HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

DRAFT

Hatchery Program	University of Washington Portage Bay Fall Chinook Program
Species or Hatchery Stock	Portage Bay Fall Chinook *(Oncorhynchus tshawytscha)*
Agency/Operator	University of Washington School of Aquatic and Fishery Sciences
Watershed and Region	Lake Washington, Puget Sound
Date Submitted	August 04, 2005
Date Last Updated	July 27, 2005

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

University of Washington Portage Bay Fall Chinook Program

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

Fall chinook salmon *(Oncorhynchus tshawytscha)* Portage Bay stock- not listed

1.3) Responsible organization and individuals

Lead agency contact:

Name (and title): Kerry Naish, Assistant Professor
Flowing Water Lab Committee Chair
School of Aquatic and Fishery Sciences
Agency or Tribe: University of Washington
Address: Fishery Sciences
1122 NE Boat Street, Box 355020
Seattle, WA 98105
Telephone: (206) 543-6475
Fax: (206) 616-9072
Email: cgrue@fish.washington.edu

On-site operations staff lead:

Name (and title): Jon Wittouck
Aquatic Lab Services
School of Aquatic and Fishery Sciences
Agency or Tribe: University of Washington
Address: Fishery Sciences
1122 NE Boat Street, Box 355020
Seattle, WA 98105
Telephone: (206) 543-4267
Fax: (206) 616-8689
Email: wittouck@u.washington.edu

Other agencies, Tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:

Northwest Fisheries Science Center, NMFS: On a seasonal basis, regularly utilize Portage Bay Chinook and the associated facility for research purposes. Involvement varies from the collection of biological material for laboratory experiments to release of experimental fish.

WDFW and National Biological Service, USGS: Occasionally utilize Portage Bay Chinook and the associated facility for research purposes. Involvement varies from the collection of biological material to tagging and research on the released runs.

Salmon In the Classroom Program, Seattle Public Utility and WDFW: On a seasonal basis, regularly receive small numbers of green eggs, milt, eyed eggs and carcasses from the Portage Bay Chinook stock for K-12 educational programs. The hatchery facility also provides approximately 150-guided tours for K-12 classes during salmon spawning season. This program is focused on teaching water quality values and environmental stewardship to 5th grade students in the City of Seattle and surrounding communities. The yearly curriculum involves over 4,000 students annually.

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

Source: State of Washington

Staffing: Direct staffing includes a full-time Operations Manager, a full-time Assistant Hatchery Manager and 2-10 part-time hourly Hatchery Technicians depending on the season. The majority of Hatchery Technicians is current, or recently graduated, UW students. The facility also supports a part-time Tour and Outreach Coordinator and a vocational rehabilitation volunteer from Harborview Medical Center or University of Washington Medical Center.

The School of Aquatic and Fishery Sciences provides administrative staff support and a faculty steering committee for development of overall programmatic goals.

Operational costs: The annual cost to the School is $110 000 per annum. This figure includes instructional support but does not include the subsidy from University of Washington (land, physical space, electricity).

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

Broodstock Collection; Incubation; Rearing and Release:
University of Washington Portage Bay Hatchery:
Northeast section on north shore of Portage Bay just west of Montlake Cut at RM 5.0.
Lake Washington Watershed, Washington State.
Latitude 47° 38’ “55.14”, Longitude 122° 18’ “33.35”.

1.6) Type of program.

Isolated research. The proposed isolated 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.

Research: The first goal of this program is to provide salmonid stocks and fish culture space to support research programs by University of Washington Faculty, Research Scientists, Graduate Students and other affiliated research organizations such as NMFS, USGS and WDFW.

Education: A second goal of this program to provide salmonid stocks and fish culture space in order to support educational activities for undergraduate and graduate students within the University of Washington and also to provide K-12 outreach opportunities for Puget Sound region schools.

1.8) Justification for the program.

The UW Portage Bay Fall Chinook Program provides chinook salmon at different life stages for research and educational use. The facility maintains a dedicated and flexible resource to support cutting-edge research and education pertaining to the biology, ecology, aquaculture and conservation of salmonid species. This research is applicable not only to the Lake Washington Watershed, but also across the species range.

The UW hatchery stock is relatively isolated and is produced specifically for research work. The run reduces the need to use naturally produced chinook salmon for research purposes, thereby allowing a greater degree of freedom in the type of research that can be conducted at either at a harvest augmentation hatchery or on naturally produced stocks.

The location of the UW Portage Bay Hatchery offers to UW students and educators a unique level of access to a self-sustaining anadromous salmon population. This level of access and flexibility is not duplicated elsewhere in the NW region. Furthermore, the close proximity and research focus of the UW Portage Bay Hatchery to NMFS's Northwest Fishery Science Center at Montlake offer UW / NMFS affiliate faculty, and other joint researchers, regular and interactive access to a unique research platform. Finally, the educational focus of the UW Portage Bay Hatchery also facilitates the large and active K-12 educational outreach programs that the facility supports. In cooperation with the City of Seattle, we provide the largest single "Salmon In the Classroom" educational site in the state, offering water quality and environmental stewardship education to over 4,000 school age children annually.

Although secondary to the primary goals of the program, the UW Portage Bay Hatchery currently produces harvestable numbers of hatchery chinook salmon. This benefit may reduce harvest pressure on naturally produced chinook salmon in the Lake Washington Watershed.

The nature of the chinook stock and the hatchery facility is unique; the needs associated with the maintenance of the run differ from the goals of other hatcheries. Thus, this isolated research program incorporates a number of operational goals in order to minimize adverse effects on listed fish.

First, the target number of salmon smolt released each year is based on a predicted minimum number required to maintain integrity and stability of the population in poor year classes. This target number is regularly evaluated by the department's quantitative geneticist, to determine if sufficient adult salmon return to the facility. This number should meet the minimum needs of the research and educational programs.

Second, as of brood year (BY) 1996, all chinook released as part of the hatchery's smolt production were coded wire tagged (CWT) and/or adipose fin clipped. In BY '96 and '97 some surplus fry were released unmarked. Since BY '98 no surplus fry have been released from the hatchery. As of BY 1998, all fish released from the Portage Bay Hatchery will be at a minimum adipose-fin clipped and preferably coded wire tagged. In addition, beginning with BY 2000, all salmonids raised at the facility will be otolith marked during incubation. By fall of 2003 the above marking program will be fully integrated into the returning chinook population and only chinook marked, as hatchery stock will be used for spawning. Any unmarked chinook returning to the hatchery pond will be released back into Portage Bay with as little handling as possible.

Finally, active imprinting procedures are followed and regularly evaluated. Juvenile release is timed so most if not all of the chinook fry are smolting when released. The goal is to eliminate any freshwater residency, and substantially minimize the possibility of straying by returning adult chinook.

1.9) List of program "Performance Standards".

The following are objectives for the research and education oriented program based on the University of Washington Portage Bay Fall Chinook run **(information and text provided by U of W hatchery personnel).**

Objective 1: Produce chinook at different life history stages for research use, while minimizing the risk of adverse effects to listed wild populations through proper broodstock management and rearing and release strategies.

Objective 2: Provide opportunity for educational experiences for graduate and undergraduate students at the University of Washington

Objective 3: Provide University outreach opportunities through the Puget Sound region K-12 students and the “Salmon In the Classroom” Program.

Objective 4: Conserve the genetic diversity and stock integrity in order to maintain a self-sustaining population. Maximize in-hatchery survival of broodstock and their progeny. Limit the impact of pathogens associated with hatchery stocks on listed fish.

Objective 5: Determine the need and methods for improvement of hatchery operations or, if warranted, the need to discontinue the program.

Objective 6: Collect and evaluate information on all life stages of the chinook stock in the program. Maintain an existing database on all biological information for long-term monitoring programs.

Objective 7: To a limited extent, harvestable chinook will be produced as a by-product of our activities.

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

1.10.1) “Performance Indicators” addressing benefits.

Objective 1: Hatchery chinook will be available for research studies by UW, NMFS, USGS, WDFW, and other affiliated organizations. The stock meets a demand for experimental fish, relieving pressure on supplementation hatcheries and on wild-produced fish. The fish are also produced on-site, reducing difficulties associated with access to experimental animals.

Objective 2 and 3: Hatchery chinook will be available for undergraduate and graduate education at the University of Washington. Activities arranged around the run also support a variety of K-12 educational programs.

Objective 4: The maintenance of a self-sustaining and healthy population reduces the need to obtain broodstock from elsewhere. This objective in turn reduces the potential of genetic interactions between the UW run and other runs in the region.

Objective 5: Improved techniques in broodstock development and hatchery rearing will be developed and subsequently published.

