# HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

**DRAFT**

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|---|---|
| Hatchery Program | NF Nooksack Native Chinook Restoration Program (Kendall Creek Hatchery) |
| Species or Hatchery Stock | NF Nooksack River Chinook (*Oncorhynchus tshawytscha*) |
| Agency/Operator | Washington Department of Fish and Wildlife |
| Watershed and Region | NF Nooksack River, Puget Sound |
| Date Submitted | August 04, 2005 |
| Date Last Updated | July 25, 2005 |

# SECTION 1. GENERAL PROGRAM DESCRIPTION

**1.1) Name of hatchery or program**.

Nooksack Native Spring Chinook Restoration Program

**1.2) Species and population (or stock) under propagation, and ESA status**.

North Fork Nooksack River Chinook (*Oncorhynchus tshawytscha*) - listed as "threatened"

The original stock is an element of the Puget Sound Chinook ESU that has been listed under the Endangered Species Act (ESA) as threatened. The hatchery component of this stock has been listed as essential to the recovery of the stock.

**1.3) Responsible organization and individuals**


| | | |
|---|---|---|
| **Name (and title):** | Chuck Phillips, Region 4 Fish Program Manager | |
| | Ted Thygesen, Complex Manager | |
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**Other agencies, Tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:**

The Lummi and Nooksack tribes, the US Fish and Wildlife Service, US Forest Service and Whatcom County have all contributed to this recovery program.

The Nooksack Chinook Technical Committee composed of members from WDFW, USFWS, US Forest Service and Lummi and Nooksack Tribes had been active in Nooksack River chinook restoration since about 1980. Additionally, the Nooksack Salmon Enhancement Association (NSEA), the Nooksack area Regional Fisheries Enhancement Group, has been involved in this program when volunteers were needed to feed fish at the acclimation ponds (when in operation). Whatcom County has provided acclimation site maintenance and volunteer labor per diem.

## 1.4) Funding source, staffing level, and annual hatchery program operational costs.

| Operational Information | Number |
|---|---|
| Annual operating cost (dollars) | $364,697 |
| The above information for annual operating cost applies cumulatively to the Kendall Creek Hatchery Fish Programs and cannot be broken out specifically by program. Funding source is General Fund – State and General Fund - Federal. | |

## 1.5) Location(s) of hatchery and associated facilities.

**Broodstock Collection; Incubation; Rearing & Release:**

Kendall Creek Hatchery: Located on Kendall Creek (01.0406), which is a tributary to the NF Nooksack River (01.0120) at RM 46.

**Rearing and Release site:**

Excelsior Creek side channel: NF Nooksack River (01.1020), 6000 feet downstream (opposite side) of the original release site at Excelsior Camp Ground RM 65.1

## 1.6) Type of program.

Integrated recovery. The proposed integrated strategy for this program is based on WDFW's assessment of the genetic characteristics of the hatchery stock and local natural populations, the current and anticipated productivity of the habitat used by the populations, the potential for successfully implementing programs as integrated, and NOAA's final listing determinations (64 FR 14308, June 28, 2005). Modification of the proposed strategy may occur as additional information is collected and analyzed.

## 1.7) Purpose (Goal) of program.

The goal of this program is to use indigenous stock and release up to 750,000 fingerling spring chinook to restore spring chinook salmon in the North Fork Nooksack River to a self-sustaining level of 2,000 natural-origin recruit spawners.

## 1.8) Justification for the program.

Driven by chronically low natural escapements, a restoration program for this locally indigenous stock was developed using a strategy of increasing the numbers of juveniles released and subsequently increasing the number of returning spawners. Recent numbers of natural-origin spawners have been extremely low which emphasizes the importance of the hatchery component of this program as a reservoir for the genome while limiting factors are being addressed.

WDFW and the tribes shall conduct the proposed program in such a way as to assure that the genetic, ecological and demographic effects on the listed chinook salmon in the Puget

Sound region do not appreciably reduce the likelihood of the survival and recovery of the Puget Sound chinook ESU.

To minimize impacts on listed fish by WDFW facilities operation and the Kendall Creek spring chinook program, the following Risk Aversions are included in this HGMP:

**Table 1**. Summary of risk aversion measures for the Kendall Creek spring chinook program.

| Potential Hazard | HGMP Reference | Risk Aversion Measures |
|---|---|---|
| Water Withdrawal | 4.2 | Well water rights are formalized through trust water right permit # G1-10562c & G1-23261c. Surface water right permit #' is S1-00317. Monitoring and measurement of water usage is reported in monthly NPDES reports. |
| Intake Screening | 4.2 | The Kendall Creek gravity water intake does not have intake screens that are in compliance with NOAA Fisheries screening criteria. These screens are identified for replacement but are a lower priority than others since listed chinook do not occur above the rack on Kendall Creek. In most years, the creek is very low or dry during the time of adult spring chinook spawning. No fish exist above acclimation ponds (Deadhorse no longer is used). |
| Effluent Discharge | 4.2 | This facility operates under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System administered by the Washington Department of Ecology (DOE) - WAG 13-3007. |
| Broodstock Collection & Adult Passage | 7.9, 2.2.3 | See section 2.2.3 and 7.9 for complete information. |
| Disease Transmission | 9.2.7 | Co-Managers Fish Disease Policy. Details hatchery practices and operations designed to stop the introduction and/or spread of any diseases. |
| Competition & Predation | 2.2.3, 10.11 | See sections 2.2.3 & 10.11 |

## 1.9) List of program "Performance Standards".

See below.

## 1.10) List of program "Performance Indicators", designated by "benefits" and "risks."

**Benefits:**

| Benefits | | |
|---|---|---|
| **Performance Standard** | **Performance Indicator** | **Monitoring & Evaluation** |
| Assure that hatchery operations support Puget Sound Salmon Management Plan (*US v Washington*), the Shared Strategy for Salmon Recovery, and production objectives. | Achieve a restoration goal of 2,000 natural-origin recruit spawners on the spawning grounds. | Survival and contribution to the natural spawning population will be estimated for each brood year released to monitor escapement goal of 2,000 NOR spawners. |
| Maintain outreach to enhance public understanding, participation and support of WDFW hatchery programs. | Provide information about agency programs to internal and external audiences. For example, local schools and special interest groups tour the facility to better understand hatchery operations. Off-station efforts may include festivals, classroom participation, stream adoptions and fairs. | Evaluate use and/or exposure of program materials and exhibits as they help support goals of the information and education program.<br><br>Record on-station organized education and outreach events. |
| Program contributes to fulfilling tribal trust responsibility mandates and treaty rights. | Follow pertinent laws, agreements, policies and executive and judicial orders on consultation and coordination with Native American tribal governments. | Participate in annual coordination between co-managers to identify and report on issues of interest, coordinate management, and review programs (FBD process). |
| Implement measures for broodstock management to maintain integrity and genetic diversity.<br><br>Maintain effective population size. | A minimum of 500 adults are collected throughout the spawning run in proportion to timing, age and sex composition of return. | Annual run timing, age and sex composition and return timing data are collected.<br><br>Adhere to HSRG (2004) and WDFW spawning guidelines (WDFW 1983). |
| Region-wide, groups are marked in a manner consistent with information needs and protocols to estimate impacts on natural and hatchery-origin fish. | All chinook in the program receive otolith marks unique to their release group. In addition, all fish released from Kendall Creek Hatchery receive a CWT. The 400,000 otolith-marked fish released at Excelsior are coded-wire tagged as a double-index (DIT) group; 200,000 fish receive an adipose fin clip and a coded-wire tag and the other 200,000 fish receive just the coded-wire tag. MF Nooksack releases will be coded-wire tagged only | Returning fish are sampled throughout their return for length, sex, and CWTs. |

| | | |
|---|---|---|
| Maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens. Follow Co-managers Fish Health Disease Policy (1998). | Necropsies of fish to assess health, nutritional status and culture conditions. | WDFW Fish Health Section inspects adult broodstock yearly for pathogens and monitor juvenile fish on a monthly basis to assess health and detect potential disease problems. As necessary, WDFW's Fish Health Section recommends remedial or preventative measures to prevent or treat disease, with administration of therapeutic and prophylactic treatments as deemed necessary.<br><br>A fish health database will be maintained to identify trends in fish health and disease and implement fish health management plans based on findings. |
| | Release and/or transfer exams for pathogens and parasites. | 1 to 6 weeks prior to transfer or release, fish are examined in accordance with the Co-managers Fish Health Policy. |
| | Inspection of adult brood-stock for pathogens and parasites. | At spawning, lots of 60 adult broodstock are examined for pathogens. |
| | Inspection of off-station fish/eggs prior to transfer to hatchery for pathogens and parasites. | Control of specific fish pathogens through eggs/fish movements is conducted in accordance to Co-managers Fish Health Disease Policy. |

