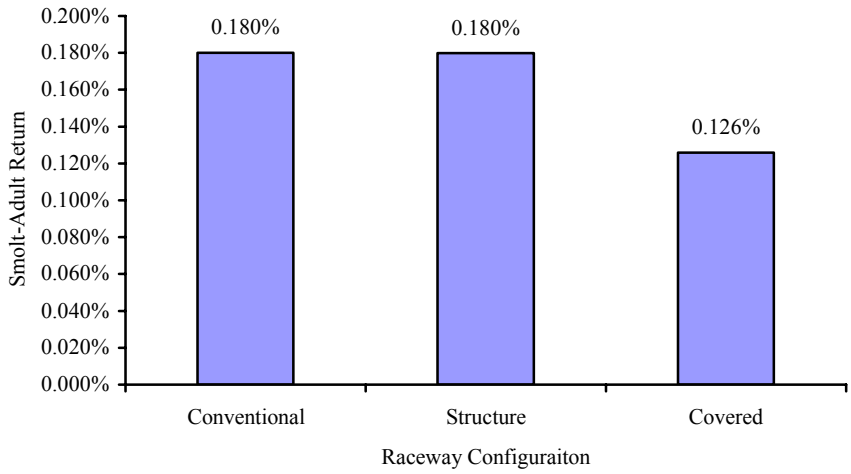

Figure 7-6. Winthrop NFH average spring Chinook smolt-adult survival rates by conventional production vs. "natures rearing" incorporating the use of within raceway structure or cover. **(MC-008)**

2. Carcass nutrient supplementation studies. (MC-008)

- *A nutrient enhancement program was established in 2000 to outplant post-spawn spring Chinook carcasses from Leavenworth Complex hatcheries in the Wenatchee, Entiat and Methow River basins. Carcasses were sanitized through freezing and the tail was removed prior to outplanting to distinguish outplants from naturally spawned carcasses.*
- *During the course of the project, decisions were made to eliminate female broodstock because they are injected with erythromycin prior to spawning to combat bacterial kidney disease. Additionally, any MS-222 treatment (fish sedative) of adults required a one month (living) withdrawal period or the subsequent carcass was not useable for outplant.*
- *In 2003, spawning practices changed to the extent that few suitable carcasses were available for outplant (use of MS-222 at both ENFH and LNFH).*
- *In 2003, carcass analogs were purchased from the fish feed manufacturer Bio-Oregon based on favorable findings about the ability of this product to mimic natural salmon carcass nutrient contribution.*
- Due to the limited availability of useable carcasses for outplanting, complications with other in basin studies, and the costs associated with the use of analogs, the Leavenworth Complex nutrient enhancement program was discontinued in 2004.

3. Spawning surveys in the Methow River.

Table 7-20. Number of SCS redds found in the Methow River Basin, 1988 – 1999 (J. Hubble, pers. comm. 2002). In 1996 and 1998, all adults were trapped at Wells Dam and transferred to Methow SFH and Winthrop NFH for broodstock.

Year	# of Redds	Year	# of Redds
1988	733	1994	133
1989	517	1995	15
1990	498	1996	Na
1991	250	1997	150
1992	738	1998	Na
1993	617	1999	36

Table 7-21. Estimates of natural-origin SCS returning to the Methow River, 1988 – 1999 (J. Hubble, pers. comm. 2002).

Year	Total Adults	# of Natural Origin Adults	Year	Total Adults	# of Natural Origin Adults
1988	2,940	1,613	1994	258	195
1989	1,720	1,525	1995	113	99
1990	939	818	1996	461	0
1991	782	690	1997	1,004	461
1992	1,623	1,232	1998	430	11
1993	2,444	1,546	1999	649	272

F. Program conflicts.

1. Biological conflicts.

- A key issue is the need for a cohesive spring Chinook operation plan for the Methow SFH and Winthrop NFH. The two facilities have different mandates but common goals.
- Methow Composite 1 fish are listed under the ESA. High BKD risk progeny groups have created past disputes regarding the disposition of those high risk fish between the two hatcheries.
- At the present time, broodstock plans change annually based on the predicted percent Carson ancestry of the various brood years available for spawning each year.
- U.S. vs. Oregon requirements for the two hatcheries to operate at "full production" has inhibited the phase-out of fish with significant (>50%) Winthrop-Carson ancestry.
- The stocking rate of spring Chinook for the Methow Basin, and the number of hatchery-origin adults spawning naturally, may exceed conservation genetic guidelines.
- The inability of both the Winthrop NFH and Methow SFH to collect natural-origin adults (NOR) and control the upstream migration of hatchery-origin adults in the mainstem Methow River confounds broodstock management and supplementation goals.

2. Harvest conflicts.

- Endangered status of upper Columbia River spring Chinook coupled with propagation of an ESA-listed hatchery stock essentially precludes harvest opportunities despite mitigation responsibility of Winthrop NFH.

3. **Conservation conflicts** (e.g. competition between unlisted hatchery fish and ESA-listed wild fish).

4. **Other conflicts between the hatchery program, or fish produced by the program, and other non-hatchery issues.**

- The following was taken directly from the Draft Methow Basin Subbasin summary (CBFWA 2002).A central limitation to building self-sustaining populations of anadromous fish in the Methow Subbasin is the high smolt and adult mortalities incurred at the nine hydropower facilities that lie downstream from the Methow's confluence with the Columbia River. These mortalities severely reduce the number of naturally produced adults that return to spawn and reseed available habitat within the Methow Subbasin.
- An additional crucial factor affecting habitat quality in the Methow Subbasin is water quantity. Numerous streams and creeks throughout the Methow watershed are prone to naturally occurring seasonal low flows and occasional dewatering. Those natural flows and instances of dewatering have been compounded in some cases by irrigation withdrawals and by agricultural water use inefficiencies in some Methow tributaries.

VIII. Upper Columbia summer steelhead hatchery program, Winthrop NFH and Wells Dam SFH.

A. General information.

- Winthrop NFH is the only Leavenworth Complex facility currently producing steelhead. **(MC-008, P. 23)**
- The current summer steelhead program at Winthrop NFH began in 1995. **(WT-003, P6)**
- In 1995, the small summer steelhead program at Leavenworth NFH was moved to the Winthrop facility. At that time, SST were not listed. Since their listing in 1997, the program has moved towards aiding in the recovery of this stock. **(WT-003, P. 3)**
- The Winthrop NFH program utilizes adults captured from the upper Columbia River run at large at the Wells Hatchery or Wells Dam collection facilities. **(MC-008, P. 23)**
- The USFWS has explored the possibility of developing a unique Methow River steelhead stock as adults can and do return to the hatchery. However, this program would require two-years of on station rearing to mimic the natural production cycle of this stock. Unfortunately, this is not possible given the limited water and rearing space available under Winthrop NFH's current production programs. **(MC-008, P. 23)**

B. Stock/Habitat/Harvest Program Goals and Purpose.

1. Purpose and justification of program.

- The program goal is to mitigate for steelhead losses associated with inundation attributable to Wells Dam and to mitigate for 7% unavoidable steelhead mortality associated with the operation of Wells Dam (Douglas PUD) and Wanapum and Priest Rapids dams (Grant PUD) and contribute to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecological integrity and supporting harvest. **(WT-006, P.4)**
- Harvest mitigation agreement with USBR as part of the Grand Coulee Fish Maintenance Project. **(MC-008, P. 23)**
- Support tribal fisheries and non-tribal recreational fisheries in the Methow River.
- The current status of steelhead in the mid-upper Columbia River region has led NMFS to conclude in their ESA-listing determination regarding steelhead that the Wells Hatchery broodstock presently used by the Washington Department of Fish and Wildlife (WDFW) for supplementation in the region is essential for recovery of the Upper Columbia River Steelhead ESU **(WT-006, P.4)**

2. Goals of program.

- In 1995, the small summer steelhead program at Leavenworth NFH was moved to the Winthrop facility. At that time, SST were not listed. Since their listing in 1997, the program has moved towards aiding in the recovery of this stock. **(WT-003, P. 3)**
- The goals for this listed stock are to maintain its high biological significance, increase its viability from low to high, and increase harvest opportunity over time. **(MC-008, P. 23)**
- **The goal of the Wells steelhead program was modified after the stock was listed as endangered in 1997, from harvest augmentation using conventional hatchery techniques to conservation/recovery using supplementation.** **(WT-006, P.14)**

3. **Objectives of program.**
   - Returning adults of WNFH origin are expected to return to the Methow Basin only, although some may be harvested in Columbia River and ocean fisheries. **(WT-003, P. 6)**
   - Release 100,000 hatchery-origin Wells steelhead smolts into the Methow River.
   - The Wells Hatchery summer steelhead program consists of 450,000 yearling smolts released annually in the Methow River Basin (320,000) and the Okanogan River Basin (130,000). Wells Hatchery also supports the Winthrop National Fish Hatchery (WNFH) steelhead program (125,000 eyed-eggs) and transfers up to 200,000 excess eyed-eggs annually for release at Ringold Hatchery on the Columbia River near Pasco, Washington. **(WT-006, P.14)**

4. **Type of program.**
   - Winthrop NFH steelhead are part of an integrated hatchery program incorporating wild origin adults into the brood each year. **(MC-008, P. 23)**
   - Type of program: Harvest mitigation. **(WT-003, P. 3)**

5. **Alignment of program with ESU-wide plans.**
   - Steelhead produced at Winthrop NFH are included in the upper Columbia River ESU which is currently listed as ~~endangered~~ threatened under the Endangered Species Act (1973). **(MC-008, P. 23)**
   - The Upper Columbia ESU of summer steelhead was listed as endangered under the ESA on August 18, 1997. This status was upgraded to threatened on January 5, 2006, largely on the basis of comparatively abundant rainbow trout that coexist in the same stream areas as steelhead.