Objective 6: Detailed data is collected on returning adult chinook and their progeny for phenotypic comparison to historical records and future salmon return and production data. This data set already spans 50 years and is now in the process of analysis for historical changes in the watershed.

Objective 7: The limited release may reduce harvest pressures on naturally produced stocks.

1.10.2) "Performance Indicators" addressing risks.

There are risks associated with the isolated research program operated at the hatchery to produce fish for research and education. The following operational goals are implemented in order to minimize adverse effects on listed fish.

Objective 1, 2 and 3: reduction of risks associated with interactions between the UW research run and listed species.

1. All hatchery chinook will be adipose fin clipped or tagged upon request by the Co-Managers to allow discrimination between hatchery chinook and naturally spawned chinook during both out-migration and adult return.
2. Returning salmon will only be allowed to enter the return pond after the 3rd week in September. By this time, in most years, the peak of the naturally produced chinook return should have migrated past the Portage Bay Hatchery. After the 3rd week of September, any fish entering the return pond that can be identified as naturally produced will be regularly removed with limited handling.
3. Chinook spawners from the hatchery stock will be selected by phenotype for delayed adult return timing, resulting in a temporal separation between Portage Bay Hatchery Chinook and naturally produced chinook in the Lake Washington Watershed.

Objective 4 and 5: Maintenance of a healthy and self-sustaining run – risks in loss of genetic variability and introduction of disease to wild populations.

1. Hatchery chinook smolt-to-adult return rates will be evaluated.
2. The number of adults used in the hatchery project will meet or exceed the minimum population size.
3. Adult chinook will be collected for spawning over the duration of the run window, set in Objective 2-3 point 2, to ensure that differences in return timing are preserved (see section 6 on selection for time of return).
4. Genetic Stock Identification (GSI) allozyme collections and DNA samples will be taken from all hatchery chinook spawned for comparison with future generations to monitor long-term changes in demographics of the population (such as effective population size, interactions with listed populations).
5. UW will determine the survival at various egg and juvenile life stages.
   a) Determine green egg to eyed egg, eyed egg to swim up fry, and swim up fry to released fry survival rates for Portage Bay hatchery chinook.
   b) Maintain and compile records of culture techniques used for each life stage, such as: collection and handling procedures, for chinook brood stock; fish and egg condition at time of spawning; fertilization procedures, incubation methods/densities, temperature unit records by developmental stage, shocking methods, and fungus treatment methods for eggs; ponding methods, start feeding methods, rearing/pond loading densities, feeding schedules and rates for juveniles; and release methods for 15-30 gram fingerlings.
   c) Summarize results of tasks for presentation in annual reports.

d) Identify where the hatchery program is not meeting objectives, and make recommendations for improvements as needed.

6. UW will determine if hatchery stock procurement methods are collecting the required number of adults that represent the demographics of the population with minimal injuries and stress to the fish.

a) Monitor operation of adult capture operations, ensuring compliance with established broodstock collection protocols.

b) Monitor timing, duration, composition, and magnitude of the run.

c) Collect biological information on collection-related mortalities and determine causes of mortality, and use carcasses for genetic stock profile sampling, if possible.

d) Summarize results for presentation in annual reports and provide recommendations on means to improve stock collection, and refine protocols if needed for application in subsequent seasons.

7. UW will monitor fish health, specifically as related to cultural practices that can be adapted to prevent fish health problems. Professional fish health specialists of the UW Veterinarian Services and WDFW will monitor fish health.

a) A fish health specialist will conduct fish health monitoring. Significant fish mortality to unknown causes will be sampled for histopathological study.

b) When necessary bacterial or viral pathogens will be isolated and appropriate treatment provided under the direction of a fish health specialist.

c) Prior to implementation, all treatments prescribed will first be evaluated for short and long-term benefits and risks to both the hatchery stock and the watershed as a whole.

d) The incidence of viral pathogens in hatchery chinook will be determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State (WDFW 1996).

e) Fish health monitoring results will be summarized for annual reports.

Objective 6: Detailed long-term biological monitoring of returning stocks.

1. UW will collect return date, species, age, sex, mark, length and weight data from all Portage Bay hatchery stocks.

2. In addition, fecundity, egg to fry survival rates, GSI, and DNA will be recorded/collected from all salmon spawned for broodstock. This information will be used as baseline data to document phenotypic changes in the population.

1.11) Expected size of program.

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

The maximum number of adults spawned to meet production goals is 125 pairs.

In some years additional chinook pairs are spawned for research, educational or K-12 outreach use. The progeny from these additional parents are not part of the chinook released as hatchery production. Historically, they may have been part of fry released as surplus. Presently the progeny from any additional chinook pairs spawned for specific research of educational use will not be released.

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		
Fry		
Fingerling	Portage Bay, Lake Washington	180,000
Yearling		

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

The hatchery escapement levels from 1995 through 2003 were 2,229, 1,822, 2,100, 2,769, 1,669, 1,328, 2,094, 1,069 and 1,563, respectively.

From the RMIS database, the smolt-to-adult survival rates for broodyears 96, 97 and 98 were 0.91%, 0.42% and 0.52% (avg.= 0.62%), respectively.

Based on the average smolt-to-adult survival rate of 0.62% and the programmed release goal of 180,000 fingerlings, the estimated adult production (goal) level would be 1,116.

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

The chinook research and education program started in 1949 (52 years).

1.14) Expected duration of program.

Ongoing for research and education.

1.15) Watersheds targeted by program.

Lake Washington/ Cedar River/ Sammamish Drainage area, WRIA 08

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

An alternative to obtaining fish for research and education would be to collaborate with State, Federal or Tribal Hatcheries. The reasons why this option is not being considered are as follows:
1) Proximity – the run returns to the UW hatchery, which is very convenient to those researchers at UW and NMFS who regularly have other time-consuming commitments such as teaching, meetings and laboratory experiments.
2) Experimentation – (for example, see section 12). The run was introduced to the UW 52 years ago and is not related to traditional hatchery activities such as recovery or supplementation. In addition, there are few known interactions between this run and listed populations. Thus, any manipulation of the run is expected to have minimal impact on any ESA-related activities.
3) Education – the chinook run is used in undergraduate classes (such as fish reproduction, aquaculture and conservation genetics) and as an outreach program for K-12. Moving these activities to production or supplementation hatcheries would be an inconvenience both to educators and to hatchery managers.

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/UW are writing the HGMP to cover all stock/programs produced at the UW/Portage Bay complex 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.

The listed salmonid populations in the region fall under the Puget Sound ESU. Realistically, the program would primarily affect populations in the Lake Washington watershed.

The state and tribes recognize natural-origin chinook populations in the Cedar River, North Lake tributaries and the Issaquah Creek;

- Issaquah creek contains a naturally spawning population that was probably founded by hatchery strays from Issaquah hatchery (the same founding stock as the UW chinook).
- Cedar river fish are native and are related to the Green River Basin fish.
- The history and status of the North Lake tributaries is not clear. Several hundred chinook are observed annually in North Creek, Bear Creek, and Cottage Lake. There are older reports of chinook in Lyons, McAleer, Thornton and Swamp Creeks.

Adult age class structure: Age information for naturally spawning chinook in the Lake Washington basin is very limited. The mean age ratio of chinook sampled at the Cedar River Sockeye Brood Stock collection weir in 1998 was 5.88% age 2, 23.53% age 3, 70.59 age 4, there were no age 5 or age 6 in the sample.

The *adult sex ratio* of sampled chinook in 1998 was 79% male and 21% female.

Size range: Age 3 adults averaged 65.5 cm and age 4 adults averaged 86.4 cm in 1998.

Migrational timing: Most naturally-spawned Lake Washington chinook migrate to salt water after spending only a few months in freshwater. Arrival of both hatchery and naturally produced smolts in the estuary peaks in late May, and after a few weeks, most begin moving to near-shore feeding grounds in Puget Sound and the Pacific Ocean.

Sexually mature fish begin arriving back at the Ballard Locks as early as June. The peak counts at the Chittenden Locks is usually in early to mid-August.

Spawn timing: The first redd observed in the Cedar River in 1999 was on August 18; however, there was no further spawning until September 7. Spawning activity peaks in early October and is generally complete by early to mid-November.

Spawning range: There are naturally spawning adult chinook in tributaries throughout the Lake Washington basin; however, their genetic origin is uncertain. There are genetically distinct chinook in the Cedar and possibly the Elwa Rivers. Adults spawn in the mainstream Cedar River from about river mile 1.0 in Renton to the City of Seattle water pipeline crossing at river mile 21.3. In 1999 81% of the chinook redds were observed above river mile 6.5. Big Bear/Cottage, Issaquah, and Kelsey creeks also have significant numbers of spawners. Recent genetic testing (1999 brood year) of Bear Creek chinook indicates that they are very similar at neutral genetic markers to the Issaquah Hatchery stock.