**Risks:**

| Risks | | |
|---|---|---|
| **Performance Standard** | **Performance Indicator** | **Monitoring & Evaluation** |
| Minimize impacts and/or interactions to ESA listed fish | Hatchery operations comply with all state and federal regulations. Hatchery juveniles are raised to smolt size (80-100 fish/lb) and released at a time that fosters rapid migration downstream. | Monitor size, number, date of release and mass mark quality. Additional WDFW projects: straying, in-stream evaluations of juvenile and adult behaviors, NOR/HOR ratio on the spawning grounds, fish health documented. |
| Artificial production facilities are operated in compliance with all applicable fish health guidelines, facility operation standards and protocols including HOPPS, Co-managers Fish Health Policy and drug usage mandates from the Federal Food and Drug Administration. | Hatchery goal is to prevent the introduction, amplification or spread of fish pathogens that might negatively affect the health of both hatchery and naturally reproducing stocks and to produce healthy smolts that will contribute to the goals of this facility. | Pathologists from WDFW's Fish Health Section monitor program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed. |
| Ensure hatchery operations comply with state and federal water quality and quantity standards through proper environmental monitoring. | NPDES permit compliance<br><br>WDFW water right permit compliance | Flow and discharge reported in monthly NPDES reports. |
| Water withdrawals and in-stream water diversion structures for hatchery facility will not affect spawning behavior of natural populations or impact juveniles. | Hatchery intake structures meet state and federal guidelines where located in fish bearing streams. | Barrier and intake structure compliance assessed and needed fixes are prioritized. |
| Hatchery operations comply with ESA responsibilities | WDFW completes an HGMP and is issued a federal and state permit when applicable. | Identified in HGMP and Biological Opinion for hatchery operations. |
| Harvest of hatchery-produced fish minimizes impact to wild populations. | Harvest is regulated to meet appropriate biological assessment criteria. | Agencies and tribes to provide up-to-date information needed to monitor harvests. |

## 1.11) Expected size of program.

### 1.11.1) Proposed annual broodstock collection level (maximum number of adult fish).

Until 2000, all returning adult Nooksack chinook were used for broodstock. In 2000, excess adults were transported back to the Nooksack River to spawn naturally. Starting in 2002, approximately 500 adults would be needed for broodstock (Egg take goal of 900,000). Maximum number of adults varies according to year class. Fecundity ranges from 3500 eggs for 3 year olds to 5200 for 5 year olds.

WDFW and the co-managers will continue to work with the NOAA Fisheries Science Branch to develop protocols using the best available science for the use of available hatchery returns in excess to the requirements of the program. These protocols will address the selection of broodstock in a manner that closely mimics the age distribution

of natural spawning population and maintains/increases the natural diversity of the naturally spawning population.

**1.11.2) Proposed annual fish release levels (maximum number) by life stage and location.**

| Life Stage | Release Location | Annual Release Level |
|---|---|---|
| **Eyed Eggs** | | |
| **Unfed Fry** | Upper NF Nooksack basin (01) | 50,000*** |
| **Fry** | | |
| **Fingerling** | Kendall Creek (01.0406)<br>NF Nooksack watershed (01)<br>Side channel below Deadhorse Cr<br><br>MF Nooksack | 150,000**<br><br>400,000**<br><br>200,000** |
| **Yearling** | see Note: below* | |

***-** Yearling releases were discontinued in 1998 (96 BY).
**- The co-managers agreed in 2002 to decrease on-station production levels and to adjust program release strategies to address excess adult return levels to Kendall Creek Hatchery and to decrease stray levels to the South Fork Nooksack River.
*** - The Upper NF Nooksack Remote Site Incubator (RSI) project has been discontinued.

**1.12) Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels. Indicate the source of these data.**

For the fingerling on-station releases, excluding the releases from acclimation ponds, the average smolt-to-adult survival rate was 0.73% for broodyears 88-89; 92; and 94-98. The yearling on-station releases have been eliminated. But the average smolt-to-adult survival rate was 0.26% for broodyears 88-90 and 92-96 (sources: coded-wire tag database (RMIS).

Escapement to the hatchery for return years 1995 through 2003 (including "Jacks") were 1,073, 1,203, 1,679, 1,313, 2,899, 2,095, 5,815, 5,694 and 5,305, respectively.

**1.13) Date program started (years in operation), or is expected to start.**

1981 (spring chinook program began)

**1.14) Expected duration of program.**

Ongoing (until restoration goal of 2,000 natural-origin recruit spawners is achieved)

**1.15) Watersheds targeted by program.**

NF and MF Nooksack River (WRIA 01.0120; 01.0339)

**1.16) Indicate alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.**

There is a significant effort underway to identify factors limiting the survival (in the freshwater environment) of natural-origin spawners in the North Fork and South Fork Nooksack River. Starting with 2002 brood, the hatchery component of this program was scaled back. WDFW and the co-managers will consult with NOAA Fisheries to determine the protocols for utilizing the hatchery production in a manner that most efficiently promotes the recovery of the natural spawning population. This will be done while maintaining sufficient reserves of hatchery broodstock to ensure protection against sudden reversals in natural spawning population survival.

Since the inception of the NF Nooksack spring chinook restoration program, alternative actions to attain program goals have been a constant consideration by WDFW and the tribes. The Puget Sound Salmon Management Plan (PSSMP), a federal court order, explicitly states that "no change may be made to the Equilibrium Brood Document (program production goals) without prior agreement of the affected parties."

# SECTION 2. PROGRAM EFFECTS ON ESA-LISTED SALMONID POPULATIONS.

## 2.1) List all ESA permits or authorizations in hand for the hatchery program.

During 2004-05, WDFW is writing an HGMP to cover the stock/program of chinook produced at the Kendall Creek facility for authorization under the 4(d) rule of the ESA.

Harvest management of chinook populations within Puget Sound is implemented through the draft Puget Sound Comprehensive Chinook Management Plan (PSCCMP) - Harvest Management Component (Puget Sound Indian Tribes and WDFW, March 2004).

## 2.2) Provide descriptions, status, and projected take actions and levels for ESA-listed natural populations in the target area.

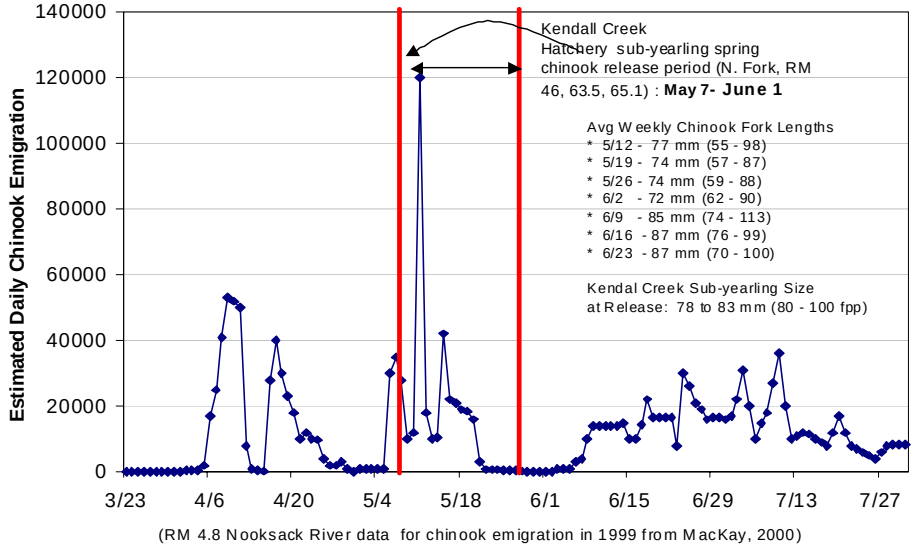
### 2.2.1) Description of ESA-listed salmonid population(s) affected by the program.

**- Identify the ESA-listed population(s) that will be directly affected by the program.**

**Puget Sound Chinook** *(Oncorhynchus tshawytscha)*

Three stocks of chinook are identified in the Nooksack basin. They are North Fork Nooksack Chinook, South Fork Nooksack Chinook, and Samish, Mainstem Nooksack Fall Chinook. The Co-manager's (Puget Sound) Technical Review Team (PSTRT) has identified the first two, as native Puget Sound populations and the health of the populations as per SaSI (draft, WDFW unpublished 2002) are considered "critical". The third is an introduced hatchery stock. Its status is "unknown".

**Figure 1. Nooksack River 0-age Chinook Out-migration Timing compared with Kendall Creek Hatchery Spring Chinook Program Release Timing Goal**




(RM 4.8 Nooksack River data for chinook emigration in 1999 from MacKay, 2000)

Like the Elwha fall chinook, the two Nooksack early returning Chinook stocks are among the most genetically distinct chinook populations in Puget Sound. Significant differences occur in the life history of the two native stocks. Regarding spawn timing, the average date of peak redd count for the South Fork stock averaged September 24, while the peak for the North Fork is about two weeks earlier (Marshall et al. 1995). This may result in earlier juvenile emergence from redds in the North Fork, but the warmer waters in the South Fork probably accelerate emergence of fish in this area. Peak catches of chinook fry in smolt traps occurred earlier in the North Fork than in the South Fork (Wunderlich, Meyer, and Boomer, 1982). However, fry were present in both forks over the same general time frame of early February through early May. The two Nooksack stocks also differ in juvenile out-migration strategies. Based on limited data, approximately 95% of the natural-origin North Fork adults out-migrated as sub-yearlings in their first year of life (Figure 1, above). In contrast, in the South Fork, 55-67% of the adults had yearling scale patterns, which indicates that a significant component of this stock remained in the river for over a full year before migrating to saltwater (Marshall et al. 1995).