6. **Habitat description and status**
   - Winthrop NFH is located on the Methow River, 50.4 river miles (rm) above its confluence with the Columbia River. **(WT-003, P. 2)**
   - *Fish released from and those returning to WNFH must travel about 524 Columbia rms and negotiate passage through nine Columbia River hydroelectric dams.* ***(WT-003, P. 2)***
   - **Upper Methow River Subwatershed** (156,160 acres). The most significant human-induced impacts in this subwatershed occur along the mainstem Methow River from the Lost River confluence downstream to the town of Winthrop. Large woody debris levels are inadequate throughout this section of the river although from the headwaters downstream to Goat Creek (RM 64.0) large woody debris levels have been improving and are reaching an "adequate" amount. Accelerated bank destabilization is occurring where riparian lands have been converted to residential and agricultural use. Dewatering of portions of the mainstem Methow River from Robinson Creek downstream to the Weeman bridge naturally occur during low water years. **(WT-004, P. 14-15)**
   - **Middle Methow River Subwatershed** (162,834 acres). Diking, the conversion of riparian areas to agriculture and residential uses, and large woody debris removal along the mainstem Methow River are the most significant human impacts in this subwatershed. As a result, there has been a loss of side channel access and habitat

complexity. Additionally, numerous man-made fish passage barriers and unscreened water diversions exist. **(WT-004, P. 15-16)**

- **Lower Methow River Subwatershed** (235,553 acres). There has been no survey or data collection on habitat conditions for the segment of the Methow River that falls within this subwatershed (RM 0.0 - 27.0). other drainages have been heavily managed for timber harvesting and livestock grazing and are heavily used areas for recreation in the Methow Valley Ranger District. Roads placement and high road densities are having a major affect on aquatic habitat in both drainages where roads parallel every major stream. **(WT-004, P. 16)**

7. Size of program and production goals (No. of spawners and smolt release goals).

- On average 118,400 juveniles (SD = 16,745) have been released from 1996-2005 at an average size of 6.5 fish per pound (SD = 1.1). **(MC-008, P. 23)**

C. Description of program and operations.

1. Broodstock goal and source.

- The Winthrop NFH program utilizes adults captured from the upper Columbia River run at large at the Wells Hatchery or Wells Dam collection facilities. **(MC-008, P. 23)**
- Steelhead propagated at Wells Hatchery originated from a mix of indigenous upper Columbia Basin stocks intercepted through the GCFMP. The current stock was developed in the early 1960s from naturally spawning populations intercepted at fish passage facilities upstream of Priest Rapids Dam (MCMCP 1997). **(WT-006, P. 46)**
- The goals for this listed stock are to maintain its high biological significance, increase its viability from low to high, and increase harvest opportunity over time. **(MC-008, P. 23)**
- Winthrop NFH steelhead are part of an integrated hatchery program incorporating some wild origin adults into the brood each year. However, Winthrop is lower in priority for the incorporation of pure wild stock (i.e. wild x wild crosses) than the Wells SFH program. This is due in part to a harvest mitigation agreement with USBR as part of the Grand Coulee Fish Maintenance Project. **(MC-008, P. 23)**

2. Adult collection procedures and holding facilities.

- The Winthrop NFH program utilizes adults captured from the upper Columbia River run at large at the Wells Hatchery or Wells Dam collection facilities. Adults are held, spawned, and eyed eggs are transferred to Winthrop NFH for incubation, rearing, and final release from the facility to the Methow River after 15 months of on station rearing. **(MC-008, P. 23)**
- The broodstock collection goal for Methow and the Okanogan River system is 373 fish (452 fish initially but has been adjusted); and in recent years, 5-12% of the steelhead captured at Wells Dam have been of natural-origin fish (WDFW 1997). **(WT-006, P. 46)**
- ESA Section 10 Permit #1395 authorizes WDFW to retain up to 395 adult steelhead for broodstock purposes. **(WT-006, P. 4)**
- Historically, the program implemented broodstock protocols that targeted mixed-origin (hatchery and wild) fish obtained randomly from the run at large, spaced

throughout the entire run time period, with retention of broodstock by proportional return time. These broodstock collection strategies provided a 4%-12% natural origin proportion within the broodstock. **(WT-006, P. 46)**

- Recent revisions (BY 04) in the broodstock protocols target a 33% natural origin component (maximum of 123 NOR adults) within the broodstock. **(WT-006, P. 46)**
- Broodstock are collected from the east and west fish ladders at Wells Dam between August and November. **(WT-006, P. 14)**
- The broodstock are held on well water at approximately11°C (53°F) throughout spawning (December-March). **(WT-006, P. 14)**
- The prolonged spawn timing (2000-2003 mean = 13 weeks) requires the hatchery to retard the maturation of eggs with a chilled water system in order to maintain consistent emergence timing between the various egg lots and provide appropriate sized smolts for release. Additionally, the hatchery component typically matures earlier than the natural origin component (likely due to past hatchery broodstock collection and mating protocols). **(WT-006, P. 14)**
- In efforts to delay the spawn timing of hatchery fish so that they are more similar to natural origin fish, the program transfers the gametes from the earliest hatchery spawners out to the upper Columbia River to Ringold FH. It is anticipated that over time, the continued infusion of natural origin gene flow into the hatchery program and continued selection of later spawning hatchery fish for the Wells program will delay the spawn timing of hatchery fish to be more consistent with natural origin fish. **(WT-006, P. 14)**
- Synchronized spawn timing of hatchery and natural origin fish will facilitate HxW crosses in the hatchery and likely greater spawning success of hatchery fish in the natural environment. **(WT-006, P. 14)**

Wells Hatchery summer steelhead programs and assumptions. (WT-006, P. 49)

Methow/Okanogan Program	450,000 yearling smolts (230 adults)
WNFH transfer (Methow R)	125,000 eyed eggs for 100,000 smolts (55 adults)
Ringold transfer (Col. R.)	200,000 eyed HxH eggs for 180,000 smolts (88 adults)
Propagation survival	87% fertilization to eyed egg
	86% eyed egg to yearling release
	75% fertilization to yearling release
Fecundity	5,400 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	97%

Table 8-1. Number of steelhead passing Wells Dam and estimates of natural component, 1990 to 2001. (www.fpc.org - 12/02). **(WT-003, P.7)**

Year	Total Adults	# of Natural Origin Adults	Year	Total Adults	# of Natural Origin Adults
1990	3,819	Not available	1996	4,127	Not available
1991	7,715	Not available	1997	4,107	Not available
1992	7,073	Not available	1998	2,668	314
1993	2,400	Not available	1999	3,557	603
1994	2,183	Not available	2000	6,280	1,787

1995	945	Not available	2001	18,483	8,381

- The USFWS has explored the possibility of developing a unique Methow River steelhead stock as adults can and do return to the hatchery. For the past several years, numerous steelhead adults (hatchery and wild) returned to and spawned in the channel that connects the adult collection ladder (WNFH) to the Methow River. A current issue is whether steelhead adults should be collected at Winthrop NFH for the current program. This program could enhance recovery of this species if it shifted to acclimating the smolts in an upper-basin acclimation site where they would be released volitionally and subsequently return to sites in the basin as adults (instead of the hatchery). **(WT-003, P.6; MC-008, P. 23)**
- However, a local broodstock program would require two-years of on station rearing to mimic the natural production cycle of this stock. Unfortunately, this is not possible given the limited water and rearing space available under Winthrop NFH's current production programs. **(MC-008, P. 23)**

3. Adult spawning (performed at Wells State Fish Hatchery by WDFW)**.**

a) Spawning protocols.

- The current goal at Wells Hatchery is to spawn 67% hatchery-origin fish with 33% natural-origin (wild) fish to yield two-thirds wild x hatchery (WxH, HxW) and one-third hatchery x hatchery (HxH) progeny.
- In past years, eyed eggs transferred to Winthrop NFH were the progeny of hatchery x hatchery (HxH) crosses **(WT-003, P.6)**
- The increase in proportion of natural origin fish in the broodstock from a proportion equal to the run (4-12%) to 33% provided a 100% HxW parental cross for the 2004 Brood Year for the Methow River releases. The program will target 100% HxW progeny for recovery in the Methow River Basin. **(WT-006, P.46)**
- Eyed eggs have recently been the progeny of wild x hatchery (WxH) crosses **(C. Pasley, Winthrop NFH, pers. comm.)**

b) Numbers of males and females spawned.