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

There are no chinook spawning in Portage Bay and therefore no populations directly affected by the program.

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

Issaquah (Lake Washington) Summer/Fall Chinook

Age information for naturally spawning chinook in the Lake Washington basin is very limited. The mean age ratio of chinook sampled at the Cedar River Sockeye Broodstock collection weir in 1998 was 5.88% age 2, 23.53% age 3 and 70.59 age 4. There were no age 5 or age 6 in the sample. The adult sex ratio of sampled chinook in 1998 was 79% male and 21% female. Age 3 adults averaged 65.5 centimeters (cm) and age 4 adults averaged 86.4 cm.

Most naturally-spawned Lake Washington chinook migrate to salt water after spending only a few months in freshwater. Juvenile chinook salmon appear to have two rearing strategies: 1) rear in the river (Cedar) and then emigrate to the lake in May or June as a pre-smolt, and 2) emigrate to the lake as fry in January, February or March and rear in the lake for several months (Tabor et al. 2004). Arrival of both hatchery and naturally produced smolts in the estuary peaks in June/July, and after a few weeks, most begin moving to near-shore feeding grounds in Puget Sound and the Pacific Ocean. Sexually mature fish begin arriving back at the Ballard Locks as early as June. The peak counts at the Chittenden Locks is usually in early to mid-August.

N. Lake Washington Tribs Summer/Fall Chinook, Cedar River Summer/Fall Chinook

There are naturally spawning adult chinook in tributaries throughout the Lake Washington basin, however, their genetic origin is uncertain. Adults spawn in the mainstem Cedar River from about RM 1.0 in Renton to the City of Seattle water pipeline crossing at RM 21.3. In 1999, 81% of the chinook redds were observed above RM 6.5 and the first redd observed was on August 18. Spawning activity peaks in early October and is generally complete by early to mid-November. Big Bear/Cottage, Issaquah, and Kelsey Creeks also have significant numbers of spawners. Recent genetic testing (Marshall, 1999) of Bear/Cottage Lake Creeks (N. Lake Washington tributaries) chinook imply that the population is a discrete, self-sustaining unit and are clearly distinct from the Cedar River chinook stock. It was also indicated that the Bear/Cottage Lake Creek stock is least differentiated from the Issaquah Hatchery (Green River lineage) population.

2.2.2) <u>Status of ESA-listed salmonid population(s) affected by the program.</u>

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

A preliminary viable population threshold for Lake Washington under ESA was determined by the Co-managers (Puget Sound) Technical Review Team (PSTRT) to be at 1,550 (PSTRT 2003). No critical population threshold has been identified. For Cedar River, preliminary critical and viable population thresholds under ESA have been determined to be at 200 and 1,200, respectively. The SaSI report (draft, WDFW unpublished 2002) determined this population (Issaquah (Lake Washington) Summer/ Fall Chinook) status to be "healthy" while the North Lake Washington tributaries and Cedar River Summer/Fall chinook stocks are "depressed".

- 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.

The table below details Lake Washington chinook brood year escapement, subsequent reconstructed run size, and return per spawner information for natural spawners in Bear/Cottage and the Cedar River mainstem. The source of this data is from WDFW run reconstruction tables.

Return Year	Run size	Brood Year Escapement	Return/Spawner
1988	2,769	1,252	2.2117
1989	1,832	949	1.9305
1990	1,214	1,470	0.8259
1991	1,517	2,038	0.7444
1992	1,407	792	1.7765
1993	321	1,011	0.3175
1994	924	787	1.1741
1995	969	661	1.4660
1996	345	790	0.4367
1997	305	245	1.2449
1998	700	888	0.7883
1999	791	930	0.8511
2000		336	
2001		294	

- 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.

The table below details "Live count Area Under the Curve" index spawning escapement estimates for the Cedar River mainstem, Bear Creek and Cottage Lake creeks. There is no expansion to non-surveyed sections or for fish not observed (WDFW data).

Return Year	Cedar	Cottage	Bear	System Total
1983	788	403	141	1332
1984	898	264	90	1252
1985	766	124	59	949
1986	942	386	142	1470
1987	1540	226	272	2038
1988	559	50	183	792
1989	558	208	245	1011
1990	469	161	157	787
1991	508	93	60	661
1992	525	75	190	790
1993	156	44	45	245
1994	452	186	250	888
1995	681	143	106	930
1996	303	6	19	328
1997	227	42	25	294
1998	432	192	73	697
1999	241	258	279	778
2000	120	97	130	347
2001	810	239	220	1,269
2002	369	146	122	637
2003	562	144	68	774

- 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.

There are initial estimates of hatchery-origin chinook (Issaquah Hatchery and Portage Bay) on the spawning grounds from 2003 returns (4 year olds). The 2000 releases (1999 BY) were 100% mass marked (adipose-fin clip only) so hatchery/ wild percentages may be calculated. For the Cedar River, estimates showed approximately 39% of all fish sampled were of hatchery origin. Issaquah Creek showed 72.2% and Bear and Cottage creeks had approximately 54% of fish on the spawning grounds being of hatchery origin. This could be expected because of their proximity to Issaquah Creek (Bruce Sanford, WDFW, pers. comm. 2004).

2.2.3) <u>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</u>

- 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.

Naturally spawned chinook adults that return to the UW hatchery are distinguishable (beginning with returns in 2003) from hatchery adults when the tagging program was implemented (see section 1.8). Therefore, it is unlikely that natural fish became part of the broodstock used for the hatchery program beginning in 2003. UW has an active policy of returning these fish to the Lake. Spawning activities occur three times a week in the pond from October 1 through December 15 and non-hatchery fish are released back into Lake Washington as soon as they are observed. It is possible that hatchery adults that do not return to the hatchery each year become part of the naturally spawning component of the listed populations, but annual releases from the UW hatchery are limited.

Smolts from the UW hatchery may compete for food with wild counterparts below the hatchery release site or in the Lake Washington system during their out-migration. Recent studies of the early life history and lake residency of chinook in Lake Washington by the Muckleshoot Tribe and USFWS (Tabor et al. 2004) illustrate the potential for competition between natural and hatchery-origin chinook. However, smolts from the UW hatchery are released downstream from natural spawning sites, and it is not clear to what extent these fish will interact with naturally produced chinook.

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

With all hatchery returns in 2003 being marked (see section 1.8), only chinook marked as hatchery stock were used for spawning. Any unmarked chinook returning to the hatchery pond will be released back into Portage Bay with as little handling as possible.

- 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).

All fish returning in 2003 and thereafter are 100% marked. Only marked fish will be used in the broodstock. All un-marked fish are released with little handling as possible.

- 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 Puget Sound hatchery will undergo a constant review for possible take situations. If the review indicates an unacceptable level of take, then a solution will be negotiated with management agencies.

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 hatchery program is not aligned with any specific ESU-wide hatchery plan. However, the research conducted at the hatchery does relate to ESU issues (see Section 12).

The Portage Bay Hatchery sub-yearling chinook salmon HGMP is included as one of 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 operations in the region.

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 (HSRG 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 Hatchery Reform Project, the 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.

The Portage Bay chinook hatchery project operates within the review of a committee comprising UW faculty and staff, UW/USGS co-op representatives and affiliate faculty from USGS and NMFS. The evaluation of the research program will be directly related to its relevance to ESU issues as well as to the biology and culture of salmonid species.

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 Indian fishing rights through the court-ordered Puget Sound Salmon Management Plan (PSSMP) (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.

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.

There is no directed harvest on this stock. However, incidental harvest may occur in the Lake Washington watershed. In years where tagging occurs, it is unlikely that listed fish are harvested while program fish are exploited, because fish from the hatchery are adipose fin-clipped.

3.4) Relationship to habitat protection and recovery strategies..

A major factor affecting natural production are losses at the Hiram Chittenden Locks at Ballard. There have been numerous improvements at the locks to improve downstream migration past the facility. Efforts have concentrated upon getting smolts past the facility without going through the filling culverts in the large locks. Operating procedures have changed during the spring and Corps of Engineers' (COE) personnel are now slowly filling the locks to reduce smolt entrainment. In addition to slow filling, there have been four smolt passage flumes installed at two of the spill gates to attract smolts and provide a safer exit from the forebay to salt water. There have been other improvements and a more detailed report is available from COE fishery biologists.