The third population in the Nooksack-Samish watersheds consists of late returning Chinook salmon, which may once have historically occupied the Nooksack basin. However, if that is the case, this stock has been heavily influenced by introductions from Soos Creek Hatchery fall Chinook from the Green River. Chinook salmon from Soos Creek were introduced in 1965, 1972, 1973 and 1977. Kalama River and Wind River Chinook salmon (Columbia River stocks) were introduced between 1914 and 1925, but records show no eggs were taken from returning adults. The hatchery and wild population has reproduced with no new introductions from other sources for the last four generations. Genetic analyses indicate that the fall Chinook hatchery stock (Kendall/Samish stock) in the Nooksack River is closely related, but diverged, from Green River-origin Puget Sound fall Chinook salmon.

**- Identify the ESA-listed population(s) that may be <u>incidentally</u> affected by the program.**

Bull Trout *(Salvelinus confluentus)*

Three stocks of native char have been identified in the Nooksack basin. These are the Lower Nooksack, Canyon Creek and Upper Middle Fork stocks. The latter is isolated from the rest of the basin due to a diversion dam. The USFWS is supportive of laddering the dam to provide passage. Char exhibit anadromous, fluvial, and resident life histories. Spawning occurs in the fall. After spawning, anadromous adults move downriver and enter the estuary during the spring while fluvial adults disperse throughout the upper river. Sub-adults may also enter the river from the estuary in late winter and early spring. Adults return to spawning staging areas in late summer.

### 2.2.2) Status of ESA-listed salmonid population(s) affected by the program.

**- Describe the status of the listed natural population(s) relative to "critical" and "viable" population thresholds**

Preliminary critical and viable population thresholds have been identified. The co-managers identified preliminary individual critical and viable thresholds of 200 and 1,250, respectively, for the NF and SF Nooksack populations. The Co-manager's (Puget Sound) Technical Review Team (PSTRT) assigned preliminary critical thresholds of 1,000 for both the NF and SF populations (2003). WDFW recently determined that the NF and SF chinook populations are "critical" in status (draft SaSI, WDFW unpublished 2002).

The status of the Dolly Varden/Bull Trout population in the Nooksack River basin is "unknown" (draft SaSI, WDFW unpublished 2002).

**- Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for the listed population. Indicate the source of these data.**

Brood year 1992 to 1997 recruit/spawner levels for natural-origin North Fork Nooksack spring chinook salmon were estimated using available data (from Castle et al., 2002):

| Brood Year | Spawners | Adult Returns | Recruits/Spawner |
|---|---|---|---|
| **1992** | 493 | 181 | 0.37 |
| **1993** | 445 | 95 | 0.21 |
| **1994** | 45 | 24 | 0.62 |
| **1995** | 230 | 32 | 0.14 |
| **1996** | 535 | 171 * | 0.32 |
| **1997** | 617 | 32 ** | 0.05 |

* Excludes five year old recruits (data not yet available).
** Excludes four and five year old recruits (data not yet available).

**- Provide the most recent 12 year (e.g. 1988-1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.**

ESTIMATED ESCAPEMENT OF NOOKSACK CHINOOK STOCKS.

| YEAR | SOUTH FORK CHINOOK | NORTH FORK CHINOOK |
|---|---|---|
| 1984 | 188 | 45 |
| 1985 | 445 | 258 |
| 1986 | 170 | 226 |
| 1987 | 248 | 181 |
| 1988 | 233 | 456 |
| 1989 | 606 | 303 |
| 1990 | 142 | 10 |
| 1991 | 365 | 108 |
| 1992 | 103 | 498 |
| 1993 | 235 | 449 |
| 1994 | 118 | 45 |
| 1995 | 290 | 230 |
| 1996 | 203 | 535 |
| 1997 | 180 | 617 |
| 1998 | 157 | 370 |
| 1999 | 166 | 892 |
| 2000 | 207 | 1,242 |
| 2001 | 267 | 7,190* |
| 2002 | 289 | 3,687 |
| 2003 | 204 | 3,107 |
| 2004 | 130 | 2,064 |

* - Does include the 4,765 hatchery "putbacks" to the NF Nooksack.

Note: In 1999 and 2000, 55.6% and 32.4%, respectively, of the carcasses surveyed in the SF Nooksack, were strays from the NF Nooksack Kendall stock rebuilding program (Ned Currence, Nooksack tribal biologist, personal communication).

**- Provide the most recent 12 year (e.g. 1988-1999) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.**

| Year | NOR's | HOR's | % of Natural Origin on NF |
|---|---|---|---|
| 1995 | 171 | 59 | 74.3 |
| 1996 | 209 | 325 | 39.1 |
| 1997 | 74 | 543 | 11.9 |
| 1998 | 37 | 333 | 10.5 |
| 1999 | 85 | 738 | 10.3 |
| 2000 | 160 | 1,082 | 12.8 |
| 2001 | 240 | 1,945* | 10.9 |
| 2002 | 224 | 3,517 | 5.9 |
| 2003 | 210 | 2,647 | 7.3 |
| 2004 | 318 | 1,428 | 18.0 |

* - Does not include the 4,765 hatchery "putbacks" to the NF Nooksack.

In the North Fork Nooksack, the 1995-1999 average wild / hatchery adult return ratio was 0.31:1 (range 0.11:1 to 3.3:1). There is limited data indicating the proportion of hatchery-origin chinook salmon comprising escapement to the South Fork Nooksack River (Pete Castle, Area Biologist, WDFW). Kirby (2002) estimated that hatchery-origin chinook salmon returns (HORs) comprised 42.9%, 24.0%, and 36.5% of the total adult chinook salmon escapement in the South Fork in 1999, 2000, and 2001, respectively. For 2002-04, the estimated % HORs were 53.7%, 64.2% and 23.5%, respectively (Sanford, WDFW pers. comm.).

**2.2.3)Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to the take of listed fish in the target area, and provide estimated annual levels of take**.

**- Describe hatchery activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take**.

**Broodstock collection:**
All listed returning hatchery-origin adult fish are trapped and held at the Kendall Creek Hatchery weir and trap (a "run-of-the-river" operation) during the entire run period. It is necessary to block Kendall Creek and trap fish during the entire spring chinook run to maintain the proper genetic diversity of the restored stock. Take effects on all listed hatchery-origin fish collected at Kendall Creek include capture and handling. Effects will also include intentional lethal take for all adult fish retained as broodstock. To date, little natural-origin adult spring chinook return to the hatchery weir (2 in 2002), and no naturally produced have been sacrificed for use as broodstock. Any natural-origin chinook trapped at Kendall Creek will be returned to the North Fork Nooksack River. Take effects on the few natural-origin adult fish encountered each year will be confined to capture, handling and release.

In the past, all returning hatchery-origin adults were killed and spawned to meet the program goals for the restoration program. More recently, excess hatchery adults have been returned to the river after capture and holding to spawn naturally. Recent discussions with the Lummi and Nooksack tribes have focused on disposition of adults excess to the program needs, should they occur. Starting in 2002, adults collected at Kendall Creek in excess of broodstock needs were trucked and released into North Fork Nooksack (RM 51.2) and the Middle Fork Nooksack River. A 1:1 male to female ratio will be maintained, and any excess males beyond these pairings will be killed and utilized by the tribes or used for nutrient enhancement.

**Disease effects:**
The risk of disease transmission to wild chinook in the area (Puget Sound) is low. Transmission of hatchery-origin diseases from the hatchery to wild fish in areas where they co-occur is an unlikely event. Although hatchery populations can be considered to be reservoirs for disease pathogens because of their elevated exposure to high rearing densities and stress, there is little evidence to suggest that diseases are routinely

transmitted from hatchery to wild fish (Steward and Bjornn 1990). Any potential impacts are addressed by rearing the chinook at lower densities, within widely recognized guidelines, continuing well-developed monitoring, diagnostic, and treatment programs already in place (Co-manager's Fish Health Policy 1998).

**Juvenile releases (predation/competition):**
Potential take issues associated with hatchery juvenile chinook released into the Nooksack River basin each year may include competition with and predation on naturally produced juvenile chinook salmon. The extent of any take is unknown. However, juvenile spring chinook salmon are released through the program at life stages and sizes that are very similar to co-occurring wild smolt out-migrants (see graph, section 2.2.1), decreasing the likelihood for predation. Salmonid predators are generally thought to prey on fish 1/3 or less their length (USFWS 1994). Chinook salmon are released, beginning in May, as smolts to foster rapid migration to minimize freshwater residence time and potential competition with listed fish (Steward and Bjornn 1990).