Table 8-2. Number of adult steelhead broodstock spawned at Wells Hatchery,1990-2005. Totals below are for the entire Wells steelhead program not broken out to a Methow portion only. **(WT-006, P.51)**

Year	Adults		
	Females	Males	Jacks
1994	339	276	-
1995	307	286	-
1996	298	242	-
1997	270	197	-
1998	231	185	-
1999	212	177	-
2000	191	205	-
2001	218	186	-
2002	206	176	-
2003	170	126	-
2004	190	231	-
2005	199	168	-

- Winthrop NFH does not receive any information regarding the number of families (number of female parents) from which the transferred eyed eggs were obtained, nor any other information regarding the brood source of eggs, other than the eggs were derived from HxH or WxH crosses. **(C. Pasley, Winthrop NFH, pers. comm.)**

4. Fertilization

a) Protocols (WT-006, P. 54)

- Spawning of adult steelhead at Wells Hatchery occurs 1:1 with an additional male used as back-up to ensure the highest likelihood of fertilization. Jack or precocious steelhead (<20" TL) are generally not seen in the population.
- In past years experience at Wells Hatchery, females occasionally outnumbered males by as much as two to one. To hedge against a sperm shortage males may be used twice as primary and twice as backup (physically crossed twice, with sperm split for primary and backup each time).
- Due to smaller number of wild males available for broodstock, the spawning protocol allows the wild males to be used twice if needed as oppose to hatchery males used once.
- Post fertilization, eggs are rinsed in a buffered iodine solution (100 ppm) and allowed to water harden for one hour in the same solution.

b) Number of eggs collected and fertilized

Table 8-3. Total steelhead egg take at Wells Hatchery, 1995-2005. Wells Hatchery retains approximately 515k eyed-eggs for its programs and transfers another 365k eyed-eggs to other programs. The permit level broodstock goal is based on a fecundity of 5,400. In some years, mean fecundity has averaged 6,232 with 2-salt female fecundity 6,744 as compared with 1-salt female (4,779).

Year	Egg Take	Green-Eyed Survival (%)	Eyed-Ponding Survival (%)
1995	1,806,500	84.3	~99.0
1996	1,526,600	82.3	~99.0
1997	1,090,000	89.9	~99.0
1998	1,719,548	85.8	~99.0
1999	1,392,098	75.7	~99.0
2000	1,148,999	84.6	~99.0
2001	987,634	86.22	~99.0
2002	1,133,000	See HGMP Section 9.2.1.	
2003	1,020,000		
2004	1,001,000		
2005*	1,094,500		

* Data preliminary until Section 10 reports are submitted by WDFW

5. **Incubation.**
   - At Wells State Fish Hatchery, each female/mating (WxH and HxH Cross) is individuallly incubated at one female per Heath Techna Incubators (16 tray) vertical stack incubators. Natyral steelhead eggs are expected to average 272/oz. Eggs from individual females (14 -26 oz. ; 3,696 – 7,020 eggs) will be incubated individually in Heath. The flow rate to each incubator is maintained at 2-4 gpm throughout the incubation period. After eggs reach the egg stage, they are incubated at 7,500 eggs per tray. **(WT-006, P. 55)**
   - Eyed eggs are bagged, then placed in coolers prior to the approximately one-hour trip to the hatchery. The current program at Winthrop NFH calls for 125,000 eyed eggs for a release of 100,000 yearling smolts **(WT-003, P. 14)**
   - The transfer of steelhead eggs or fry to Winthrop National Fish Hatchery for the U.S. Fish and Wildlife Service steelhead program authorized under an ESA Section permit No. 1396 from NOAA-Fisheries. **(WT-006, P. 4)**
   - Eyed eggs are received from Wells Dam SFH in January or February. **(WT-003, P. 18)**
   - After enumeration at Winthrop NFH, the eyed eggs are placed in Marisource stack-type incubators. **(WT-003, P. 18)**
   - Each tray is loaded with a maximum of 6,000 eggs and water flow is maintained at 2 to 5 gpm. **(WT-003, P. 18)**
   - Egg size averages 4,250 eggs/lb. **(WT-003, P. 21)**
   - Water source is 100% ground water throughout incubation and temperatures are constant at 47 to 49° F. **(WT-003, P. 18)**
   - Egg mortalities are removed by hand at the eyed stage or by mechanical egg sorting machine in instances where mortality is higher than normal (>5%). **(WT-003, P. 22)**
   - Table 5 below provides information for the number of eggs received and survival rates to ponding from 1995 to 2002. **(WT-003, P. 21)**

6. **Ponding.**
   a) **Protocols.**
      - Steelhead start out in rectangular tanks (89 cubic feet) inside the hatchery building. **(WT-003, P. 18)**
      - Steelhead are fully buttoned-up at about 1,000 Daily Temperature Units (DTU) and are ponded-out at this time. **(WT-003, P. 21)**
      - Swim-up fry average 1.0 to 1.1 inches (2,300 to 2,600 fish/lb). **(WT-003, P. 21)**
      - Ponding is forced as trays are removed from the Heath stacks and transferred to appropriate shallow concrete troughs. **(WT-003, P. 21)**
      - Density indices are kept below 0.25 lbs/cu.ft./inch during early rearing. **(WT-003, P. 21)**

b) Number of fry ponded each year, including % hatch each year.

Table 8-4. Number of eggs received and survival rates to ponding **(WT-003, P. 21)**

Year	Eyed Eggs Received	Survival Rate to Ponding (%)
1995	115,000	97.9
1996	99,947 juveniles received	Not applicable
1997	0	Not applicable
1998	137,500	99.2
1999	120,168	98.1
2000	109,126	96.9
2001	155,743	98.9
2002	125,000	98.9

Table 8-5. Winthrop NFH juvenile summer steelhead trout monthly brood production inventory and rearing environment parameters for brood year 2003. **(MC-008, P. 24)**

Month	Life Stage	Temp ^{0}F Ave	Water Source		Flow GPM	Flow Index (lbs./in.* GPM)	Density Index (lbs./in.*ft^3)	Number on Hand	Total Weight (lbs.)
			% Well	% River					
August	NA	NA	100%	0%	NA	NA	NA	NA	NA
September	NA	NA	100%	0%	NA	NA	NA	NA	NA
October	NA	NA	100%	0%	NA	NA	NA	NA	NA
November	NA	NA	100%	0%	NA	NA	NA	NA	NA
December	NA	NA	100%	0%	NA	NA	NA	NA	NA
January	NA	NA	100%	0%	NA	NA	NA	NA	NA
February	Egg	NA	100%	0%	NA	NA	NA	NA	NA
March	Alevin/Fry	47.0	100%	0%	90	0.89	0.74	118,569	116
April	Fry	46.0	100%	0%	199	0.60	0.13	121,314	210
May	Fry	45.2	100%	0%	199	0.85	0.19	119,724	356
June	Sub-yearling	47.8	100%	0%	398	0.61	0.14	119,187	612
July	Sub-yearling	50.8	100%	0%	703	0.50	0.06	118,566	1,069
August	Sub-yearling	53.0	100%	0%	701	0.79	0.10	118,241	2,119
September	Sub-yearling	52.8	100%	0%	1,403	0.54	0.07	117,998	3,396
October	Sub-yearling	50.6	100%	0%	1,392	0.70	0.09	117,874	4,954
November	Sub-yearling	48.8	100%	0%	1,369	0.99	0.13	117,530	8,133
December	Sub-yearling	42.0	30%	70%	2,006	0.74	0.10	117,196	9,338
January	Sub-yearling	42.9	30%	70%	1,344	1.11	0.16	115,359	9,486
February	Yearling	42.3	30%	70%	1,335	1.22	0.17	114,932	10,842
March	Yearling	42.3	100%	0%	1,313	1.47	0.22	114,746	13,993
April	Smolt	44.5	100%	0%	NA	NA	NA	114,708	17,540

7. **Rearing/feeding protocols.**
   - When a maximum Density Index (DI) of 0.20 lbs/cu.ft./in. is reached, the fish are split into additional tanks and eventually moved to outside Foster-Lucas ponds. **(WT-003, P. 18)**
   - The DI is maintained at or below 0.20 lbs/cu.ft./in. throughout the rearing cycle. **(WT-003, P. 18)**
   - Density indices have been successful at or below the goal of 0.25 lbs/cu.ft./inch (DI) for early rearing (fry stage) and 0.20 for latter rearing (fingerling to smolt stage). **(WT-003, P. 22)**
   - Examples of Winthrop NFH juvenile summer steelhead trout inventory and rearing parameters are presented below in Tables 14 and 15. **(MC-008, P. 24-25)**
   - Steelhead are reared on 100% ground water until they reach a size of approximately 10 fish/lb the following winter. At this time they are moved to the final rearing and acclimation ponds, which are 12' x 100' raceways, supplied with a mixture of ground and surface water. The percentage of surface water is gradually increased through release time in mid-April. **(WT-003, P. 18)**
   - BioOregon semi-moist feeds are used throughout the rearing cycle of SST at WNFH. **(WT-003, P. 24)**
   - Winthrop NFH juvenile summer steelhead trout feeding rate information is below in Table 15. **(MC-008, P. 25)**

8. **Fish growth and survival profiles.**
   - Examples of Winthrop NFH juvenile summer steelhead trout growth parameters are presented below in Table 15. **(MC-008, P. 25)**
   - Table IX-6 below provides information for fry-fingerling and fingerling-smolt survival rates for 1995 to 2002. **(WT-003, P. 22)**

Table 8-6. Winthrop NFH juvenile summer steelhead trout monthly culture and performance for brood year 2003. **(MC-008, P. 25)**