The Legislature, in 1999, created the Salmon Recovery Funding Board (SRFB) and, as indicated earlier, 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.

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).

The Lead Entity for Issaquah Creek (Sammamish Lake watershed) is King County (WRIA 8). It also covers the Cedar River watershed and Lake Washington. As work is completed (state and local resource management jurisdictions) on assessing the habitat factors limiting natural production and identifying and implementing habitat restoration and protection strategies in the Lake Washington watershed, WDFW will incorporate relevant information into this document.

3.5) Ecological interactions.

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

Relevant ecological interactions that might negatively impact the program in the pond and Portage Bay involve predation by 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
- Rainbow trout
- Smallmouth bass
- Largemouth bass
- Perch
- Lake trout
- Coho salmon

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 Portage Bay to the detriment of population abundance and the program's success in harvest augmentation. Species that may negatively impact program fish through predation may include:

- Orcas
- Sea lions
- Harbor seals
- River otters

There are ongoing predation studies in Lake Washington and the ship canal by the USFWS and the Muckleshoot Tribe to determine chinook losses by smallmouth and largemouth bass, perch, cutthroat trout and other predators. Concerns are that the predation losses are significant to both hatchery and natural chinook. Tabor et. al. (2004) reported that chinook in the Cedar River were mostly preyed upon by rainbow trout while

fry that were entering the lake were found to be consumed only by cutthroat trout, prickly sculpin, smallmouth bass and largemouth bass. Based on consumption estimates and expected abundance of juvenile chinook salmon, predatory fishes probably consumed less than 10% of the fry entering the lake from the Cedar River. In the ship canal, Tabor (2004) indicated that chinook smolts were most vulnerable to northern pikeminnow, smallmouth bass, and largemouth bass.

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).*

- Puget Sound Chinook

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

Invertebrate production in the lake and nearshore marine areas may provide an important initial natural food supply, acclimation to the natural environment, and an initial boost in growth before continuing early marine migration.

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 chinook. Nutrients provided by decaying chinook carcasses may also benefit fish in freshwater. These species include:

- Northern pikeminnow
- Coho salmon
- Cutthroat trout
- Pacific staghorn sculpin
- Numerous marine pelagic fish species
- Small and largemouth bass
- Perch

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.

Portage Bay hatchery utilizes three different water sources to rear fish. The primary source forthe facility is surface water drawn from Portage Bay. A well water source and domestic (city water) source are also utilized, depending on time of year, fish life stage and research needs. In addition the facility has a limited ability to warm surface water drawn from Portage Bay

Surface Water: Lake water is pumped from Portage Bay at up to ~2,200gpm. The volume fluctuates seasonally between ~800gpm and ~2,000gpm, depending on fish rearing requirements. Lake water temperature ranges between 7°c and 26°c, depending on the season, weather conditions and time of day.

Well Water: A ground water intrusion well located on upper campus provides the Portage Bay hatchery with ~120gpm. This water source is delivered via the campus utility tunnel system, resulting in a stable annual temperature of ~20°c. Well water is mixed with the facility's surface water source from January to April in order to maintain fish rearing water temperatures above 10°c.

Domestic Water: The facility has the capability to de-chlorinate and cold sterilize (1 micron. absolute) up to 12 gpm of City of Seattle domestic water. This source is primarily used for incubation of salmonid eggs. Temperature varies annually from ~6°c to ~20°c.

Heated Surface Water: Utilizing a heat exchanger and the available steam resource on campus, the facility has the capability to warm ~200gpm of the existing lake water supply. The lake water heat exchanger is capable of a maximum ∇T of ~25°c at 200gpm. This source is utilized from January to April in order to maintain fish rearing water temperatures above 10°c.

Year round production of most salmonid species and/or stocks is currently not possible at the Portage Bay hatchery due to elevated water temperatures during July, August and early September. Lake water pumped from Portage Bay is usually above 22°c for most of the summer months.

The water sources listed above are also utilized for instructional and research needs. For this reason, all of the facility's water resources are not typically available for salmonid production purposes.

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.

Because of pump house design, it is unlikely Portage Bay hatchery withdrawal of surface water will lead to any take of listed salmonid species. Surface water is drawn through a layered bed of gravel and sand approximately 5,000 sq. ft. in surface area and 2-3m deep. This type of intake has no perceptible intake suction and a maximum passable particle size of <100 microns, and meets the NMFS screening criteria. Portage Bay hatchery fish production is substantially less than the 20,000 pounds of fish per year criteria set by Washington DOE as the limit for concern of hatchery effluent discharge and the requirement for an NPDES permit. Due to relatively low fish production and the degraded ecological nature of Portage Bay, it is unlikely that discharge from the facility will lead to adverse effects on water quality or any take of listed fish.

SECTION 5. FACILITIES

5.1) Broodstock collection facilities (or methods).

Returning adult chinook are held in a pond, about 100 feet (35m) in diameter. The bottom of the pond is gravel. The water level varies from two to about 5 feet in depth (avg. depth 1.5 m). The pond is an extension of the Fisheries Center waterfront facilities, which in turn has a constant flow of circulating water pumped from Portage Bay. The chinook enter the pond via a small fish ladder connecting Portage Bay to the hatchery pond. The returning adult fall chinook are held in the pond for the remainder of their lives where the final process of artificial spawning is also performed.

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

N/A

5.3) Broodstock holding and spawning facilities.

Adult fall chinook are captured and held in the pond via a fish ladder. Spawning is performed on a concrete pad adjacent to the pond.

5.4) Incubation facilities.

Eggs are reared in Heath trays. Cold sterilized de-chlorinated domestic water is passed through a serial reuse system (a partially closed re-circulation system). About 5 gallons per min of water is delivered to the incubation systems. Each incubator system comprises 5 full stacks heath trays- we currently have 2 systems. Some “back up eggs” are raised in single pass surface water for supplementation of losses to the production and for research. Konnecki incubators are used for research work.

5.5) Rearing facilities.

Fry and fingerlings are reared in different facilities, according to stage of development.

Inside hatchery facilities: twenty-four troughs approx 30 feet long, 12 inches wide, 6 inches deep, four 6-4 feet diameter circular tanks, fifteen 3 ft diameter polyethylene circulars
Outside facilities: six 40 foot long by 5 feet wide by 4 feet deep concrete raceways. Gravel pond – depth changes to 2 meters (see 5.1).

5.6) Acclimation/release facilities.

Gravel pond (see 5.1).
Water sources: Portage Bay surface water – temperature varies between 10 to 16 degrees. Fingerlings are moved to the pond and exposed to lake water, as well as a small leak of hatchery effluent distributed via venturi to “scent” the pond.

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

There have been no recent events. One electrical and pump failure occurred about 10 years ago and fish were rapidly released. Fingerlings are released in May to correspond with increased invertebrate blooms as an increased food source. Occasionally, severe algal blooms result from increased sun exposure and water temperatures during this month. These blooms sometimes create the need to release fish early and can cause increased fingerling mortality as overnight oxygen levels decrease.

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.

We do not handle listed natural fish and there are no spawning populations in the vicinity. Alarm systems are in place to alert staff if an emergency (water loss, equipment failure, etc.) is occurring.

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.

It is important to emphasize at this point that the current runs at the hatchery may be replaced according to research needs. All replacements will be carried out with NOAA Fisheries and WDFW consultation.

6.1) Source.

Historically, broodstock were derived from fish returning to Soos Creek Hatchery, from 1949 until adequate numbers of return were accomplished in 1955. Thereafter, the stock has been self-sustaining with the exception of years in which chinook returns were low. In a low return year (1961), eggs from Soos Creek Hatchery and Issaquah Hatchery were transferred to the UW Hatchery (Fish Transfer Records, University of Washington).

6.2) Supporting information.

6.2.1) History.

The broodstock of the University of Washington fall chinook program originated from Soos Creek (Soos Creek Hatchery). Soos Creek Hatchery stock is understood to have originated primarily from Green River stock.

The donor stock originated from native Green River fall chinook salmon adults trapped in the mainstem river at the outlet of Soos Creek beginning in 1902 (Becker, 1967). Chinook salmon did not enter Soos Creek to any extent at the time that the trapping program began in 1902. An adult chinook return to Soos Creek of sufficient size to sustain juvenile chinook production objectives for the program was established beginning in 1924 and the trapping in the mainstem was abandoned (Becker, 1967). Some additional stocks were occasionally imported in the early days of the hatchery operation (e.g., Columbia river-origin chinook in the 1920's), but genetic analyses (Marshall et al., 1995) indicate that the contribution of these transferred, out-of-basin stocks was not significant.