**Facility issues**:
The hatchery weir spans Kendall Creek and no chinook salmon are passed upstream. The stream has very low to no flows in the spring and summer and is not suitable for chinook spawning and rearing. Screens on the Kendall Creek intake are currently not in compliance with state and federal standards. Since there is no chinook production above the rack on Kendall Creek, there is no associated take.

**Genetic effects:**
Straying of Kendall Creek Hatchery-origin adult chinook salmon into the South Fork has been identified as a significant concern by the co-managers (Kirby 2002; Castle et al. 2002; Young and Shaklee 2002). The genetic diversity of the South Fork population is likely to be adversely affected by hatchery fish straying, and by straying of non-indigenous fall chinook that interbreed with the native stock. The recent reduction in the size of the Kendall Creek Hatchery program, especially the decrease in annual on-station releases from 600,000 fish to150,000 fish, should dramatically reduce North Fork spring chinook stray levels into the South Fork. In 2004, the contribution rate to the South Fork was much lower. Acclimation ponds have been eliminated from the current strategy in favor of releases to natural pools in the upper reaches to improve natural selection and distribution of returning adults throughout the system.

**- Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish**.

To date, there has been no natural-origin volunteers trapped and spawned for broodstock. Past takes of natural-origin spring chinook have included capture, handling, and release of adults (up to two per year), ecological effects on the supplemented natural-origin population at unknown levels, and ecological and genetic effects on South Fork Nooksack spring chinook at unknown levels. Take associated with listed Kendall Creek

hatchery-origin spring chinook has included capture, handling, spawning, incubation and rearing of the listed species. See 7.4.2 for additional information.

**Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).**

Annual take levels for listed fish are estimated where feasible in Take table at the end of HGMP.

**- Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.**

The annual number of adult fish retained for spawning and the number of juvenile fish released will be limited as described in this plan, and take levels are not expected to be exceeded. Reductions in juvenile hatchery fish release levels, adjustments in juvenile fish release locations, and implementation of new excess hatchery adult protocols is expected to reduce adult fish stray rates into the South Fork Nooksack River from current levels. If listed hatchery-origin adult, egg, fry or fingerling losses begin to exceed normal levels, appropriate corrective measures will be applied. NOAA Fisheries will be notified if and when the recovery program is expected to exceed the take in any category.

# SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

**3.1) Describe alignment of the hatchery program with any ESU-wide hatchery plan (e.g. *Hood Canal Summer Chum Conservation Initiative*) or other regionally accepted policies (e.g. the NPPC *Annual Production Review* Report and Recommendations - NPPC document 99-15). Explain any proposed deviations from the plan or policies.**

The Kendall Creek Hatchery spring chinook salmon HGMP is included as one of the 29 WDFW-managed plans under the co-managers' Resource Management Plan (RMP) for Puget Sound region chinook salmon hatcheries. This HGMP is in alignment with the RMP, which serves as the overarching comprehensive plan for state and tribal chinook salmon hatchery programs in the region. The overall goal is meeting harvest augmentation and natural-origin salmon population conservation objectives.

As affirmed in the co-managers' RMP, WDFW hatchery programs in Puget Sound must adhere to a number of guidelines, policies and permit requirements in order to operate. These constraints are designed to limit adverse effects on cultured fish, wild fish and the environment that might result from hatchery practices. Following is a list of guidelines, policies and permit requirements that govern WDFW hatchery operations:

*Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington*. These guidelines define practices that promote maintenance of genetic variability in propagated salmon (Hershberger and Iwamoto 1981).

*Spawning Guidelines for Washington Department of Fisheries Hatcheries*. Assembled to complement the above genetics manual, these guidelines define spawning criteria to be use to maintain genetic variability within the hatchery populations (Seidel 1983).

*Hatchery Reform- Principles and Recommendations of the Hatchery Scientific Review Group*. This report provides a detailed description of the HSRG's scientific framework, tools and resources developed for evaluating hatchery programs, the processes used to apply these tools, and the resulting principles, system-wide recommendations, and program-specific recommendations to reform (2004).

*Stock Transfer Guidelines*. This document provides guidance in determining allowable stocks for release for each hatchery. It is designed to foster development of locally adapted broodstock and to minimize changes in stock characteristics brought on by transfer of non-local salmonids (WDFW 1991).

*Fish Health Policy of the Co-managers of Washington State*. This policy designates zones limiting the spread of fish pathogens between watersheds, thereby further limiting the transfer of eggs and fish in Puget Sound that are not indigenous to the regions (WDFW, NWIFC, WSFWS 1998).

*National pollutant Discharge Elimination System Permit Requirements* This permit sets forth allowable discharge criteria for hatchery effluent and defines acceptable practices for hatchery operations to ensure that the quality of receiving waters and ecosystems associated with those waters are not impaired.

In 1999, several PS and coastal stocks were listed as threatened under the federal Endangered Species Act (ESA). State, tribal and federal managers need to ensure that their hatcheries do not present a risk to listed species. Through this HGMP and hatchery reform efforts, the Co-managers have sought to go beyond merely complying with ESA directives. The new approach is to reform hatchery programs to provide benefits to wild salmon recovery and sustainable fisheries. Hatchery management decisions will be based on system-wide, scientific recommendations, providing an important model that can be replicated in other areas.

In addition, the Legislature, in 1999, created the Salmon Recovery Funding Board (SRFB) and the Shared Strategy for Salmon Recovery. Both are collaborative efforts to protect and restore salmon runs across Puget Sound. They bring together the experience and viewpoints of citizens, major state and federal natural resource agencies, local governments, non-government organizations and Puget Sound Tribes. The SRFB provides grant funds to protect or restore salmon habitat and assist related activities that produce sustainable and measurable benefits for fish and their habitat. The Shared Strategy process helps identify what is needed in each watershed to recover salmon habitat through a watershed recovery plan (see section 3.4 for more details).

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

This hatchery program, and all other WDFW anadromous salmon hatchery programs within the Puget Sound Chinook ESU, operates under *U.S v Washington* that provides the legal framework for coordinating these programs, defining artificial production objectives, and maintaining treaty-fishing rights through the court-ordered Puget Sound Salmon Management Plan (1985). This co-management process requires that both the State of Washington and the relevant Puget Sound Tribe(s) develop *Equilibrium Broodstock Programs* and to enter into agreement the function, purpose and release strategies of all hatchery programs. Two documents are completed each year, describing agreed hatchery fish production levels for each brood year. The "Future Brood Document" is a detailed listing of agreed annual juvenile fish production goals. This document is reviewed and updated each spring, and finalized in July. The "Current Brood Document" presents actual juvenile fish production levels relative to the annual production goals. This second document is developed in the spring after eggs spawned that year have been enumerated and actual resultant juvenile fish production levels can be estimated. Through this process, the co-managers document their agreement on the function, purpose and release strategies for all Puget Sound region hatchery programs.

## 3.3) Relationship to harvest objectives.

There is no directed harvest on the North Fork spring chinook salmon population in the terminal area; however, there is a restricted sport fishery in mixed stock areas. The predicted overall exploitation rate in all 2000 fisheries upon Nooksack spring chinook was 13% and the exploitation rate in southern U.S. fisheries was 4%.

### 3.3.1) Describe fisheries benefiting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years (1988-99), if available.

Although there is no directed harvest in the terminal area, there are fisheries (below) that benefit from the program (see above). The long-term objective of the program is to recover the stock to the extent that sustainable tribal and non-Indian fisheries harvesting spring chinook salmon can occur. The current fisheries management objective is to minimize the impact of incidental harvest to a level that does not impede recovery. Catch is incidental in the Puget Sound sport fishery (<4%), net fishery (<2%), Canadian fisheries (<10%) and Alaska fisheries.

## 3.4) Relationship to habitat protection and recovery strategies.

Hatchery production is supplementing natural production while efforts for habitat recovery programs are on-going. There is a significant effort underway to identify factors limiting the survival of natural-origin spawners in the North Fork Nooksack River. Initial findings (Smith 2002) show that the NF Nooksack has a naturally high sediment load due to glacial inputs. However, human-caused sedimentation is considerable. An estimated 632 landslides have been documented in the North Fork. Roads have been associated with 36% and clearcuts with 28% of the landslides. Other habitat problems include impacts to riparian, floodplain, water quality and flow conditions, and most of these problems occur in the lower reaches. EDT analysis suggest that the carrying capacity of the existing habitat is significantly less than the number of adults volunteering in the spawning population outside of the hatchery. As habitat recovers, and natural spawners become productive, the hatchery component of this program will be scaled back accordingly. WDFW and the co-managers will consult with NOAA Fisheries to determine the protocols for scaling back the hatchery production in a manner that most efficiently promotes the recovery of the natural spawning population. This will be done while maintaining sufficient reserves of hatchery broodstock to ensure protection against sudden reversals in natural spawning population survival. A Watershed Recovery Plan for chinook salmon (part of the Shared Strategy for Salmon Recovery, see below) in the Nooksack River basin is being developed and this program is an essential factor in this plan.