Month	Life Stage	Ave Size (#/lb)	Ave Size (gms)	Length Ave (in)	Length Ave (mm)	Condition Factor (C=lbs/in)	Feed Fed Per Day (lbs.)	Feeding Rate %BW/day	Food Conversion (lbs. Fed/lb. Gain)	Comments
August	NA	NA	NA	NA	NA	NA	NA	NA	NA	
September	NA	NA	NA	NA	NA	NA	NA	NA	NA	
October	NA	NA	NA	NA	NA	NA	NA	NA	NA	
November	NA	NA	NA	NA	NA	NA	NA	NA	NA	
December	NA	NA	NA	NA	NA	NA	NA	NA	NA	
January	NA	NA	NA	NA	NA	NA	NA	NA	NA	
February	Egg	NA	NA	NA	NA	NA	NA	NA	NA	Eyed eggs received from Wells SFH
March	Alevin/Fry	1,022.1	0.4	1.453	36.91	3.19E-04	1.2	1.06%	0.57	Transferred to starter troughs
April	Fry	577.7	0.8	1.76	44.65	3.19E-04	3.3	1.56%	1.04	
May	Fry	336.3	1.3	2.10	53.42	3.20E-04	5.7	1.59%	1.87	Transferred to starter tanks
June	Sub-yearling	194.8	2.3	2.52	64.06	3.20E-04	13.5	2.20%	2.77	
July	Sub-yearling	110.9	4.1	3.04	77.29	3.20E-04	14.0	1.31%	1.69	Adipose clipping/transferred to FL's
August	Sub-yearling	55.8	8.1	3.83	97.18	3.20E-04	26.0	1.23%	1.76	
September	Sub-yearling	34.7	13.1	4.48	113.82	3.20E-04	48.4	1.43%	1.38	
October	Sub-yearling	23.8	19.1	5.08	129.11	3.20E-04	67.0	1.35%	1.63	
November	Sub-yearling	14.5	31.4	6.00	152.45	3.20E-04	89.9	1.11%	1.73	
December	Sub-yearling	12.6	36.2	6.29	159.79	3.20E-04	70.5	0.76%	0.69	Transferred to converted FL's
January	Sub-yearling	12.2	37.3	6.36	161.49	3.20E-04	25.7	0.27%	0.66	
February	Yearling	10.6	42.8	6.66	169.06	3.20E-04	61.8	0.57%	11.68	
March	Yearling	8.2	55.4	7.25	184.15	3.20E-04	81.6	0.58%	1.87	Release window is mid-April.
April	Smolt	6.5	69.4	7.82	198.58	3.20E-04	189.5	1.08%	0.90	Forced & volitional release.

Table 8-7. Percent survival estimates for juvenile SST, WNFH **(WT-003, P. 22)**

Brood Year	Fry to Fingerling (%)	Fingerling to Smolt (%)
1995	72 (water supply failure)	99.8
1996	NA (received as fingerlings)	99.9
1997	NA (no SST received this year)	NA
1998	97.8	97.2
1999	94.8	99.1
2000	99.2	99.3
2001	97.2	97.7
2002	98.7	NA

9. Fish health.

- No cases of disease have occurred with the steelhead during early life stages. **(WT-003, P. 22)**
- Disease monitoring is accomplished by daily visual observations by hatchery staff and twice monthly monitoring by fish health biologists/pathologists from the Olympia Fish Health Center (OFHC). **(WT-003, P. 24)**
- Any abnormal situation observed by hatchery staff is called to the attention of the OFHC, which performs diagnostic and confirmatory clinical tests before recommending appropriate treatments. **(WT-003, P. 24)**
- Treatment procedures may include environmental manipulation to control stresses and enhance the fish's natural ability to recover from infectious agents and/or appropriate chemicals or antibiotics. **(WT-003, P. 24)**
- Antibiotics and chemicals that are registered for fish disease treatments are applied as per labeled instructions. Other therapeutic drugs and chemicals may be applied through appropriate INAD permits or by allowable extra-label prescription by staff Veterinary Medical Officer or local Veterinarian. All test records and results are on file at the Olympia Fish Health Center. **(WT-003, P. 24)**
- Prior to release, sixty fish from all juvenile lots are sampled and tested for reportable bacterial and viral pathogens with methods that meet or exceed all national, international, IHOT or co-manager requirements. Semi-monthly monitoring of juveniles for parasites, gill, internal organ and overall condition continues until release. **(WT-003, P. 24)**

10. Chemotherapeutant use.

- Formalin treatments are not necessary during incubation. **(WT-003, P. 18)**

11. Tagging and marking of juveniles.

- Juvenile steelhead are 100% adipose clipped, however, a unique CWT is not applied for adult return/harvest contribution evaluation. **(MC-008, P. 23)**
- Recently, approximately 50,000 PIT tags were applied to this stock annually (brood years 2002-2004) as part of an Army Corps of Engineers lower Columbia River transportation study. **(MC-008, P. 23)**
- Hatchery steelhead released from the Wells Hatchery into the Methow River basin are 100% marked/tagged. Current mark/tag strategies include 75% adipose clip rate and

25% VIE tag rate of steelhead released into the Methow Basin. Additionally, a representative proportion will receive CWT or PIT tags.

Table 8-8. Marks and tags applied to hatchery-produced steelhead in the mid-Columbia region.

Hatchery	Release Site	Stock	Purpose	Mark	Approximate 2002 Release
Wells	Methow River	Wells HxW	Recovery/test	VIE/PIT	320,000
	Methow River	Wells HxH	Recovery/control	Ad/VIE/PIT	/1
	Okanogan River	Wells HxH	Recovery	Ad	70,000
	Methow River	Wells HxH	Recovery	Ad	/1
	Similkameen	Wells HxH	Recovery	Ad	60,000
	River	Wells HxH	Mainstem studies	Ad/PIT	- -
	Columbia River	Wells HxH	General release	Ad	- -
	Columbia River				
Winthrop	Methow River	Wells HxH	Recovery	Ad	100,000
Turtle Rock	Wenatchee River	Wenatchee HxH	Recovery/control	VIE/PIT/Ad	50,000
& Eastbank	Wenatchee River	Wenatchee HXW	Recovery test	VIE/PIT	200,000
	Wenatchee River	Wenatchee WxW	Recovery test	VIE/PIT	150,000
Ringold	Columbia River	Wells HxH	General release	Ad/RV	180,000

/1 In the event that HxW plants are significantly under program (i.e. below 320,000 smolts), HxH steelhead will be used in the Methow Basin to achieve the total 320K Methow release target. This location would be best for maintaining stock separation of the returning adults.

12. Fish Release.

a) Protocols.

- At this time, all acclimation occurs at Winthrop NFH. **(WT-003, P. 27)**
- Fish are reared on 100% ground water for the first 10 months of the 14-month rearing cycle, if possible. **(WT-003, P. 27)**
- When the fish reach 10 fish/lb (in winter), they are moved to the final rearing and acclimation ponds, which are 12' x 100' raceways, supplied with a mixture of ground and surface water. **(WT-003, P. 18)**
- River water is gradually introduced during the 10th or 11th month of rearing. The percentage of river water is gradually increased each month to a final mixture of about 80% river water and 20% ground water. **(WT-003, P. 27)**
- All releases of steelhead start when fish are beginning to smolt in early to mid-April and continue through a volitional release window of roughly five weeks. **(WT-003, P. 27)**
- The release is semi-volitional (voluntary for a set time then forced) from mid-April to mid-May. **(MC-008, P. 23)**
- Release is volitional over notched dam boards and through an underground pipe system, which empties at the base of the collection ladder. **(WT-003, P. 18)**
- The current plan for listed steelhead surplus to our production goal, allows for out-planting of fish to tributary streams as needed by WDFW. **(WT-003, P. 27)**
- Steelhead released from this facility normally move out in 24 hours following a release. **(WT-003, P. 27)**

- Steelhead reared at Well Hatchery are allowed to volitionally migrate from the earthen rearing ponds, and trucked to release sites in the Methow and Okanogan River Basins for direct release. **(WT-006, P. 14)**
- WDFW suggests that tributary specific acclimation ponds would decrease stress associated with truck transport and allow a greater flexibility for the management of non-migrant steelhead. The Wells facility produces high quality smolts, but a proportion of the annual releases residualize in tributaries utilized by wild steelhead, spring chinook and bull trout. Acclimation ponds may provide year-round holding of non-migrant steelhead, or allow recreational fishing opportunities to occur (e.g., Tucannon River program). **(WT-006, P. 14)**

b) Number of fish released each year.

- On average 118,400 yearling juveniles (SD = 16,745) have been released from 1996-2005 at an average size of 6.5 fish per pound (SD = 1.1). **(MC-008, P. 23)**
- All released fish are AD-clipped but not CWT'd.
- Preliminary data regarding juvenile outmigration and adult return characteristics are presented below in LNFHComplexrpt2005 Table 16. **(MC-008, P. 26)**
- Monthly production summaries describing the rearing environment are presented below in the LNFHComplexrpt2005, Table 14. **(MC-008, P. 24)**
- The Wells Hatchery program smolt release objective is 450,000 smolts (350,000 Wells Dam HCP and 100,000 Priest Rapids BiOp). Of the 450,000 smolt program, 320,000 are expected to be released in the Methow River Basin.
- In addition to the 100,000+ smolt release from the Winthrop NFH, smolts are also directly outplanted from the Wells Hatchery into the Methow River Basin (see Table XX).
- At Wells Hatchery, smolts volitionally migrate to a collection raceway/chamber downstream of the large rearing ponds and are pumped from the collection chamber into a tanker truck for transport and direct release into Twisp River (RKm 17.6), Chewuch River (RKm 32), and the upper Methow River near Mazama (RKm 88). Depending on returning adult steelhead distribution objectives, the use of acclimation ponds for steelhead releases may have merit. **(WT-006, P. 60)**

Table 8-9. Number of steelhead released from Winthrop NFH. **(MC-008, P. 26)**

Brood Year	Beginning Release Dates		Number Released	Size @ Rel. #/LB	Number PIT Tagged	McNary Travel Time	Rel-McNary Survival	PIT Adults BON	PIT Survival
	1st Group	Last Group							
1995	04/22/96	04/23/96	141798	6.3	0	NA	NA	NA	NA
1996	04/23/97	04/24/97	104,098	5.2	0	NA	NA	NA	NA
1997*	04/29/98	05/22/98	127,020		0	NA	NA	NA	NA
1998	04/21/99	06/10/99	112,908	7.0	0	NA	NA	NA	NA
1999	04/12/00	05/22/00	105,510	5.4	0	NA	NA	NA	NA
2000	04/30/01	04/30/01	98,834	5.5	0	NA	NA	NA	NA
2001	04/30/02	04/30/02	150,488	8.0	0	NA	NA	NA	NA
2002	04/28/03	04/28/03	119,370	6.5	49,217	13.0	27.2%	87	0.18%
2003	04/27/04	04/28/04	113,603	6.0	49,475	24.3	37.1%	27	0.05%
2004	04/22/05	04/29/05	110,368	8.2	49,233	20.7	22.5%	NA	NA

Winthrop NFH steelhead are 100% adipose clipped, however, they are not marked with an identifiable coded-wire tag.