Purposeful selection: The run was initiated with selection in mind. The originator of the run, Prof. Lauren Donaldson, intended that the run be used as experimental to demonstrate that a selectively bred “superior” line could be used to redress the fall in salmonid productivity experienced on the West Coast. Thus, the fish were initially selected for early return (return in three years as opposed to four), early migration and high fecundity. Following this early selection protocol, selection for shortened spawning cycle in the three-year olds was deemed the main goal. Selection protocols typically involved skewed sex ratios – a few two-year old males were used to fertilize the eggs of many females. At the fry stage, individuals demonstrating disease susceptibility, poor growth and malformations were removed (Hines, 1976). The program ended in the mid-60s, when research moved towards broodstock management. The chinook continue to be

selected for time of return (see section 2) and there is a visually-based selection for body size since high rate of return is the main goal (see 8.1). There are no other deliberate selection protocols.

Inadvertent selection: It is likely that early maturation has been selected against – on average, only 1-2% of jack males are used during spawning procedures. The stock has also been through a founder event and some bottlenecks, and it is possible that overall genetic variability in the run is reduced in comparison to its source population. A recent and thorough analysis of the historical data shows that the fish are smaller and less fecund than fish in earlier runs (Professors T.Quinn and V.Gallucci, University of Washington). It is not clear if this outcome is a result of inadvertent selection, long-term loss of genetic variability, or environmental conditions (the trend is reflected in other West Coast stocks).

6.2.2) Annual size.

The number of males and females used for broodstock has varied during the period 1988-1999, from 42 to 198 females and 23 to 197 males. The current goal is to use a 1:1 ratio, males to females. However, in years where there were few suitable males (2-4 year olds; the majority of the males returning during 1988-1991 were mini-jacks and during 1992, were jacks), males were mated 1:2 with females

The total number of chinook returning to the pond has ranged from 266 to 2,768. For a complete listing of annual total returns to the pond see "Run Size" Section 1.12.

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

Natural broodstock have been typically discriminated from hatchery broodstock using tagging methods. However, the level of tagging at the UW hatchery has varied. The majority of the hatchery chinook were tagged in some form from 1949 until 1988 (brood year). From 1988 to 1996, tagging was either not funded or not supported (funded) by the state. In 1996-1997 (brood year), the smolt production and some experimental fish were tagged with adipose clips and coded-wire tags. Even though the majority of the chinook released were marked, there was still a small proportion of fish released from the hatchery without marks. Thus, during these years, it is possible that naturally produced fish were incorporated into the broodstock although chinook produced from these releases are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 16, 2005). Finally, since 1998 brood year, all UW hatchery chinook were mass marked, so the returns in 2003 will be distinguishable from the natural chinook population.

6.2.4) Genetic or ecological differences.

There have been no clear studies to date to examine genetic differences between the UW run and natural stocks in the Puget Sound area. However, the following are known;

- the stock was derived from the Green River, via the Soos Creek Hatchery.

- the run was selected for certain life history and phenotypic traits soon after its founding. Thus, it is likely that the genetic variability at certain quantitative traits in the UW chinook differ from those in natural populations.
- finally, the run has undergone both a founding event and some bottlenecks during its history; therefore, the genetic variability within the run may be reduced relative to large, undisturbed natural populations.

Given past selection protocols, it is not surprising that phenotypic differences are observed between hatchery stocks and natural stocks in the target area. However, these phenotypic differences may also be a result of hatchery rearing conditions. Characters include:

Age at Maturity: Naturally spawning chinook in the Lake Washington basin comprises ages 2-4. UW hatchery chinook stock varies between ages 1-4, with some age-5, but the majority of the return spawners are age-3. Further, a new age class (age-1) is observed in the UW chinook stock. This shift of age classes by one year younger than the natural population is probably a product of increased growth rate through better diet and increased water temperature (early maturing males are not typically used in spawning; thus, it is unlikely that this outcome is a result of selection protocols).

Return timing: see 6.2.1

Size and Fecundity: UW chinook are smaller and less fecund than those returning to the Issaquah Hatchery. However, UW fish are raised at higher temperatures during their early life history and return a year earlier than Puget Sound stocks. The size and fecundity may be due to a combination of earlier return and genetic and environmental factors.

Upper temperature tolerance: Incidental information suggests that the UW chinook are more tolerant to higher temperatures than their wild counterparts. This may be a response to their early rearing conditions.

6.2.5) Reasons for choosing.

The stock was selected for historical reasons, rather than for any specific characteristic. The Green River Hatchery, constructed in 1901, provided the stock to establish runs throughout the Puget Sound region. The UW stock was derived from this stock, via the Soos Creek Hatchery.

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.

Chinook produced from these releases are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005).

We will seek to prevent spawning between naturally produced fish and UW stocks by avoiding crosses between these populations in the hatchery. Since the 1998 brood year, the UW hatchery chinook have been consistently mass marked to discriminate hatchery from naturally producing chinook.

SECTION 7. BROODSTOCK COLLECTION

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

Returning adult chinook salmon and their eggs will be collected at the UW hatchery pond during the spawning season.

7.2) Collection or sampling design.

Returning adult chinook are collected by beach seine from the UW hatchery pond (4.5 miles from Puget Sound), located next to the shoreline of Portage Bay, from the beginning of the run (late-September) to the end of the run (mid to late-December). Capture efficiency is 100%. All chinook salmon that enter the pond via the fish ladder remain until they mature and are spawned artificially. The chinook salmon are spawned three times a week (Mon., Wed., and Fri.). An allotted number of chinook are captured each week. Thus, a random representative sample of the broodstock source (~90 pairs) is collected throughout the spawning season. The broodstock are not selected based on any phenotypic criteria (but see the exception with early maturing males Section 6.2.4).

7.3) Identity.

a. Only one population of chinook returns to the hatchery
b. Hatchery origin fish are differentiated from natural fish by tagging.

7.4) Proposed number to be collected:

7.4.1) Program goal (assuming 1:1 sex ratio for adults):

The program goal is ~90 pairs of hatchery chinook with a release goal of 180,000 fish. If these 90 pairs produce approximately 4,000 eggs per pair, 360,000 eggs are produced with 180,000 excess eggs to compensate for mortalities that may occur throughout the rearing process.

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

Year	Adults			Eggs	Juveniles
	Females	Males	Jacks		
1991	78	48	3	270,969	0
1992	110	69	5	518,023	0
1993	77	73	1	336,219	0
1994	78	66	12	343,904	0
1995	114	107	5	475,070	0
1996	118	112	5	498,534	0
1997	198	196	1	542,071	0
1998	135	125	0	610,671	0
1999	147	129	0	578,963	0
2000	98	97	2	506,836	0
2001	87	82	1	484,621	0
2002	205	167	33	1,035,666	0
2003	252	250	4	1,080,586	0

Data source: UW hatchery database

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

Currently, surplus fish are anesthetized and the carcasses are disposed at the local landfill. Alternatively, by permission of WDFW, the surplus chinook salmon are released into bodies of water that are landlocked with no seawater access. Subject to WDFW approval, we propose that the surplus hatchery chinook be culled, sampled for virology, stored, and distributed to various co-op projects for nutrient loading in the Green River system or various Lake Washington Rivers and tributaries.

7.6) Fish transportation and holding methods.

Hatchery chinook are held in a return pond, about 50 yards in diameter. The water level varies from a couple of feet to about 5' in depth and has a constant flow of circulating water pumped from Portage Bay. The bed is gravel. The chinook enter the pond via a small fish ladder connecting Portage Bay to the hatchery pond. The returning adult fall chinook are held in the pond until they mature. Ripe fish are trapped by beach seining and are spawned on site.

7.7) Describe fish health maintenance and sanitation procedures applied.

A sample (usually 60 – 65 fish) of the hatchery chinook captured for broodstock will be virology tested in accordance with procedures set forth in the "Co-managers Salmonid Disease Control Policy (WDFW 1998). Artificial spawning will occur in sterile containers that will be cleaned and sterilized after each use.

7.7) Disposition of carcasses.

Spawned and unspawned carcasses are frozen and held for the next scheduled landfill dump. We propose that some of the spawned and unspawned carcasses be used for stream reseeding after they are tested for viruses and any other diseases. Should this proposal be supported, a carcass distribution report will be made for each distribution site.

7.8) 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.

Chinook produced from these releases are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005).

Returns to the pond are examined at least three times a week. Those fish that do not have UW hatchery marks will be released over the bulkhead into Portage Bay to spawn naturally, without injury.

SECTION 8. MATING

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

8.1) Selection method.