The Legislature, in 1999, created the Salmon Recovery Funding Board (SRFB) and the Shared Strategy for Salmon Recovery. Both are collaborative efforts to protect and restore salmon runs across Puget Sound. They bring together the experience and viewpoints of citizens, major state and federal natural resource agencies, local governements, non-government organizations and Puget Sound Tribes. The SRFB

provides grant funds to protect or restore salmon habitat and assist related activities that produce sustainable and measurable benefits for fish and their habitat. The Shared Strategy process helps identify what is needed in each watershed to recover salmon habitat through a watershed recovery plan.

**Shared Strategy**

The Shared Strategy is based on the conviction that:
1) People in Puget Sound have the creativity, knowledge, and motivation to find lasting solutions to complex ecological, economic, and cultural challenges;
2) Watershed groups that represent diverse communities are essential to the success of salmon recovery;
3) Effective stewardship occurs only when all levels of government coordinate their efforts;
4) The health and vitality of Puget Sound depends on timely planning for ecosystem health and strong local and regional economies; and
5) The health of salmon are an indicator of the health of our region salmon recovery will benefit both human and natural communities.
The 5-Step Shared Strategy
1) Identify what should be in a recovery plan and assess how current efforts can support the plan.
2) Set recovery targets and ranges for each watershed.
3) Identify actions needed at the watershed level to meet targets.
4) Determine if identified actions add up to recovery. If not, identify needed adjustments.
5) Finalize the plan and actions and commitment necessary for successful implementation.

**Salmon Recovery Funding Board**

Composed of five citizens appointed by the Governor and five state agency directors, the Board provides grant funds to protect or restore salmon habitat and assist related activities. It works closely with local watershed groups known as lead entities (see below). SRFB has helped finance over 500 projects. The Board supports salmon recovery by funding habitat protection and restoration projects. It also supports related programs and activities that produce sustainable and measurable benefits for fish and their habitat.

**Lead Entities**

Lead entities are voluntary organizations under contract with the Washington State Department of Fish and Wildlife (WDFW). Lead entities define their geographic scope and are encouraged to largely match watershed boundaries. Lead entities are essential in ensuring the best projects are proposed to the Board for funding in its annual grant process.

All lead entities have a set of technical experts that assist in development of strategies, and identification and prioritization of projects. The lead entity citizen committee is responsible under state law for developing the final prioritized project list and submitting

it to the SRFB for funding consideration. Lead entity technical experts and citizen committees perform important unique and complementary roles. Local technical experts are often the most knowledgeable about watershed, habitat and fish conditions. Their expertise is invaluable to ensure priorities and projects are based on ecological conditions and processes. They also can be the best judges of the technical merits and certainty of project technical success. Citizen committees are critical to ensure that priorities and projects have the necessary community support for success. They are often the best judges of current levels of community interests in salmon recovery and how to increase community support over time with the implementation of habitat projects. The complementary roles of both lead entity technical experts and citizen committees is essential to ensure the best projects are proposed for salmon recovery and that the projects will increase the technical and community support for an expanded and ever increasing effectiveness of lead entities at the local and regional level. (http://www.iac.wa.gov/srfb/leadentities.htm)

Whatcom County, with the passage of resolutions by the Nooksack Tribe, Lummi Nation, Cities of Ferndale, Everson, Lynden, Sumas, Nooksack, Blaine and Bellingham; and Skagit and Whatcom counties, was selected to be the Lead Entity in the Nooksack River basin. The County is working on a long-term strategy to ensure the protection and restoration of healthy salmon populations. The local Watershed Recovery Plan being developed will "rollup" into the regional salmon recovery plan (Shared Strategy for Salmon Recovery). This "Shared Strategy" will become the official ESA recovery plan when it is completed.

## 3.5) Ecological interactions.

*(1) Salmonid and non-salmonid fishes or other species that could negatively impact the program.*

Negative impacts by fishes and other species on the Kendall Creek Hatchery fingerling spring chinook program could occur directly through predation on program fish, or indirectly through food resource competition, genetic effects, or other ecological interactions. In particular, fishes and other species could negatively impact chinook survival rates through predation on newly released, emigrating juvenile fish in the freshwater and marine areas. Certain avian and mammalian species may also prey on juvenile chinook while the fish are rearing at the hatchery site, if these species are not excluded from the rearing areas. Species that could negatively impact juvenile chinook through predation include the following:

- Avian predators, including mergansers, cormorants, belted kingfishers, great blue herons, and night herons
- Mammalian predators, including mink, river otters, harbor seals, and sea lions
- Cutthroat trout

Rearing and migrating adult chinook originating through the program may also serve as prey for large, mammalian predators in marine areas, nearshore marine areas and in the

Nooksack River to the detriment of population abundance and the program's success in recovery. Species that may negatively impact program fish through predation may include:

- Orcas
- Sea lions
- Harbor seals
- River otters

*(2) Salmonid and non-salmonid fishes or other species that could be negatively impacted by the program (focus is on listed and candidate salmonid species).*

- Chinook
- Bull trout

*(3) Salmonid and non-salmonid fishes or other species that could positively impact the program.*

Fish species that could positively impact the program may include other salmonid species and trout present in the Nooksack River watershed through natural and hatchery production. Juvenile fish of these species may serve as prey items for the chinook during their downstream migration in freshwater and into the marine area. Decaying carcasses of spawned adult fish may contribute nutrients that increase productivity in the watershed, providing food resources for the emigrating chinook. Chinook adults that return to the river may provide a source of nutrients and stimulate stream productivity. Many watersheds in the Pacific Northwest appear to be nutrient-limited (Gregory et al. 1987; Kline et al. 1997) and salmonid carcasses can be an important source of marine derived nutrients (Levy 1997). Carcasses from returning adult salmon have been found to elevate stream productivity through several pathways, including: 1) the releases of nutrients from decaying carcasses has been observed to stimulate primary productivity (Wipfli et al. 1998); 2) the decaying carcasses have been found to enrich the food base of aquatic invertebrates (Mathisen et al. 1988); and 3) juvenile salmonids have been observed to feed directly on the carcasses (Bilby et al. 1996). Addition of nutrients has been observed to increase the production of salmonids (Slaney and Ward 1993; Slaney et al. 2003; Ward et al. 2003). With integrated spawning and any carcass seeding efforts, 2,000 adult chinook carcasses (escapement goal) could contribute, assuming average size of adult chinook is 18 pounds, approximately 36,000 pounds of marine derived nutrients to organisms in the river.

*(4) Salmonid and non-salmonid fishes or other species that could be positively impacted by the program.*

The chinook program could positively impact freshwater and marine fish species that prey on juvenile fish. Nutrients provided by decaying chinook carcasses might also benefit fish in freshwater. These species include:

- Northern pikeminnow
- Coho salmon
- Cutthroat trout
- Pacific staghorn sculpin
- Numerous marine pelagic fish species

# SECTION 4. WATER SOURCE

**4.1) Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.**

Kendall Creek Hatchery is supplied with well water at a constant year-round temperature 47°F. Adults are held on well water at Kendall Creek. Kendall Creek is a seasonal stream that goes dry in the summer. The creek does sustain flows in the spring months; however, it is not possible to provide water from the creek for hatchery use, including to the spring chinook rearing ponds. Additionally, the creek is dry during the time the adult spring chinook are returning and is therefore not available as attraction water. Well water is discharged into Kendall Creek as the attraction water.

**4.2) Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge.**

The Kendall Creek gravity water intake does not have intake screens that are in compliance with NOAA Fisheries screening criteria. These screens are identified for replacement but are a lower priority than others since listed chinook do not occur above the rack on Kendall Creek. In most years, the creek is very low or dry during the time of adult spring chinook spawning. Wells supply most of the water needed for incubation and rearing. It is also discharged into Kendall Creek as attraction water. The water right permit #'s are G1-10562c and G1-2361c. The surface water right permit # is S1-00317.

Effluent discharge from the Kendall Creek program is regulated and authorized under NPDES permit WAG13-3007, administered by Washington Department of Ecology. Kendall Creek conducts effluent monitoring and reporting in compliance with this NPDES permit.

# SECTION 5. FACILITIES

**5.1) Broodstock collection facilities (or methods)**.

Adult spring chinook are collected as volunteers by a weir trap on Kendall Creek. The weir spanning the creek directs returning fish into a fish ladder leading into the holding pond.

**5.2) Fish transportation equipment (description of pen, tank truck, or container used).**

Adults are transported from the holding pond to the raceways using a 4'X 4' X 3' deep plastic tote. Adults are placed in the tote by hand. The tote of fish is transported to the raceways by tractor where the fish are taken out of the tote by hand and placed in the raceway. The adults are held in the raceways through maturation and spawning.

**5.3) Broodstock holding and spawning facilities.**

Broodstock are held in the adult pond. The pond has been modified into 5 sections. Fish are segregated by entry date to facilitate proper erythromycin inoculation. These measures limit the amplification and transfer of Bacterial Kidney Disease (BKD).

**5.4) Incubation facilities**.

Eggs are incubated in vertical incubators using well water.

**5.5) Rearing facilities.**

Fish are reared in 100' X 10' concrete raceways using well water.