All adult broodstock are collected and spawned at Wells SFH. Therefore, adult return data is limited.

*Release files indicate Wells Hatchery produced the fish that were released at Winthrop NFH.

Data of harmonic travel time (# of days from release to each Columbia River Dam, McNary, John Day & Bonneville) & survival generated by Columbia Basin Research, School of Aquatic & Fishery Sciences, University of Washington, http://www.cbr.washington.edu/dart/

Cormack/Jolly-Seber Estimates survival estimates are generated from capture histories for each fish that are based on data downloaded from the PTAGIS database system. The particular data used for these estimates contain only last detections and therefore do not take into account the full detection history for a fish at a given site and may not account for errors in detection sequence recording. This may lead to minor over censoring sequence recording. This may lead to minor over censoring of the data that in turn may lead to slightly higher standard errors in parameter estimates when compared to systems that use the full detections history of the fish.

The number of adult PIT tagged steelhead detected at Bonneville Dam adult ladders as of 2/21/06 with current PIT survival shown.

Table 8-10. Release dates, how, what stage, and where released, WNFH.

Migration Year	Release Date	Type Release	Life Stage	Release Site
1997	April 23	Forced	Yearling/smolt	Methow River at Winthrop
1998	NA			
1999	April 14 – May 22	Volitional/ Remaining trucked and forced	Yearling/smolt	Methow River at Winthrop, and Methow River at rm 8
2000	April 10 – May 22	Volitional/ Remaining forced	Yearling/smolt	Methow River at Winthrop
2001	April 11 – April 30	Volitional/ Remaining forced	Yearling/smolt	Methow River at Winthrop
2002	April 15 – April 30	Volitional/ Remaining forced	Yearling/smolt	Methow River at Winthrop

Table 8-11. Numbers and sizes of steelhead smolts outplanted from Wells Hatchery into the Methow River Basin, 1995-2005.

Methow System Plants							
Release Year	Methow River Plants			Chewuck and Twisp River Plants			
	No.	Date (MM/DD)	Avg Size (fpp)	Release Year	No.	Date (MM/DD)	Avg Size (fpp)
1995	226,520	May 18-26	5.8	1995	Unk.		
1996	238,500	May 1- 24	5.0	1996	Unk.		
1997	310,480	April 25- May 23	6.5	1997	Unk.		
1998	127,020	April 29-May 22	5.8	1998	126,000 Into the Twisp	April 27- May 22	7.0
				1998	125,300 Into the Chewuch	April 24- May 22	7.0
1999	350,431	April 21-June 8	6.9	1999	127,515 Into the Twisp	April 21-June 8	5.1
				1999	96,225 Into the Chewuch	April 21-June 7	5.5
2000	165,900	April 11-May 24	6.8	2000	136,681 Into the Twisp	April 25-May 23	6.3
				2000	138,300 Into the Chewuch	April 25-May 23	6.3
2001	116,830	April 27-May 22	7.4	2001	109,950 Into the Twisp	May 1- 22	5.9
				2001	99,490 Into the Chewuch	May 1- 22	5.9
2002	94,020	April 29-May 23	6.0	2002	84,475 Into the Twisp	April 29-May 23	5.8
				2002	85,615 Into the Chewuch	May 1- 23	6.0
2003	100,035	April 23- May 5	6.1	2003	105,323 in the Twisp	May 1- 8	6.0
				2003	117,495 in the Chewuch	April 23- May16	6.2
2004	80,580	April 21- May 6	6.4	2004	97,105 Into the Twisp	April 23- May 7	7.3
				2004	78,205 Into the Chewuch	April 21- May 6	7.3
2005	86,041	April 25- May 11	5.4	2005	96,420 Into the Twisp	April 25- May 11	5
				2005	82,280 Into the Chewuch	April 25- May 11	5.4

D. Program benefits and performance.

(NOTE: All hatchery reared summer steelhead released from WNFH are adipose fin-clipped but they are not coded-wire tagged. Because adults are not collected at Winthrop NFH, very little survival data with respect to adult returns are available.) **(WT-003, P. 6)**

1. Adult returns.

a) Numbers of adult returns (need data for the past 10-20 years).

- The run size needed at Priest Rapids Dam to meet minimum escapement objectives for the tributary streams of the region totals 9,550 adults.
- The 9,550 fish run size is intended to provide a minimum of 2,500 natural spawners in the Wenatchee River, 500 natural spawners in the Entiat River, 2,500 natural spawners for the Methow River and 600 natural spawners for the Okanogan River. **(MC-013, P. 23)**

Table 8-12. Priest Rapids Dam adult steelhead returns. **(WT-006, P. 12)**

	Artificially Propagated		Naturally Produced		
Year	Total	Percent	Number	Percent	Total Run
1986	20,022	90%	2,342	10%	22,364
1987	9,955	71%	4,058	29%	14,013
1988	7,530	74%	2,670	26%	10,200
1989	8,033	75%	2,685	25%	10,718
1990	6,252	80%	1,585	20%	7,837
1991	11,169	80%	2,799	20%	13,968
1992	12,102	88%	1,618	12%	13,720
1993	4,538	84%	890	16%	5,428
1994	5,880	87%	855	13%	6,735
1995	3,377	77%	993	23%	4,370
1996	7,757	90%	843	10%	8,600
1997	8,157	91%	785	9%	8,942
1998	4,919	84%	928	16%	5,847
1999	6,903	83%	1,374	17%	8,277
2000	9,023	79%	2,341	21%	11,364
2001	24,174	81%	5,670	19%	29,844
Average	9,362	82.2%	2,027	17.8%	11,389

Table 8-13. Upper Columbia River steelhead run composition at Wells Dam (Methow and Okanogan basins) (Letter from Kirk Truscott, WDFW, July 9, 2003). **(WT-006, P. 23)**

	Artificially Propagated		Naturally Produced		
Year	Number	Percent	Number	Percent	Total Run
1998	2,849	92%	234	8%	3,083
1999	3,511	89%	447	11%	3,958
2000	6,142	92%	541	8%	6,683
2001	18,034	95%	889	5%	18,923
2002	9,098	93%	706	7%	9,804

River Basin	Run Size	Escapement	Wild-origin Escapement	Hatchery-origin Escapement
Wenatchee	2,700	2,500	800	1,700
Methow & Okanogan	3,950	3,100	350	2,800
Entiat	unknown	unknown	unknown	unknown
Total	~6,650	~5,600	~1,150	~4,500

b) Return timing and age-class structure of adults.

- Females make up about 65% of adults sampled at Wells Dam. **(WT-003, P. 6)**
- Adults returning after one year average 59 to 64 cm, whereas those spending two years at sea average 67 to 76 cm when returning to freshwater. **(WT-003, P. 6)**

c) Smolt-to-adult return rates.

- Spawning grounds are not surveyed for steelhead because the adults generally spawn over a 4 to 5 month period coinciding with the spring run-off when water visibility is low and discharge high. **(WT-003, P. 6)**
- Limited PIT tag information indicates adult survival to Bonneville Dam of 0.18% in 2002 and 0.05% in 2003. **(MC-008, P. 26)**

Table 8-14. Smolt/Adult return of Wells Stock, hatchery-origin upper Columbia River summer steelhead for brood years 1981-1996. **(WT-006, P. 13)**

Brood Year	Release Year	Number Smolts	Total Brood Year Return to Wells	1-Salt	2-Salt	% BY Return	Adult Return Past Wells	1-Salt	2-Salt	% Return
1981	1982	379,472	28,615	19,140	9,475	7.54	27,734	18,636	9,098	7.31
1982	1983	494,784	17,236	7,444	9,791	3.48	16,768	7,148	9,620	3.39
1983	1984	466,545	18,421	9,791	8,630	3.95	17,948	9,620	8,328	3.85
1984	1985	413,066	7,556	4,854	2,702	1.83	7,122	4,684	2,438	1.72
1985	1986	452,844	5,517	2,702	2,815	1.22	4,888	2,438	2,450	1.08
1986	1987	564,315	3,220	1,654	1,566	0.57	2,791	1,439	1,352	0.49
1987	1988	826,208	5,727	3,040	2,686	0.69	4,880	2,625	2,255	0.59
1988	1989	623,003	4,201	1,323	2,878	0.67	3,766	1,111	2,655	.060
1989	1990	740,433	8,845	4,696	4,149	1.19	8,136	4,331	3,805	1.10
1990	1991	656,997	5,169	3,067	2,102	0.79	4,509	2,812	1,697	0.69
1991	1992	514,610	2,408	701	1,707	0.47	1,895	566	1,329	0.37
1992	1993	511,295	1,461	919	542	0.29	1,050	716	334	0.21
1993	1994	420,110	2,144	813	1,331	0.51	1,722	500	1,222	0.41
1994	1995	450,395	5,351	2,961	2,390	1.19	4,867	2,720	2,147	1.08
1995	1996	328,100	3,432	2,036	1,396	1.05	3,039	1,829	1,210	0.93
1996	1997	477,900	2,775	1,453	1,322	0.58	2,270	1,260	1,010	0.47
1997	1998	478,327	2,849	2,157			1,649	1,649		
1998	1999	843,385	3,479							
1999	2000									
2000	2001									
2001	2002									
2002	2003									
Median						0.92				0.81
Mean						1.63				1.52

d) Stock productivity (e.g. recruits per spawner).