The main goal of the hatchery has been to maintain as small a run as possible to produce fish mainly for research. Thus, the current goal of the hatchery has been to generate a significantly higher return rate than other local hatcheries.

Spawners are selected 3 times a week, from mid-September to mid-December. In the past, females have been spawned artificially with males that are of equal or greater size and appear to be of similar health and fitness. (Future research directions will require that fish will be spawned randomly). Targets for egg production are usually met late in the season by replacing eggs that do not develop normally. A "rule of thumb" high-grade selection procedure has been employed.

The criteria for selection are as follows; Females - size, observed GSI, observed level of maturation, age class; Males- size, milt quality (observed level of maturation), observed body condition, age class.

Selection occurs anew each day - no fish are held over. Following selection, matings are randomized.

8.2) Males.

Attempts are made to spawn at least one male with one female (1:1). A limited number of chinook jacks are used for spawning. Repeat spawners are not anticipated in collection, but they may be used if their return rates are low.

8.3) Fertilization.

Females are spawned 1:1 unless there are too few male returns. Eggs and semen are mixed in a bucket, and hatchery water is added to complete the fertilization process. After 2-3 minutes, water is drained from the bucket, and iodine solution is added to sterilize the fertilized eggs. Chinook selected for broodstock are virology tested, and the buckets or containers used for fertilization are sterilized and cleaned after each use.

8.4) Cryopreserved gametes.

Currently, no cryopreserved gametes are maintained, but future research protocols may require this step.

8.4) 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.

Chinook produced from these matings are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005). See section 6.2.3

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.

Egg survival rate is estimated at approximately 80-90%. Fry survival after ponding is estimated at greater than 90 %.

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

Surplus eggs are taken as a safeguard against potential losses between egg and smolt development. However, if there are smolt surpluses that exceed the maximum release goal of 180 000, the excess are destroyed before release, or are used in experiments and then destroyed.

9.1.3) Loading densities applied during incubation.

Heath trays are loaded with a single female's total number of eggs, which usually average between 3,000-6,000 eggs per tray. Incubator flow rates are about 5 gallons per minute per heath tray stack. Egg size data is in the table below:

Season	Egg Size* # eggs per 6"			Egg Diameter (mm)			Egg Weight (g)		
	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
1988	18.3	22.1	16.9	8.4	9.0	6.9	0.33	0.40	0.18
1989	19.1	30.0	17.1	8.0	8.9	5.1	0.29	0.39	0.08
1990	18.6	20.9	17.0	8.2	9.0	7.3	0.31	0.40	0.22
1991	19.3	22.9	17.2	7.9	8.9	6.7	0.28	0.38	0.17
1992	18.5	21.2	16.1	8.2	9.5	7.2	0.31	0.47	0.21
1993	19.2	23.1	17.2	8.0	8.9	6.6	0.28	0.38	0.16
1994	18.3	21.8	16.8	8.4	9.1	7.0	0.33	0.41	0.19
1995	19.5	23.9	16.7	7.8	9.1	6.4	0.27	0.42	0.15
1996	19.2	21.8	17.0	8.0	9.0	7.0	0.28	0.40	0.19
1997	18.9	22.0	16.9	8.1	9.0	6.9	0.30	0.40	0.19
1998	18.5	21.1	16.6	8.3	9.2	7.2	0.32	0.43	0.21
1999	18.3	20.0	17.0	8.3	9.0	7.6	0.32	0.40	0.25

*In the table, "Egg Size" equals the number of eggs that would fit side by side in a row within a 6" trough. It is the inverse of Egg Diameter; when egg size is large, egg diameter is small. In this table, a large "egg size" value means that the egg diameter is small.

9.1.4 Incubation conditions.

- Minimum dissolved oxygen criteria – prior to hatching, at or near saturation. After hatching, DO about 8ppm.
- Nitrogenous wastes – input of de-chlorinated water is increased if detected above trace amounts.
- Silt – N/A
- Temperature regimes – 10-12°C
- Monitoring methods - Eggs are incubated using only de-chlorinated city water to minimize the risk of egg loss due to siltation and to variance in water temperature. Dead and dying eggs are removed by hand (described in 9.1.6) first within 24 hours of fertilization, again after being shocked once they have eyed-up, and again after hatching. These steps are taken to prevent the possibility of fungal growth, which in turn may cause further egg mortality, and reduce the availability of dissolved oxygen.

9.1.5 Ponding.

- Ponding dates are from late December through early February
- Swim up is volitional and ponding is forced
- The yolk sac is 90% absorbed
- No fork lengths or weights are taken.

9.1.6) Fish health maintenance and monitoring.

- Disease monitoring - daily mortality levels, fish inspected for external disease signs.
- Disease treatment- the fish are maintained in a manner where disease seldom occurs. We are an organic facility. If diseased fish are detected, we follow the advice of a WDFW fish health specialist on the course of treatment. Usually, the action followed involves immediate removal of diseased fish.
- Egg mortality removal methods – performed by hand using specially designed but standard metal tongs that have loops at the end of each tong for easier handling of eggs. Dead and dying eggs are removed as described in 9.1.4.
- Incidence of yolk-sac malformation - low
- Fungus control methods; the regular removal of dead or dying eggs and the use of de-chlorinated, cold sterilized city water reduces the incidence of fungus. (Filtered to 1 um absolute).

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.

The hatchery population is not included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005).

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..

Data still being analyzed.

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

- Density targets – maintain a maximum density of 2 kg fish per 1 gallon per minute (gpm).
- In grow-out pond –5 kg fish per 1 gpm.
- Density level reached – goals are reached

9.2.3) Fish rearing conditions

- Monitoring methods - performed on a daily basis, both visually and with the use of test equipment
- Temperature regimes – main aim is accelerated maturation, thus all fish except the surplus are held at a min of 10–13°C. Density and temperature are used to equalize the size of fish, to avoid grading fish. The temperature regime of pond is usually above 10°C. This temperature is not altered and will slowly increase during the year to 16°C maximum (the critical release temperature).
- Release – is dependant on local conditions and size and age of fish. Fish are placed in the acclimation pond when water is above 10°C and held until water reaches 16°C, usually in May.
- Minimum dissolved oxygen of the effluent – within 10% of saturation

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.

The data is available but not analyzed extensively. Fish are measured every 2 weeks, and on average, size doubles every 2 weeks. The growth rate is dependant on temperature and space availability.

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

See 9.2.4.

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*).

- Food type used - Moore Clarke, nutra plus, nutra fry, nutra 2000, nutra freshwater transfer.
- daily application schedule - to satiation 3-8 times a day, depending on life stage.
- food conversion efficiency - during rearing, less than 1:1 and sometimes as low as 0.85:1.

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

- Monitoring – see 9.1.6
- Treatment – see 9.1.6
- Sanitation of non fish-holding surfaces (floors, walls) – washed with quartnery ammonium solution once a week
- Sanitation of fish-holding surfaces (trough, circulars) - iodophore base solutions following manufacturers' recommendations, once fish are moved
- Sanitation of pond – gravel base – does not lend itself to sterilization. The best management practices are the cleaning of detritus and feces. The pond is hosed for a week with a fire hose and effluent is sluiced out. The pond is allowed to sit dry during summer. The pump is maintained dry for at least 2 months prior to fish reintroduction.

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

Gill ATPase activity is not monitored.

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

Not used.

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.

Chinook reared are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005).

SECTION 10. RELEASE

10.1) Proposed fish release levels.

Age Class	Maximum Number	Size (fpp)	Release Date	Location
Eggs				
Unfed Fry				
Fry				
Fingerling	180,000	22	May 23	Portage Bay, Lake Washington
Yearling				

Note: 22 fpp ~ 120 mm fork length

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

Stream, river, or watercourse: Portage Bay, WRIA 8
Release point: Latitude 47° 38' "55.14", Longitude 122° 18' "33.35"
Major watershed: Lake Washington
Basin or Region: Puget Sound

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

Release year	Fingerling	Avg size (fpp)	Yearling	Avg size
1992	157,276	30		
1993	153,234	23		
1994	194,713	25		
1995	201,024	23		
1996	180,047	31		
1997	160,976	27		
1998	118,419**	22		
1999	160,018	22		
2000	143,417	25		
2001	180,937	35		
2002	309,287	37		
2003	233,028	81		
Average	182,698	32		

Data source: UW Hatchery
**1998 fingerling releases are not the total released; data on one release group is missing.

10.3) Actual dates of release and description of release protocols.

The target fingerling release date is May 23rd. On this date, they are moved to the large pond where they can migrate on their own. This time coincides with historical spring peak plankton bloom in Puget Sound and should provide increased food availability for migrating smolts. Elevated water temperatures in Portage Bay sometimes necessitate early release: a surface water temperature above 16°C is considered a critical husbandry threshold.