**5.6) Acclimation/release facilities.**

Fish are released from the raceways into Kendall Creek and from a side channel below Deadhorse Creek (RM 63). It is a temporary pond situated in a side channel of the NF Nooksack River.

**5.7) Describe operational difficulties or disasters that led to significant fish mortality.**

Adult chinook are collected and segregated on a weekly basis for the purpose of erythromycin inoculation for Bacterial Kidney Disease. Each fish requires up to 3 separate inoculations during the holding and maturation period. In some years, mortalities of chinook males may be high, apparently due to multiple handlings required to transfer them into the rearing ponds. Losses have ranged from a few percent to as high as 12% of the total number of male spring chinook retained as broodstock. This has not affected the overall spawning operations as males are generally in surplus to females. Since the holding pond has been modified, high male loss has not occurred.

**5.8) Indicate available back-up systems, and risk aversion measures that will be applied, that minimize the likelihood for the take of listed natural fish that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.**

The hatchery will be staffed full-time and equipped with a low-water alarm system to help prevent catastrophic fish loss resulting from water system failure. At Kendall Creek a generator and backup well pumps are available. A Fish Health Specialist monitors the health of the fish and prescribes proper treatment to minimize loss. There were no backup power or water sources at the acclimation sites not in use at this time. The water was supplied passively via natural gravity sources.

# SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

**Describe the origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to wild fish of the same species/population.**

## 6.1) Source.

Broodstock are collected from hatchery-origin chinook returning to the point of their release as juveniles at the Kendall Creek Hatchery. These fish are from indigenous Nooksack River spring chinook stock reared and released at Kendall Creek and an off channel site. The hatchery program is self-sustaining and broodstock are no longer collected from the North Fork Nooksack River natural spawning areas.

## 6.2) Supporting information.

### 6.2.1) History.

Initial attempts to establish a spring chinook hatchery program at Kendall Creek used a variety of local and non-local stocks. These attempts included importation of out-of-region Sol Duc River stock chinook for release into Kendall Creek. The year and number of Sol Duc River juvenile chinook releases were as follows:

1975 80,000 smolts
1976 123,450 smolts
1978 113,000 smolts
1981 80,000 smolts

It is unknown how or to what extent past introductions affected the genetic integrity of the native spring chinook in the Nooksack River basin. However, based on an allozyme analysis (using 29 variable loci) comparing South Fork and North Fork Nooksack River spring chinook collections to Sol Duc spring chinook, WDFW found little evidence of genetic similarity between the Sol Duc stock and either Nooksack spring stock. Also, direct G-tests between the Sol Duc stock and both Nooksack spring stocks were highly significant (Young and Shaklee 2002).

The present program began in 1981 utilizing the NF Nooksack spring chinook stock. Adult fish used as the founding stock to establish an adult return to Kendall Creek were gillnetted in Wicks Slough, a clear water branch near the hatchery, and transferred to the hatchery for holding and spawning. From CWT data (1988-present), no other stocks have been found to stray (and incorporated) into the Kendall Creek hatchery broodstock.

### 6.2.2) Annual size.

Currently, 500 adults are needed for broodstock (see Section 1.11.1).

**6.2.3) Past and proposed level of natural fish in broodstock**.

The restoration program was started with natural origin fish from the North Fork Nooksack River. Since then, the program has relied totally on volunteer returns to the hatchery. In the past, hatchery/wild fish were not entirely differentiated with distinguishing marks so it was possible that wild fish contributed to the broodstock at some level. All hatchery fish are now identified with a coded-wire tag or otolith mark. All spring chinook spawned in recent years have been of hatchery-origin.
Chinook adults arriving after August 24th are spawned individually and gametes are held separately, in coolers, until otoliths or CWTs are read to ensure positive identification. The hatchery propagation of only the early-returning, indigenous spring chinook stock will enhance the total Nooksack River spring chinook returns and prevent possible extirpation of this "critical", native stock.

**6.2.4) Genetic or ecological differences**.
There are no known genetic or ecological differences between the natural and hatchery maintained chinook.

**6.2.5) Reasons for choosing.**

The program artificially propagates the indigenous spring chinook stock for conservation purposes. The adults collected are selected for spawning only if they have been identified as NF Nooksack chinook through the proper otolith mark or coded-wire tag. Each potential hatchery spawner is positively identified via coded-wire tag recovery or otolith band analysis.

**6.3) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish that may occur as a result of broodstock selection practices.**

The RSI (discontinued) and acclimation pond fish (see section 10.4 and 10.6) were otolith marked as sac-fry. Each RSI and acclimation release group was uniquely otolith-marked. All of the150,000 fingerlings that are released at the North Fork acclimation sites receive a CWT. Beginning in 2003, a calcein dye mark was also applied to a portion of the fish released on-station at Kendall Creek Hatchery (the calcein mark was not successful due to what we thought was photosensitivity). When returning fish are spawned, CWTs and/or otoliths are excised and read. To ensure genetic purity, only fish that are identified as Nooksack spring chinook by the otolith mark or CWT are selected for spawning. Adult spawners are selected for spawning randomly across the entire run timing prior to August 24th.

# SECTION 7. BROODSTOCK COLLECTION

**7.1) Life-history stage to be collected (adults, eggs, or juveniles)**.

Adults

**7.2) Collection or sampling design.**

A weir trap on Kendall Creek captures adults. They enter the holding pond via a fish ladder. A finger weir is used to keep the adults from escaping the holding pond. Broodstock collection occurs from May to September. All chinook trapped during this period are held for broodstock consideration.

**7.3) Identity.**

The method for identifying the target population is the use of otolith marks and coded-wire tags. These fish are genetically the same as the naturally produced fish. Only chinook volunteering into the hatchery trap prior to September 21 will be considered for spawning. All eggs from adults spawned prior to August 24 will be used. After that date, and until September 21st, only eggs from positively identified hatchery-origin Nooksack spring chinook will be used.

**7.4) Proposed number to be collected:**

**7.4.1) Program goal (assuming 1:1 sex ratio for adults):**
Currently, the number of adults needed for broodstock is approximately 500. The program egg take goal is 900,000. The number of adults required to provide this number of green eggs varies because of the fecundity difference among 3, 4 and 5 year old fish. For example, in 1998 most of the females returning were 4 year olds; 192 females were needed to produce 1,000,000 eggs. In 1999 most of the females were 3 year olds that meant 263 females were required to produce 1,000,000 eggs.

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

| Year | Males | Females | Jacks | Eggs | Juveniles |
|---|---|---|---|---|---|
| **1995** | 525 (105) | 244 (78) | 304 (2) | 265,220 | |
| **1996** | 760 (289) | 310 (286) | 133 (3) | 1,004,950 | |
| **1997** | 1,100 (479) | 563 (480) | 16(0) | 1,913,180 | |
| **1998** | 662 (532) | 616 (576) | 35 (2) | 2,969,200 | |
| **1999** | 2,301 (539) | 572 (535) | 26 (1) | 2,060,700 | |

| Year | Males | Females | Jacks | Eggs | Juveniles |
|---|---|---|---|---|---|
| **2000** | 1,396 (588) | 654 (585) | 45 (3) | 2,303,000 | |
| **2001** | 3,922 (486) | 1,443(491) | 450 (4) | 1,956,000 | |
| **2002** | 3,568 (489) | 2,084(216) | 42 (0) | 878,000 | |
| **2003** | 2,853(383) | 2,193(212) | 259 (3) | 870,000 | |

Note: Numbers in parentheses are adult broodstock totals. Actual adults returning to hatchery are to the left of the broodstock numbers.

### 7.5) Disposition of hatchery-origin fish collected in surplus of broodstock needs.

In recent years all spring chinook adults returning in excess of annual broodstock needs have been returned to the river to spawn naturally. Starting in 2002, excess adults, maintaining a 1:1 male to female ratio, will be trucked to the North Fork Nooksack (RM 51.2) and the Middle Fork Nooksack River. The numbers (not to exceed carrying capacity) and priority for the sites will be determined by the Co-managers. Any additional excess males will be killed and utilized by the tribes or out-planted as carcasses for nutrient enhancement.

WDFW and the co-managers will work with NOAA Fisheries to develop protocols based on the best available science for the use of hatchery adults returning in excess of annual program broodstock requirements. These protocols will address the selection of broodstock in a manner that closely mimics the age distribution of natural spawning population and maintains/increases the natural diversity of the naturally spawning population.

### 7.6) Fish transportation and holding methods.

Each fish is removed from the trap using a dip net with soft webbing. Each fish is inoculated for Bacterial Kidney Disease (BKD), and placed by hand into a 4' X 4' X 3' high plastic tote. Each tote is used to transport 15 fish at a time. Fresh water is circulated through the totes during the entire process that takes approximately 15 minutes.
Chinook are initially segregated by run time to facilitate secondary and tertiary BKD inoculations. They are later segregated by sex, as males are more prone to pre-spawning mortality due to handling. The raceways contain tarped areas to protect the fish from sunburn. If surplus adults are hauled to upriver spawning sites, an adult fish pump is used to transport adults from the holding pond to the truck. The trucks have oxygen and aerators.