- Wild steelhead returning to the upper Columbia River region sustain themselves only at threshold population size today.
- The high hatchery return rate, genetic homogeneity of hatchery and wild steelhead, and maintenance of near MSY levels in most years suggest a truly wild fish does not exist. **(MC-013, P. 23)**

2. Contributions to harvest and utilization (e.g. food banks).

- All of the artificial production programs operating in the region are intended to contribute to recovery of the naturally produced component as well as provide selective harvest opportunities. **(MC-013, P. 23)**
- At present, non-treaty harvest opportunities outside the Upper Columbia region are limited to mark selective recreational fisheries below McNary Dam on mixed stocks. Within the region, non-treaty harvest opportunities include the Wanapum band tribal harvest near Priest Rapids Dam, and incidental take in Colville Tribal fisheries as well as recreational fisheries. In addition, as abundances allow, a non-treaty selective recreational fishery is authorized with conservation implications above Priest Rapids Dam (NOAA Fisheries Federal Permit #1395). **(MC-013, P. 23)**

3. Contributions to conservation.

- Juveniles are volitionally released directly from the hatchery to promote homing back to the facility and/or basin. **(WT-003, P. 6)**
- Optimal release time is estimated using historical emigration data, hatchery records, and the smoltification assessment protocol. **(WT-003, P. 6)**
- Eggs are obtained and utilize eggs from adults taken throughout the entire spectrum of the run as per WDFW protocol used at Wells Dam. **(WT-003, P. 6)**
- Hatchery produced steelhead have strongly dominated spawning escapements, with recent contributions estimated to average 54% in the Wenatchee River and 81% in the Methow and Okanogan rivers. **(WT-006, P. 4)**

4. Other benefits.

- Although the life history of this ESU is similar to that of other inland steelhead, smolt ages for natural-origin steelhead are some of the oldest on the west coast (up to 7 years old), probably due to the ubiquitous cold water temperatures (Mullan *et al.* 1992).
- Adult steelhead from this ESU enter the lower Columbia between May and September with fish arriving at Wells Pool in early July. Fish enter the Wenatchee and Methow Rivers in mid-July and peak between mid-September and October. During winter, adult steelhead generally return to the warmer Columbia River and re-enter the Methow to begin spawning in mid-March after the ice has thawed. Spawning continues through May and many fish seek out higher reaches in the tributaries. **(WT-006, P. 20)**

UCR Spring chinook:

Table 9. Annual total redd counts and proportion of artificially propagated to natural origin spring chinook salmon by tributary basin (Andrew Murdoch, WDFW, pers. comm.).

	Return Year								
Basin	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
				Redd Count					
Wenatchee Basin [a]									
Chiwawa River	82	13	23	82	39	34	128	1,046	
Nason Creek	27	7	33	55	29	8	100	367	
White River	3	2	12	15	5	1	8	93	
Entiat Basin	34	13	20	37	24	27	73	202	112
Methow Basin									
Twisp River	32	4	0	32	0	7	99	370	109
Chewuch River	27	2	0	55	0	6	20	1,037	301
Methow River	64	9	0	56	0	17	232	2,828	722
				Proportion of Hatchery to Natural Origin Spawners [b]					
Wenatchee Basin [a]									
Chiwawa River	0.40	0.05	0.43	0.70	0.56	0.33	0.56	0.74	
Nason Creek	0.23	0	0.33	0.63	0.19	0	0.24	0.61	
White River	0	0	0	0	0	0	0	0.21	
Entiat Basin [c]	0	0	0.20	??	0	0	0.58	0.25	0.18
Methow Basin									
Twisp River	0	0	0	0.25	0	0.64	0.96	0.33	027
Chewuch River	0.29	0	0	0.33	0	0.64	0.42	0.64	087
Methow River	.014	0	0	0.37	0	0.39	0.91	0.95	0.95

[a] *Areas upstream of Tumwater Dam*

[b] *Based on coded-wire tag recoveries*

[c] *Minimum values, some carcasses were of unknown origin*

E. Research, monitoring, and evaluation programs.

- Recently, approximately 50,000 PIT tags were applied annually (brood years 2002-2004) to steelhead released from the Winthrop NFH as part of an Army Corps of Engineers lower Columbia River transportation study. This tagging is beginning to provide some preliminary data regarding juvenile outmigration and adult return characteristics (Table IX-6).
- The Abernathy Fish Technology Center has been "dove-tailing" with the COE studies comparing downstream survival and passage rates of volitionally released versus forced released smolts. Results to date indicate no significant difference between the two groups for either downstream survival or passage time to McNary Dam. These M&E studies will continue with evaluations of adult returns back to downstream dams.
- All (wild and hatchery) steelhead brood fish will be DNA tissue-sampled at both Wells Hatchery. This is a relatively simple sampling activity and we will archive the samples for possible future use when demand and budget may allow DNA sample processing. **(WT-006, P. 50)**

F. Program conflicts.

1. Biological conflicts.

2. Harvest conflicts.

3. Conservation conflicts

- ESA-listed population(s) that will be directly affected by the program: Methow Basin summer steelhead. **(WT-003, P. 9)**
- ESA-listed population(s) that may be incidentally affected by the program: UCR steelhead and Methow Basin spring Chinook salmon **(WT-003, P. 9)**
- When hatchery-origin salmonids are released into the Methow River the potential exists for intra- and inter-specific competition with natural-origin juvenile salmonids, including listed spring Chinook salmon and steelhead. **(WT-003, P. 13)**
- Due to their location, size, and time of emergence, newly emerged Chinook salmon fry are likely to be the most vulnerable to predation by hatchery-released fish. **(WT-003, P. 14)**

4. Other conflicts between the hatchery program, or fish produced by the program, and other non-hatchery issues.

IX. Upper Columbia coho salmon hatchery restoration program, Winthrop, Entiat, and Leavenworth NFHs. *(Yakama Tribal program)*

A. General Information

- The Yakama Nation seeks to return coho to the Wenatchee and Methow River basins through a long-term multiphase mid-Columbia River reintroduction project (HGMP, 1999). The beginning phase of this project focuses on the use of artificial propagation of available lower Columbia River stock for acclimation and release to the Methow and Wenatchee River Basins. The Yakama Nation currently does not have a hatchery facility in these basins and through agreement with various agencies including the USFWS utilizes hatcheries from around the region to support the coho program. Each Leavenworth Complex hatchery is currently involved in the mid-Columbia coho reintroduction program to varying extents as described below. **(LNFHComplexrpt2005, P. 26)**
- Mid-Columbia coho salmon populations were decimated in the early 1900s by impassable dams, harmful forestry practices, and unscreened irrigation diversions in the tributaries, along with an extremely high harvest rate in the lower Columbia River. The loss of natural stream flow degraded habitat quality and further reduced coho productivity. Over the years, irrigation, livestock grazing, mining, timber harvest, road and railroad construction, development, and fire management also contributed to destruction of salmon habitat. Mullan (1983) estimated historical mid-Columbia River adult coho populations as follows: **(YINmidColcohoMaster, P. 2)**
    - Wenatchee—6,000 - 7,000
    - Methow—23,000 - 31,000
    - Entiat—9,000-13,000
    - Okanogan—Presence documented but no numbers specified
- By the end of the 20th century, indigenous natural coho salmon no longer occupied the mid- Columbia river basins. **(YINmidColcohoMaster, P. 2)**
- Coho salmon were once widely distributed within the Columbia River Basin (Fulton 1970: Chapman 1986). In the early 1900's coho were extirpated from the middle reach of the Columbia River including the Wenatchee and Methow River Basins (Mullan 1983). Mullan (1984) estimated historical populations of 23,000 to 31,000 annually in the Methow River drainage and 6,000 to 7,000 annually in the Wenatchee River drainage. **(LNFHComplexrpt2005, P. 26)**
- The YIN Mid-Columbia Coho Restoration program Master Plan builds on the success of the feasibility phase and is designed to achieve coho restoration goals as identified in the Tribal Restoration Plan (*Wy-Kan-Ush-Mi Wa-Kish-Wit*) and in the Wenatchee and Methow subbasin plans. We present a phased approach to restoration which incorporates development of a mid-Columbia hatchery broodstock, local adaptation to tributaries in the Wenatchee and Methow basins, and habitat restoration that will benefit coho as well as ESA-listed spring chinook, steelhead, and bull trout. **(YINmidColcohoMaster, P. vii-viii)**
    - The **broodstock development** phases are designed to eliminate transfers of lower Columbia River stocks and then encourage adaptation of the broodstock so that returning coho can reach key habitat within the subbasins.
    - Once broodstock development goals are met, **natural production phases** will focus on decreasing domestication selection and increasing fitness in the natural

environment. In these phases, hatchery coho will be introduced to habitat areas where Ecosystem Diagnosis and Treatment (EDT) analysis predicts coho would be the most successful; and hatchery and natural broodstock compositions will be managed to increase the proportion of natural influence (PNI) in the population with the goal of having a PNI value > 0.5—that is, the natural environment must have a greater influence on the population than the hatchery environment.