10.4) Fish transportation procedures, if applicable.

Fish are not typically released off-station. Chinook were released in BY98 into Green Lake, a step authorized by WDFW. The fish were transported via a planting truck. There was no temperature control, the loading densities were appropriate, and the tank was oxygenated during transport.

10.5) Acclimation procedures

Fingerlings are moved to the pond and exposed to lake water, as well as a small leak of hatchery effluent distributed via venturi to "scent" the pond.

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

- 1988-1995 - none of the fingerlings were marked.
- 1996-1997 - 100% of chinook production was both coded-wire tagged and adipose fin clipped. Surplus fish were not marked.
- 1998 – 67% of the production was CWT and adipose fin clipped (see section 11). Remaining production – adipose-fin clip only. No surplus.
- 1999 – 100% of the production was adipose fin clipped only.
- 2000 – 100% of the production was CWT and adipose fin clipped.

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

Excess chinook will be destroyed. If permission is granted from WDFW, excess chinook may be planted in a land-locked lake (Green Lake).

10.9) Fish health certification procedures applied pre-release.

Fish are verified as healthy. Un-healthy populations have been destroyed in the past and surplus fish are used for the release. Un-healthy fish are not released.

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

Response is rapid and action is life stage dependant. We do not have an efficient procedure if the fish are still in the hatchery – a subset transferred by bucket. If the fish are in pond, the screen is withdrawn. The pond flows directly into Portage Bay and emergency release only requires the removal of the screen.

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.

Chinook produced from these releases are not considered a viable population segment in the Puget Sound ESU nor is the hatchery population included in NOAA Fisheries Hatchery Listing Policy (June 28, 2005). 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 in late May as fingerling smolts.

Smolts from the UW hatchery may compete for food with wild counterparts below the hatchery release site or in the Lake Washington system during their out-migration. Recent studies of the early life history and lake residency of chinook in Lake Washington by the Muckleshoot Tribe and USFWS (Tabor et al. 2004) illustrate the potential for competition between natural and hatchery-origin chinook. However, smolts from the UW hatchery are released downstream from natural spawning sites, and it is not clear to what extent these fish will interact with naturally produced chinook. The majority of naturally produced fish reared in the lake leave prior to release from the UW hatchery, whereas naturally produced fish that rear in streams and rivers leave post release.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

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

Note: See section 1.10 for Monitoring and Evaluation. The purpose of a 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, to allow for evaluation of each particular rearing and/or release strategy. 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. WDFW shall 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.

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

The UW collects and maintains basic phenotypic data on all fish returning to the hatchery. This data includes return date, length, weight, age at spawning, date of spawning, egg volume and tag returns. This long-term monitoring allows us, amongst other research activities, to respond to each performance indicator.

Objective 1, 2 and 3: reduction of risks associated with interactions between the UW research run and listed species.

1. Data is collected on the number of untagged fish returning, and the number of fish returned to the pond. Therefore, we are able to monitor the frequency of interactions between hatchery and wild fish.
2. Data on the return date is collected. Recently, our data has been compared to the dates that fish return to the Soos Creek Hatchery (source of the UW fish). It appears that the UW fish spawn later than their originating population, and that the objective of shifting the return date of the UW fish has been achieved to a large degree.

Objective 4 and 5: maintenance of a healthy and self-sustaining run – risks in loss of genetic variability and introduction of disease to wild populations.

1. Data on smolt-to-adult returns is maintained and evaluated annually.
2. A continual assessment of smolt-to-adult returns allows us to estimate the number of adults that should be spawned in order to maintain a healthy population.

3. The data maintained on return dates allows the determination of the peak and tails of the run – thus, we are able to maintain the differences in run timing during the spawning window we have selected.
4. All DNA data will be stored for long-term studies.
5. Survival data is maintained for all the juvenile life history stages. Similarly, the incidence of disease is also noted. Thus, we are able to continuously review our husbandry techniques and the genetic representation of crosses in our releases.

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

The School of Aquatic and Fisheries Sciences at the UW provides baseline funding. This funding supports staffing – additional assistance is provided in the form of hourly hires, researchers and graduate students in the School and interested external researchers. Implementation and monitoring is dependant on the processing and evaluation of all data. Evaluation, in turn, is dependant on hatchery staff and on researchers involved with the hatchery program. Recently, a greater interest in the historical data has grown with the construction of a database. This data will be maintained.

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.

All monitoring and evaluation occurs in the return pond or in the hatchery. Listed fish may return to the pond. The returns are examined every second day, and non-hatchery fish are immediately returned to the lake with minimal handling.

SECTION 12. RESEARCH

We describe two current and ongoing research projects in the hatchery. However, our facility has a strong research oriented program, and we suggest that our "Section 12" be reviewed frequently.

Project one: development of rearing strategies for juvenile salmon

12.1) Objective or purpose.

We conduct a variety of physiological experiments on chinook and coho salmon stock that returns to the UW pond. The broad goal of the work is to improve rearing of juvenile salmon in public hatcheries and develop technology for conservation hatcheries, including supplementation and captive broodstock. We do not envision that the research would have any negative impact on naturally rearing stocks. Results of the research should lead to potential success of conservation hatchery enhancing natural stocks, or at least minimize negative impacts of hatchery on wild fish.

12.2) Cooperating and funding agencies.

National Marine Fisheries Service, Bonneville Power Administration.

12.3) Principle investigator or project supervisor and staff.

Dr. Walton Dickhoff. Principal Investigator

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.

Fish are collected from the spawning pond at UW and offspring are used. Only marked fish are used.

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

Autumn

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

Fish are reared in closed re-circulating system at NOAA Fisheries Montlake lab.

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

No effects on listed fish anticipated.

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).

No take anticipated.

12.10) Alternative methods to achieve project objectives.

N/A

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

N/A

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. (e.g. "Listed coastal cutthroat trout sampled for the predation study will be collected in compliance with NMFS Electrofishing Guidelines to minimize the risk of injury or immediate mortality.").

N/A

Project two : Consequences of inbreeding in chinook salmon

12.1) Objective or purpose.

Research on Consequences of Inbreeding in Chinook Salmon

This research seeks to determine the relationship between the loss of genetic variability within a salmonid population and its consequences for fitness. Inbreeding depression, a reduction in fitness due to reduced genetic variability or to unmasking of deleterious recessive alleles, can result from matings between relatives within a population, and can further reduce genetic variability through the loss of genotypes from either genetic drift or selection. Inbreeding depression is a prominent concern in captive breeding programs for many species, including salmonids, because the small sizes of many of these populations create opportunities for inbreeding and loss of population viability to be accelerated.

Because of the relationship of inbreeding depression to genetic variation and fitness and the experimental scheme we designed to investigate it, this study seeks to address two primary objectives:

1) What are the life-historical consequences of close inbreeding in chinook salmon?
2) What are the genetic and environmental influences on quantitative traits affecting fitness?

This study is being conducted with Grovers Creek Hatchery fall chinook salmon (broodstock source: Green River Hatchery, 1978-1981) in Puget Sound. This research was identified in NMFS's Recover Protected Species Initiative as a key area of scientific uncertainty in salmon conservation. The primary benefit expected from this work is a substantially enhanced understanding of the consequences of reduced genetic variability for adaptive population characteristics.

Effects on listed chinook salmon in Puget Sound are possible but are not likely to adversely effect this species because of the small scale of the study. The primary potential effect on listed chinook salmon are straying of project adults into Puget Sound watersheds, and ecological interactions between project juveniles and listed juvenile chinook salmon in the Lake Washington watershed, Puget Sound, and the Pacific Ocean.

The research is described in greater detail in the attached work statement.

12.2) Cooperating and funding agencies.

National Marine Fisheries Service-Northwest Fisheries Science Centre, Bonneville Power Administration (funding agency).

12.3) Principal investigator or project supervisor and staff.

Dr. Jeffrey Hard, Northwest Fisheries Science Center (P.I.)
Dr Kerry Naish, School of Aquatic and Fishery Sciences
Mark Tetrick, University of Washington School of Fisheries Hatchery Manager
Dr. William Hershberger, USDA (formerly with the University of Washington)

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

Puget Sound chinook salmon ESU. Listed as Threatened, March 1999.

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

The following is a brief history and description of the project to date.