**7.7) Describe fish health maintenance and sanitation procedures applied**.

Each fish requires up to 3 separate inoculations during the holding and maturation period. In some years, mortalities of chinook males may be high, apparently due to multiple handlings required to transfer them into the rearing ponds. Losses have ranged from a few percent to as high as 12% of the total number of male spring chinook retained as broodstock. This has not affected the overall spawning operations as males are generally in surplus to females. Since the holding pond has been modified, high male loss has not occurred. Broodstock collection is conducted consistent with Co-Managers Fish Health Policy (1998).

**7.8) Disposition of carcasses.**

All fish spawned have been buried because of the use of erythromycin. These fish may be used for nutrient enhancement in the future. Non- injected (erythromycin) fish could go to the tribes, food banks or be used for nutrient enhancement.

**7.9) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.**

Only known hatchery-origin Nooksack spring chinook adults are used for broodstock. Wild-origin broodstock are no longer collected on the spawning grounds. The program artificially propagates the indigenous spring chinook stock for conservation purposes. Each potential hatchery spawner is positively identified via coded-wire tag recovery or otolith band analysis.

# SECTION 8. MATING

**Describe fish mating procedures that will be used, including those applied to meet performance indicators identified previously**.

## 8.1) Selection method.

Fish are randomly chosen from ripe fish on spawning days. Spawning occurs once per week.

## 8.2) Males.

Sperm from two males is used to fertilize the eggs from two females. Jacks are spawned at the rate of 2% each week of spawning. On occasion, in the early part of the spawning season, there are insufficient ripe males and, as a consequence, the ratio of males to females may be less than 1:1. Normally, males are not used twice.

## 8.3) Fertilization.

For chinook arriving prior to August 24:
Fish are selected at random and mated in pairs (1:1). After fertilization eggs are pooled. Coded-wire tags or otoliths are collected from all fish to allow reading at a later date.

For chinook arriving after August 24:
Males and females are spawned individually and gametes are held separately, in coolers until otoliths or CWTs are read to ensure positive identification, then fertilized as above.

## 8.4) Cryopreserved gametes.

No cryopreservation.

## 8.5) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

The annual collection of 500 adult fish at a 1:1 sex ratio ensures retention of an adequate effective spawning population size for the program, decreasing the likelihood for within population diversity loss. Mates are chosen randomly from all ripe fish; fish spawned represent the entire run timing prior to August 24th.

# SECTION 9. INCUBATION AND REARING -

**Specify any management *goals* (e.g. "egg to smolt survival") that the hatchery is currently operating under for the hatchery stock in the appropriate sections below. Provide data on the success of meeting the desired hatchery goals.**

## 9.1) Incubation:

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

The annual green egg take goal for the program is 900,000. The range for green egg to fry survival has been 86 to 93% (Avg. 90.7%).

### 9.1.2) Cause for, and disposition of surplus egg takes.

To date no surplus has occurred. All eggs have been utilized in this program, and the likelihood for surpluses will be limited by adherence to described annual adult collection and green egg procurement goals.

### 9.1.3) Loading densities applied during incubation.

Vertical incubators are used. Flow is maintained at 3 gallons per minute (gpm) for each stack of eight trays. Maximum loading is 8,000 eggs per tray.

### 9.1.4) Incubation conditions.

Eggs are incubated in well water. The water temperature is a constant 47EF. Dissolved oxygen is monitored and minimum criteria is 8 parts per million (ppm). Chillers are used to lower the water temperature to create otolith marks.

### 9.1.5) Ponding.

Ponding is forced. Each egg take is monitored using a KD factor. The appropriate range is 1.97 - 2.04 KD. This KD factor corresponds to approximately 1800 Temperature Units (TU's).

### 9.1.6) Fish health maintenance and monitoring.

Formalin is delivered via drip method from a closed system, to treat eggs for fungus. Egg mortality is removed prior to hatching. Vexar substrate is used to improve egg and alevin development.

**9.1.7) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.**

Eggs are incubated in well water. Siltation is not a factor. There are low flow alarms on incubators to decrease the likelihood of catastrophic loss. All dead eggs are removed to prevent any disease transmission.

**9.2) Rearing:**

**9.2.1) Provide survival rate data (*average program performance*) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.**.

The annual fry to smolt survival rate goal is 90%. In recent years (1999-2003), actual range has been 89.9% to 97.5%.

**9.2.2) Density and loading criteria (goals and actual levels).**

Fish are reared at flow indexes of less then 2.07 at 47°F and density indexes of less than 0.3.

**9.2.3) Fish rearing conditions**

Fish are reared on well water at a constant 47°F. Dissolved oxygen is monitored to assure levels are above 8 ppm. Ponds are vacuumed weekly.

**9.2.4) Indicate biweekly or monthly fish growth information (*average program performance*), including length, weight, and condition factor data collected during rearing, if available.**

Not available.

**9.2.5) Indicate monthly fish growth rate and energy reserve data (*average program performance*), if available**.

Not available.

**9.2.6) Indicate food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (*average program performance*).**

Fish are started on Bio-Oregon Biodiet then fed Biomoist feeds until released. This may change as feed products improve. Feeding rate is 2 to 3% body weight /day and the pounds of feed fed/day/gpm pond flow is kept below 0.15 lbs/gpm/day.

### 9.2.7) Fish health monitoring, disease treatment, and sanitation procedures.

Fish Health Specialists conduct fish health exams on a monthly basis. This may include evaluation of rearing conditions and lethal sampling of small numbers of juvenile fish to assess the health status of the population and to detect pathogens of concern. In the event of disease outbreaks or elevated mortality in the stock, the fish health staff is available to diagnose problems and provide treatment recommendations as per the Co-managers Fish Health Policy (1998).

### 9.2.8) Smolt development indices (e.g. gill ATPase activity), if applicable.

Gill ATPase activity is not monitored. The migratory state of the release population is determined by fish behavior. Aggressive screen and intake crowding, leaner condition factors, a more silvery physical appearance and loose scales during feeding events are signs of smolt development.

### 9.2.9) Indicate the use of "natural" rearing methods as applied in the program.

No NATURES rearing methods are used at Kendall Creek Hatchery. WDFW is working to identify modification to rearing methods which might produce fish at release that are closer to natural-origin juveniles in behavior and size.

### 9.2.10) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation.

Fish are reared in well water to fingerling smolt size (zeros) to mimic the natural fish size at out-migration. The Area Fish Health Specialist monitors fish health on a routine basis. If needed, treatment plans are prescribed in accordance with the Co-managers Fish Health Policy (1998).

# SECTION 10. RELEASE

**Describe fish release levels, and release practices applied through the hatchery program**.

## 10.1) Proposed fish release levels.

| Age Class | Maximum Number | Size (fpp) | Release Date | Location |
|---|---|---|---|---|
| **Eggs** | | | | |
| **Unfed Fry** | 50,000* | 1,200<br>(35 mm fl) | December | NF Nooksack |
| **Fry** | | | | |
| **Fingerling** | 550,000<br><br>200,000 | 80 - 100<br>(78-80 mm fl)<br>100<br>(78 mm fl) | May-June 1<br><br>May-June 1 | NF Nooksack<br><br>MF Nooksack |
| **Yearling** | | | | |

* The Upper NF Nooksack Remote Site Incubator (RSI) project has been discontinued.

## 10.2) Specific location(s) of proposed release(s).

**Stream, river, or watercourse:**
**Release point:**

Kendall Creek Hatchery: Located on Kendall Creek (01.0406), which enters the NF Nooksack River (01.0120) at RM 46.

NF Nooksack Side Channel: NF Nooksack River (01.1020), downstream of an original release site at Deadhorse Creek (RM 63)

MF Nooksack: MF Nooksack River (01.0339).

**Major watershed:** Nooksack River (01.1020)
**Basin or Region:** Puget Sound

## 10.3) Actual numbers and sizes of fish released by age class through the program.

| Release Year | Eggs/ Unfed Fry | Avg size (fpp) | Fry | Avg size (fpp) | Fingerling | Avg size (fpp) | Yearling | Avg size (fpp) |
|---|---|---|---|---|---|---|---|---|
| **1988** | | | | | | | 90,841 | 8 |
| **1989** | | | | | 1,142,520 | 75 | 94,266 | 7 |
| **1990** | | | | | 545,817 | 87 | 376,792 | 7 |
| **1991** | | | | | | | 346,632 | 8 |
| **1992** | | | | | | | 173,200 | 8 |
| **1993** | | | | | 871,091 | 76 | 170,900 | 6 |
| **1994** | | | | | 1,077,826 | 88 | 292,300 | 5 |
| **1995** | | | | | 193,145 | 104 | 347,450 | 8 |
| **1996** | | | | | 2,638 | 96 | 185,962 | 7 |
| **1997** | | | | | 755,453 | 82 | 187,765 | 10 |
| **1998** | | | 135,000 | 850 | 1,614,857 | 78 | 187,636 | 6 |
| **1999** | 142,458 | 1,300 | | | 2,303,700 | 92 | | |
| **2000** | | | | | 1,487,800 | 76 | | |
| **2001** | | | | | 1,647,300 | 72 | | |
| **2002** | | | | | 1,745,300 | 87 | | |
| **2003** | | | | | 778,400 | 92 | | |
| **Average** | 142,458 | 1,300 | 135,000 | 850 | 1,089,681 | 85 | 204,500 | 7 |

## 10.4) Actual dates of release and description of release protocols.

At Kendall Creek, the fish are now normally released between May and June 1. The fish are released as they attain the desired minimum release size of 100 fish per pound (fpp). Fish of a larger size frequently characterizes later releases. If possible, the fish are released during a freshet. All releases from Kendall Creek are forced. Release dates from the acclimation ponds are scheduled to occur after the departure of wild-origin fingerling chinook in the area. USFWS pre-recovery-project assessment showed that, by April 15, most of the wild-born chinook fingerlings had migrated out of the acclimation site reaches and were progressing down river (Wunderlich, Meyer, and Boomer, 1982). The plan (2004 release) is to release fish in three lots spaced one week apart, beginning the first week of May. The pond will not be screened hence the fish will be allowed to emigrate volitionally.