- The **habitat improvement phase** is expected to last 15 years, concurrent with the broodstock development and natural production phases. It represents a comprehensive effort to increase the productivity and capacity of coho salmon in the natural environment by coordinating with other entities to help implement the habitat improvement schedule developed for the Upper Columbia Salmon Recovery Board (UCSRB).
- The **M&E program** is designed to monitor and evaluate the results of reintroduction so that operations can be adaptively managed to optimize hatchery and natural production while minimizing any negative ecological impacts. Pursuing this goal, research data collection and analysis is structured to: 1) demonstrate when the reintroduction program is meeting the established phased restoration goals; 2) determine whether a change in status of sensitive species is occurring and whether it is a result of coho reintroduction; and 3) provide science-based recommendations for management consideration.
- The Mid-Columbia Restoration Plan **continues the reintroduction** of coho salmon in the Wenatchee and Methow subbasins through the artificial production and acclimation/release of the progeny of locally captured broodstock. Proposed releases decline from a peak of 2,155,000 smolts in 2012 to no releases at program termination in 2026.
- After initially releasing "domesticated" hatchery fish for reintroduction, the program seeks to increase the fitness of reintroduced coho salmon by reducing domestication selection and emphasizing local adaptation. The program would use strict broodstock protocols that maximize natural-origin adults in the hatchery program and would place a limit on the proportion of hatchery origin returns on the spawning grounds. The AHA model was used as a guide to address the fitness loss that commonly occurs with hatchery programs and that presumably occurred in the lower Columbia River hatchery source stock. **(YINmidColcohoMaster, P. 8)**
- Fish produced for the broodstock development phases would be captured at existing adult traps, produced from existing hatcheries, and released from acclimation sites that do not require new rearing unit construction. However, modifications to these existing facilities may be necessary in order to meet project goals. **(YINmidColcohoMaster, P. 86)**
    - Broodstock capture:
        - Wenatchee subbasin: traps on the Wenatchee River will include Leavenworth NFH, and Tumwater and Dryden Dams.
        - Methow subbasin: trapping facilities will include Wells FH, Winthrop NFH, and Wells Dam east/west ladders.
    - Broodstock holding and early incubation: Entiat and Winthrop NFHs.
    - Rearing to pre-smolt size: Cascade FH, Willard and Winthrop NFHs.

- Acclimation:
    - Wenatchee: Rohlfing, Coulter, Butcher, and Beaver ponds and the Leavenworth NFH on Icicle Creek.
    - Methow: Winthrop and Wells hatcheries.
- The Yakama Nation fisheries staff conducts the primary evaluation of the Leavenworth Complex coho programs. **(LNFHComplexrpt2005, P. 27)**

B. Goals

- The Yakama Nation's long-term vision for coho reintroduction is: *To re-establish naturally spawning coho populations in mid-Columbia tributaries to biologically sustainable levels which provide significant harvest in most years.* **(YINmidColcohoMaster, P. vi)**
- Biological objectives include: **(YINmidColcohoMaster, P. vi)**

  1*) Develop locally adapted, naturally spawning coho stock in the Wenatchee and Methow river subbasins by 2026.*

  2) Evaluate the efficacy of coho reintroduction in Mid-Columbia tributaries.

  3) Increase the freshwater productivity of coho salmon in the Wenatchee and Methow subbasins.
- Coho reintroduction will be considered successful when the following numerical restoration goals are achieved: **(YINmidColcohoMaster, P. vii)**

  Goal 1 - *The 3-year mean escapement of natural origin returns in the Wenatchee (upstream of Tumwater Dam) and the Methow river subbasins exceeds 1,500 per subbasin,*

  Goal 2 - *A total harvest rate of 23%, which includes a 10% mixed stock harvest, 10% mainstem harvest, and 5% terminal harvest in most years.*
- The Yakama Nation along with project participants and the Mid-Columbia Technical Work Group (TWG) developed two goals from which to determine the feasibility of reintroduction coho to mid-Columbia tributaries:

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

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

  Both feasibility studies goals have been achieved. **(YINmidColcohoMaster, P. vii)**

C. Program at Leavenworth NFH

- In 1996, the YN initiated a program to re-introduce coho salmon into the upper Columbia Basin. Starting with brood year 1997, approximately 450,000 coho smolts were transferred to Leavenworth NFH for acclimation and release into Icicle Creek. The old river channel behind Dam #5 was utilized. Since that time, and through an agreement with FWS, the tribe has upgraded and retrofitted several unused Foster Lucas Ponds for their program. Currently, the FL's are used for acclimation and holding for release or transfer to other upper Columbia tributaries. **(LNFHchmp, P. 42)**

- Leavenworth NFH receives coho yearlings (primarily reared at the lower Columbia River hatcheries of Willard NFH, Eagle Creek NFH, and Cascade SFH) on station in winter for 1-4 month acclimation and subsequent release. Yearlings had initially been acclimated behind dam 5 in Icicle Creek; however, more recently they are acclimated in Leavenworth NFH's Yakama Nation renovated Foster-Lucas ponds prior to release into Icicle Creek. **(LNFHComplexrpt2005, P. 26)**

D. Program at Entiat NFH

- Entiat NFH provides adult holding ponds for use during Wenatchee River coho brood collection and spawning operations in October through November annually. Hatchery staff assists the Yakama Nation in holding, spawning, fertilizing, and incubating approximately one million of coho eggs annually. A separate Yakama Nation funded isolation incubation quarantine facility was constructed on station to accommodate this program. Coho brood is transferred as eyed eggs off station primarily to lower Columbia River hatcheries (Willard NFH, Cascade NFH) for rearing and subsequent return to the Wenatchee Basin for release. **(LNFHComplexrpt2005, P. 26-27)**

E. Program at Winthrop NFH

- Winthrop NFH is the only Leavenworth Complex facility currently providing a complete coho production program.
- Adults return to the hatchery ladder and are spawned, their progeny incubated, reared, and released as yearlings for the most part back to the Methow River.
- Smolts are volitionally released directly into the outfall channel at a size of 16 to 18 fish per pound to minimize interactions with other fish populations. Releasing fish at 18 fish/pound or larger helps ensure that the released fish are functional smolts which actively migrate through the Methow River corridor. The volitional release period begins in mid-April and remaining fish are forced out at the end of the month.
- Detection of PIT tagged fish at McNary and Bonneville Dam's bypass facilities provides evidence of rapid movement of smolts released from Winthrop NFH. The average travel time from release to McNary Dam, for release years 2000 – 2004, is 51 days with a minimum travel time of 29 days to a maximum time of 115 days. The average survival from release to McNary Dam is 25% with a minimum survival of 9% in 2001 to a high of 34% in 2000 (YN, personal communication, 2006).
- Hatchery performance targets for the Winthrop NFH coho program are described in table 4. Coho adult broodstock management, performance, and spawning practice data are displayed in table17. Monthly production summaries describing the rearing environment (Table 18) and juvenile performance (Table 19) for brood year 2003 are shown. On average 251,027 coho juveniles (SD = 110,720) have been reared on station from 1996-2005 to an average size of 17.3 fish per pound (SD = 2.0) for release in late-April to early-May each year (Table 20). **(LNFHComplexrpt2005, P. 27)**

Winthrop NFH coho adult brood stock management, performance, and spawning practices, 2001-2005. **(LNFHComplexrpt2005, P. 27, Table 17)**

Return Year	Hatchery Return	Surplus	Returned to Stream	Hatchery Transfers	Jump Outs DIP's	Brood Kept for Propagation	Green, Bad Spent	Used for Production	Pre-spawn Survival	Male:Female Ratio	Green Eggs Taken	Average Fecundity
2001	334	10	128	0	3	206	0	193	99%	1.0 : 1.0	239,661	2,577
2002	52	0	0	0	8	52	0	44	85%	3.0 : 1.0	19,800	1,800
2003	208	66	0	0	40	142	0	102	81%	1.1 : 1.0	105,600	2,200
2004	119	20	0	0	12	99	0	87	90%	1.3 : 1.0	68,400	1,800
2005	354	0	55	0	17	299	0	282	95%	1.0 : 1.0	308,000	2,200
AVE	213	19	37	0	16	160	0	142	90%	1.5 : 1.0	148,292	2,115
MAX	354	66	128	0	40	299	0	282	99%	3.0 : 1.0	308,000	2,577
MIN	52	0	0	0	3	52	0	44	81%	1.0 : 1.0	19,800	1,800
STDEV	132	27	56	0	14	96	0	95	7%	1.0 : 1.0	121,007	326

Winthrop NFH juvenile coho monthly brood production inventory and rearing environment parameters for brood year 2003. **(LNFHComplexrpt2005, P. 28, Table 18)**

Month	Life Stage	Temp ^{0}F Ave	Water Source % Well	Water Source % River	Flow GPM	Flow Index (lbs./in.* GPM)	Density Index (lbs./in.*ft^3)	Number on Hand	Total Weight (lbs.)
August	NA	NA	100%	0%	NA	NA	NA	NA	NA
September	NA	NA	100%	0%	NA	NA	NA	NA	NA
October	Egg	NA	100%	0%	NA	NA	NA	NA	NA
November	Egg	NA	100%	0%	NA	NA	NA	NA	NA
December	Egg	NA	100%	0%	NA	NA	NA	NA	NA
January	Alevin	NA	100%	0%	NA	NA	NA	NA	NA
February	Fry	46.3	100%	0%	121	0.64	0.14	76,512	138
March	Fry	46.8	100%	0%	121	1.11	0.25	76,362	313
April	Fry	46.2	100%	0%	219	0.85	0.19	76,204	516
May	Sub-yearling	47.2	0%	100%	299	0.96	0.13	75,893	987
June	Sub-yearling	52.0	0%	100%	300	1.05	0.14	75,762	1,136
July	Sub-yearling	55.6	0%	100%	601	0.57	0.08	65,311	1,388
August	Sub-yearling	56.7	0%	100%	597	0.67	0.09	64,869	1,755
September	Sub-yearling	51.0	0%	100%	597	0.80	0.11	64,784	2,292
October	Sub-yearling	46.8	40%	60%	601	0.91	0.12	64,745	2,811
November	Sub-yearling	43.3	50%	50%	600	0.94	0.13	64,729	2,942
December	Sub-yearling	39.6	50%	50%	598	0.95	0.13	64,707	2,979
January	Yearling	37.8	40%	60%	600	0.95	0.13	64,687	2,992
February	Yearling	38.5	30%	70%	598	1.00	0.14	64,659	3,214
March	Yearling	42.8	10%	90%	600	1.05	0.14	64,622	3,474
April	Smolt	48.0	0%	100%	NA	NA	NA	64,604	3,983

Winthrop NFH juvenile coho monthly culture and performance for brood year 2003. **(LNFHComplexrpt2005, P. 29, Table 19)**

Month	Life Stage	Ave Size (#/lb)	Ave Size (gms)	Length Ave (in)	Length Ave (mm)	Condition Factor (C = lbs /in)	Feed Fed Per Day (lbs.)	Feeding Rate %BW/day	Food Conversion (lbs. Fed/lb. Gain)	Comments
August	NA	NA	NA	NA	NA	NA	NA	NA	NA	
September	NA	NA	NA	NA	NA	NA	NA	NA	NA	
October	Egg	NA	NA	NA	NA	NA	NA	NA	NA	Eggs collected from broodstock
November	Egg	NA	NA	NA	NA	NA	NA	NA	NA	fertilzed and placed in Heath trays
December	Egg	NA	NA	NA	NA	NA	NA	NA	NA	
January	Alevin	NA	NA	NA	NA	NA	NA	NA	NA	
February	Fry	554.4	0.8	1.78	45	3.21E-04	0.9	0.67%	0.29	Transferred to starter tanks
March	Fry	244.0	1.9	2.34	59	3.20E-04	2.9	0.92%	0.51	
April	Fry	147.7	3.1	2.77	70	3.20E-04	4.4	0.85%	0.75	
May	Sub-yearling	76.9	5.9	3.44	87	3.20E-04	6.3	0.64%	0.97	Coded Wire Tagging
June	Sub-yearling	66.7	6.8	3.61	92	3.20E-04	7.6	0.67%	0.48	Transferred to converted FL's
July	Sub-yearling	47.1	9.6	4.05	103	3.20E-04	10.1	0.73%	2.10	
August	Sub-yearling	37.0	12.3	4.39	111	3.20E-04	11.5	0.65%	1.41	
September	Sub-yearling	28.3	16.1	4.80	122	3.20E-04	14.8	0.65%	1.21	
October	Sub-yearling	23.0	19.7	5.14	131	3.20E-04	17.7	0.63%	1.02	
November	Sub-yearling	22.0	20.6	5.22	133	3.20E-04	5.0	0.17%	0.29	
December	Sub-yearling	21.7	20.9	5.24	133	3.20E-04	4.2	0.14%	0.99	
January	Yearling	21.6	21.0	5.25	133	3.20E-04	2.9	0.10%	2.43	
February	Yearling	20.1	22.6	5.38	137	3.20E-04	7.2	0.22%	15.54	
March	Yearling	18.6	24.4	5.52	140	3.20E-04	17.0	0.49%	2.38	Release window is mid-April.
April	Smolt	16.2	28.0	5.78	147	3.20E-04	30.7	0.77%	1.77	Forced release.

A summary of Winthrop NFH coho releases, brood years 1994-2003. **(LNFHComplexrpt2005, P. 30, Table 20)**

Brood Year	Release Dates		Production Numbers		Total Number	Est. #CWT's	Size @ Rel. #/LB
	Methow Rel. Date	Transfer Date	# Rel. to Methow	# Transferred[1]			
1994	05/15/96		235,281		235,281		15.4
1995	05/15/97		69,230		69,230		14.8
1996	4/20-5/7/98		169,199		169,199	39,622	15.1
1997							
1998	4/30-5/15/00		199,763		199,763	26,472	17
1999	04/30/01	3/21-3/23/01	260,319	144,892	405,211	133,989	19.8
2000	04/30/02		185,787		185,787	120,679	19.3
2001	04/28/03	3/17-3/18/03	242,401	160,615	403,016	232,840	19.9
2002	04/29/04		308,063		308,063	296,901	17.7
2003	04/29/05		283,695		283,695	146,587	16.7

Above data acquired from MCRFRO Leavenworth Complex CRIS release database (SR80's).

[1]Records indicate 144,892 brood year 1999 coho yearlings were transferred to the Butcher Creek acclimation ponds in the Wenatchee basin for release and 160,615 brood year 2001coho yearlings were transferred to Icicle Creek for release.

F. Proposed release numbers for the Natural Production Phase of program,

Proposed release numbers and locations for the Natural Production phases in the Wenatchee subbasin**(YINmidColcohoMaster, P. 107)**

Location	Implementation Phase Release Number (one generation only)	Support Phase (I) Initial Release Number (est. three generations)	Support Phase (F) Final Release Number (PNI >0.5; est. two generations)	Long-Term (PFC) Periodic Supplementation may be needed to avoid extirpation again.
Chiwawa River	440,000	308,000	154,000	0
White River	210,000	147,000	73,500	0
Nason Creek	210,000	147,000	73,500	0
Little Wenatchee River	120,000	84,000	42,000	0
Upper Wenatchee River	100,000	70,000	35,000	0
Icicle Creek	75,000	50,000	25,000	100,000 (3 generations until we have shown the population can persist without continued supplementation)
Total	1,155,000	806,000	403,000	100,000

Proposed release numbers and locations for the Natural Production phases in the Methow subbasin **(YINmidColcohoMaster, P. 187)**

Location	Implementation Phase Release Number (one generation only)	Support Phase (I) Initial Release Number (Est. 3 generations)	Phase (F) Final Release Number (PNI >0.5; Est. 2 generations)	Long-Term (PFC) Periodic supplementation may be needed to avoid extirpation again
Mid & Upper Methow	350,000	245,000	122,500	100k release may be retained at WNFH for 3 generations until it can be shown that the population will persist without supplementation.
Chewuch River	325,000	227,500	113,750	0
Twisp River	275,000	192,500	96,250	0
Wolf Creek	50,000	35,000	17,500	0
Total	1,000,000	700,000	350,000	100,000

G. Overall Program Description and Benefits to Coho

- The Mid-Columbia Coho Reintroduction Feasibility Study began in 1996 with acclimated releases of reprogrammed lower Columbia River stocks in the Methow River. **(YINmidColcohoMaster, P. 67)**
- In 1999 the focus of the feasibility study shifted to the Wenatchee River basin due to low smolt-to-adult survival rates (SARs) and a lack of suitable broodstock collection facilities in the Methow River. Acclimated coho releases in the Wenatchee basin began with coho pre-smolts reprogrammed from lower Columbia River facilities; since then, the feasibility program has transitioned to 100% local brood collected in both basins. **(YINmidColcohoMaster, P. 67)**
- Second generation mid-Columbia brood coho are currently being reared at Winthrop NFH, Cascade FH, and Willard NFH. **(YINmidColcohoMaster, P. 67)**
- Evidence that this approach is working comes from data collected during the feasibility phases of the mid-Columbia and Yakima River coho reintroduction programs. **(YINmidColcohoMaster, P. 67)**

- In 2002 (BY 2000) and 2003 (BY 2001), we released differentially coded-wire-tagged lower Columbia brood (LCR) and first generation mid-Columbia brood (MCR) from Dam 5 on Icicle Creek, to determine if a survival advantage can be observed with one generation of broodstock development. Both groups were reared at lower Columbia facilities and were acclimated in the same pond, for the same duration of time. Figure 3-3 shows that SARs for BY 2000 and BY2001 were higher for mid-Columbia brood (0.53% and 0.56%;) than for lower Columbia brood (0.31% and 0.45). In both years, results of a z-test for differences in proportions indicated that mid-Columbia brood survive at statistically higher rates than reprogrammed lower Columbia brood coho. **(YINmidColcohoMaster, P. 70)**
- The feasibility phase demonstrated that a local broodstock can be developed from lower river stocks. It appears that a survival advantage can be achieved with one generation of selection. Our proposal uses methods that are expected to encourage a continuation of the selection process, eventually resulting in a locally adapted population. We expect to continue to see increases in survival as local adaptation progresses. **(YINmidColcohoMaster, P. 70)**