## 10.5) Fish transportation procedures, if applicable.

Fish are transported by truck in 300 and 800-gallon tanks (250 and 675 pounds of fish, respectively). Each truck is equipped with circulation pumps and oxygen stones. Oxygen levels are monitored. Transit time to the acclimation sites is 1 hour or less. Fish size is 90 to 100 fpp.

**10.6) Acclimation procedures**

Fish are trucked to a side channel below Deadhorse Creek (RM 63). It is a temporary pond situated in a side channel of the NF Nooksack River. At this site, fish are acclimated (de-stressed) for 3 days.

**10.7) Marks applied, and proportions of the total hatchery population marked, to identify hatchery adults.**

All chinook in the program receive otolith marks unique to their release group. In addition, all fish released from Kendall Creek Hatchery receive a CWT. The 400,000 otolith-marked fish released from the acclimation site (see section 10.4 and 10.6) are coded-wire tagged as a double-index (DIT) group; 200,000 fish receive an adipose fin clip and a coded-wire tag and the other 200,000 fish receive just the coded-wire tag. MF Nooksack releases will be coded-wire tagged only. All broodstock returning to the hatchery will have their coded-wire tags and otoliths read to maintain separation between spring and fall chinook stocks. WDFW will monitor chinook escapement to the Nooksack River sites to estimate the number of tagged, untagged and marked fish escaping to the river each year. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.

**10.8) Disposition plans for fish identified at the time of release as surplus to programmed or approved levels.**

Every effort will be made to take only enough eggs to meet program needs.

**10.9) Fish health certification procedures applied pre-release.**

Fish are monitored by fish health specialist prior to release as per the Co-managers Fish Health Policy (1998).

**10.10) Emergency release procedures in response to flooding or water system failure.**

Flooding is not a problem at Kendall Creek. Generators and creek water back up water supply system failure. If severe drought conditions arise, fish may be released early to prevent fish loss.

**10.11) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases.**

The production and release of only smolts through fish culture and volitional release practices fosters rapid seaward migration with minimal delay in the rivers, limiting interactions with listed chinook. To minimize the risk of residualization and impact upon natural fish, hatchery fingerlings are released from May – June as fingerling smolts reared to sub-yearling size (75-85 fpp). Juvenile spring chinook salmon are released through the program at life stages and sizes that are very similar to co-occurring wild smolt out-migrants, decreasing the likelihood for predation (see section 2.2.1 and 2.2.3). Chinook salmon are released (May to June 1) as smolts to foster rapid migration to minimize freshwater residence time and potential predation and competition of listed fish (Steward and Bjornn 1990).

In addition, a rearing parameter of the sub-yearling program is to attain a coefficient of variation (CV) for length of 10.0% or less in order to increase the likelihood that most of the fish are ready to migrate (Fuss and Ashbrook 1995). Such fish would be less likely to residualize in fresh water and interact with listed wild fish. The average CV for release years' 1995-2002 was 6.63%.

# SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

## 11.1) Monitoring and evaluation of "Performance Indicators" presented in Section 1.10.

Elements of the annual Monitoring and Evaluation plan for this program are identified in Section 1.10. The purpose of the monitoring program is to identify and evaluate the benefits and risks that may derive from the hatchery program. The monitoring program is designed to answer questions of whether the hatchery is providing the benefits intended, while also minimizing or eliminating the risks inherent in the program. A key tool in any monitoring program is having a mechanism to identify each hatchery production group.

Each production group is identified with distinct otolith marks, adipose clips, coded wire tags, blank wire tags or other identification methods as they become available. This will allow for selective harvest on hatchery stocks when appropriate, monitoring of interactions of hatchery and wild fish wherever they co-mingle in riverine, estuarine and marine habitats and assessment of the status of the target population. Through extensive annual spawning ground surveys, WDFW will monitor the chinook salmon escapement into the target and non-target chinook populations to estimate the number of tagged, un-tagged and marked fish escaping into the river each year and the stray rates of hatchery chinook into the rivers. Recent reports by the co-managers provide adult return and stray rate monitoring and evaluation results for the hatchery program (Castle et al., 2002; Kirby, 2002).

In addition, another important aspect of hatchery management is the monitoring and evaluation of the genetic profile of hatchery stock(s) and of nearby natural stock(s). This is an ongoing monitoring need to evaluate changes in the genetic structure of both hatchery and natural populations and the amount, in geographic extent, of gene flow between them. A recent technical report by WDFW (Young and Shaklee, 2002) evaluates the genetic profiles of extant chinook salmon stocks in the Nooksack River basin, producing a baseline for on-going, future evaluations of Kendall Creek Hatchery program effects.

#### 11.1.1) Describe plans and methods proposed to collect data necessary to respond to each "Performance Indicator" identified for the program.

Continue to coded-wire tag and otolith mark fish to allow identification at the hatchery rack and on the spawning grounds. All broodstock returning to the hatchery will have their coded-wire tags and otoliths read to maintain separation between spring and fall chinook stocks. WDFW shall continue to monitor chinook escapement to the NF and SF Nooksack River to estimate the number of tagged, untagged and marked fish escaping or straying to the river each year. That, coupled with the revised development of a baseline microsatellite DNA profile, will allow a more precise evaluation of the natural-origin spawner production from the two watersheds above plus the Middle Fork Nooksack River. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.

#### 11.1.2) Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

Additional funding and resources are needed to monitor and evaluate this program as well as to analyze samples for DNA profiles. Funding is committed to CWT and otolith analysis.

### 11.2) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities.

Monitoring and evaluation has/will be undertaken, with consultation with NOAA Fisheries, in a manner which does not result in an unauthorized take of listed chinook.

# SECTION 12. RESEARCH

None proposed in direct association with the Kendall Creek Hatchery program.

**12.1) Objective or purpose.**

**12.2) Cooperating and funding agencies**.

**12.3) Principle investigator or project supervisor and staff.**

**12.4) Status of stock, particularly the group affected by project, if different than the stock(s) described in Section 2.**

**12.5) Techniques: include capture methods, drugs, samples collected, tags applied**.

**12.6) Dates or time period in which research activity occurs.**

**12.7) Care and maintenance of live fish or eggs, holding duration, transport methods.**

**12.8) Expected type and effects of take and potential for injury or mortality.**

**12.9) Level of take of listed fish: number or range of fish handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table" (Table 1).**

**12.10) Alternative methods to achieve project objectives.**

**12.11) List species similar or related to the threatened species; provide number and causes of mortality related to this research project.**

**12.12) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed fish as a result of the proposed research activities.**

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## SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the foregoing information is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name, Title, and Signature of Applicant:

Certified by_____ Date:_____

Take Table. Estimated listed salmonid take levels by hatchery activity.

*Chinook*

| | |
|---|---|
| ESU/Population | Puget Sound Chinook *(Oncorhynchus tshawytscha)*- North Fork Nooksack |
| Activity | Kendall Creek Spring Chinook Fingerling Program |
| Location of hatchery activity | Kendall Creek Hatchery, Kendall Creek (01.0406) |
| Dates of activity | April-June |
| Hatchery Program Operator | WDFW |

| Type of Take | Annual Take of Listed Fish by life Stage (number of fish) | | | |
|---|---|---|---|---|
| | Egg/Fry | Juvenile/Smolt | Adult | Carcass |
| Observe or harass (a) | - | - | - | - |
| Collect for transport (b) | - | - | - | - |
| Capture, handle, and release (c) | - | - | 2 | |
| Capture, handle, tag/mark/tissue sample, and release (d) | - | - | | - |
| Removal (e.g., broodstock (e) | - | - | | - |
| Intentional lethal take (f) | - | - | * | - |
| Unintentional lethal take (g) | | | | - |
| Other take (indirect, unintentional) (h) | - | Unknown (ecological impacts) | - | - |

* - Total number of broodstock is 500 hatchery-origin chinook.

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the wild and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.