Establishment of the Base Population and Initial Breeding Design

Adult ocean-type ("fall") chinook salmon returning to the Suquamish Tribe's Grovers Creek Hatchery were spawned in 1994 to establish a conventional half-sib/full-sib family breeding design. The hatchery is located on the northern Kitsap Peninsula near Kingston, Washington. The breeding design we employed to establish the study on inbreeding depression is commonly used in animal and plant breeding to estimate genetic parameters that describe a population's ability to respond to genetic manipulation. This design permits estimation of genetic and environmental components of variance for a variety of

phenotypic traits, as well as providing a convenient means of establishing different levels of inbreeding in experimental groups within the population.

Grovers Creek Hatchery fall chinook salmon have been a self-sustaining hatchery stock since 1982; they were originally sourced from Washington Department of Fish and Wildlife's Green River Hatchery in eastern Puget Sound between 1978 and 1981. We collected adults to establish the experiment from fish returning to the hatchery, and sampled adults without regard to observed phenotypic characters through the use of a random numbers table

From 4-26 April 1995, Northwest Indian Fisheries Commission personnel marked 257,093 progeny of the chinook salmon adults spawned at Grovers Creek Hatchery with family-specific coded-wire tags (CWTs). These 1994-brood smolts represented 96 full-sib and 30 half-sib families. From 6-8 June 1995, NMFS personnel marked 50 fish from each of the full-sib families with uniquely coded passive integrated transponder (PIT) tags; we combined the 4,850 fish after marking at the hatchery, where we held them for approximately 10 days before transfer to seawater net-pens. We transferred the remaining 19,720 fish, which had already been marked with CWTs, into a similar pond and held them at the hatchery for an equivalent period. On 19-20 June 1995, we transported these smolts approximately 80 km to seawater net-pens at the NMFS Marine Experimental Station at Manchester, Washington in southwestern Puget Sound. We transferred fish in three groups: two groups of 9,860 fish each marked solely with coded-wire tags, and one group of 4,850 fish marked with PIT tags as well as coded-wire tags. We estimated mean fish weight at transfer (wt) from average fish weight on 28 May (wo, 8.3 g) and the exponential growth equation $w_t = w_0e^{rt}$, where r is the estimated growth rate of 1.5% per day and t is 22 days; estimated mean weight at transfer was 11.5 g.

Maturation of 1994-brood Parents

We sampled adults marked with CWTs and released in 1995 as they returned to Grovers Creek Hatchery in 1996-1998. From these returns we sampled marked experimental fish using body size and the absence of an adipose fin to determine which fish were part of the inbreeding study. We collected age, sex, fork length, and round weight data, as well as family-assignment information from their decoded CWTs. For females, we estimated total fecundity from volumetric measurements of the egg mass and collected individual samples of eggs for egg-size measurements. In addition, we collected tissue samples for later genetic analysis and took three digital photographs of each adult for morphometric measurements.

Maturation of 1994-brood parents was complete with the return of five-year-old adults to Grovers Creek Hatchery in September and October 1999. We established two broods of experimental inbreeding groups between 1996 and 1999; the 1997 brood, derived from three-year-old 1994-brood adults maturing in 1997 and the 1998 brood, derived from corresponding four-year-old fish maturing in 1998. We established both of these broods at the University of Washington's School of Fisheries Hatchery after transfer of unmixed gametes from either Grovers Creek Hatchery (hatchery-reared and released fish) or the

Manchester Station (captively reared fish). These groups developed to the juvenile stage in isolated full-sib family groups at the School of Fisheries Hatchery until they could be identifiably marked with either CWTs or PIT tags, at which time they were pooled into common raceways until transfer to sea water. The table below summarizes the marking data.

Summary of marking of 1997- and 1998-brood chinook salmon with coded-wire tags (CWTs) or Passive Integrated Transponder (PIT) tags at the University of Washington School of Fisheries Hatchery. Fish were marked with PIT tags from 19-22 May 1998 (1997 brood) or 6-9 April 1999 (1998 brood). Mean lengths and weights (± 1 SD) of the PIT-tagged fish were 85.2 ± 8.8 mm (n = 3,614) and 7.3 ± 2.6 g (n = 3,616) for the 1997 brood, and 87.4 ± 8.6 mm (n = 2,088) and 8.6 ± 2.6 g (n = 2,086) for the 1998 brood. Average weights for the 1997-brood CWT fish at time of marking were 8.4 g, 7.6 g, and 8.4 g for the full-sib, half-sib, and unrelated groups, respectively. Size statistics for the 1998-brood CWT fish at time of marking were not estimated.

1997 brood

Tag	*Cross type*	*No. marked*	*No. families*
PIT	Full sib	805	7
PIT	Half sib	1,483	11
PIT	Control	1,330	10
PIT	Total	3,618	28
CWT	Full sib	2,856	7
CWT	Half sib	3,830	11
CWT	Control	3,968	10
Total released		10,654	

1998 brood

PIT	Full sib	618	21
PIT	Half sib	750	25
PIT	Control	720	24
PIT	Total	2,088	70
CWT	Full sib	29,371	21
CWT	Half sib	26,021	25
CWT	Control	29,719	24
Total released		85,111	

Capture methods: Adults for broodstock are collected annually at the University of Washington School of Fisheries Hatchery rack beginning in 2000.

Samples collected: While in culture, juveniles are sampled non-lethally every few weeks to determine survival and growth rates and to evaluate morphometric variation. Samples are collected non-lethally from fish anesthetized with MS-222.

Tags applied: All project fish are marked as pre-smolts with either coded-wire tags (for smolt releases) or Passive Integrated Transponder tags (for captively reared fish).

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

First-generation returns of adults from these releases into Portage Bay are expected from 2000-2003. The total number of adults returning over this period is not expected to exceed 1,000 fish (assuming 1% smolt-to-adult survival to the rack), and is estimated according to the following maturation schedule for two different smolt-adult ratios (unpubl. data on Grovers Creek chinook salmon returns):

	No. 1997-brood adults		No. 1998-brood adults	
Year	*0.5%*	*1.0%*	*0.5%*	*1.0%*
2000	25	50	5	9
2001	27	54	200	400
2002	2	3	213	426
2003			9	17

Under the lower survival rate, 30, 227, 215, and 9 adults are expected to return in 2000, 2001, 2002, and 2003, respectively. Under the higher survival rate, 59, 454, 429, and 17 adults are expected to return in these respective years. Return and collection of adults at the University of Washington occurs annually in September and October, juvenile culture from September to May, with smolt releases or transfers made in May (beginning in 2002).

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

Adult chinook salmon returning to the Portage Bay Hatchery are recovered at the hatchery rack and sorted and evaluated for ripeness as per the Hatchery's protocol described elsewhere in this HGMP. Adults are held in the hatchery pond with other marked chinook salmon recovered at the hatchery rack and held for an equivalent period. All study adults are screened for Bacterial Kidney Disease (BKD); offspring of adults with high Elisa titers are destroyed. For study fish, fertilized embryos are incubated in Heath Tray stack incubators in an isolated incubation room using chilled water. Fry are then reared as separate individual full-sib families in small raceways, apart from the hatchery's regular chinook salmon production, until marking or transport to marine net pens. Marked fish to be transferred to marine net pens for captive culture are taken to the NMFS Manchester Marine Experimental Station at the smolt stage in a tanker truck designed for salmon transport.

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

Expected take from study activities is limited to interactions between project fish and listed fish in the wild. This take may take two forms: 1) direct or indirect ecological interactions between study smolts and pre-adults in the Lake Washington watershed, Puget Sound, and the Pacific Ocean, and 2) potential straying of study adults.

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).

Juvenile interactions in the Lake Washington watershed, Puget Sound, and the Pacific Ocean are expected to be limited because of the small scale of the infrequent releases. The largest release of project fish was in 1999, when 85,111 marked smolts were released as part of the hatchery's chinook salmon smolt production. No releases have since been made; the next expected release, depending upon the size and composition of the adult returns to the hatchery in 2001 (4-year-old adults from the 1998 release of 10,654 smolts and 3-year-old adults from the 1999 release of 85,111 smolts), will be in 2002. It is likely that this release will be of similar size to that in 1999. No direct mortality to listed fish is expected.

The extent of straying of chinook salmon released from the Portage Bay Hatchery as part of this research is not known, as the first adult returns from smolt releases are expected in 2000. However, inspection of the PSMFC coded-wire tag database for chinook salmon released from the University's Portage Bay Hatchery since the 1982 brood year (the first year of substantial marked releases from the Hatchery) indicate that observed straying of hatchery fish from this facility is low. Of 419 recoveries between 1986 and 1988, 3 fish strayed to other facilities. The stray adults were recovered at two hatchery facilities: Hoodsport (one adult recovered in 1985) and Capitol Lake (two adults recovered in 1986 and 1987). No marked fish from Portage Bay Hatchery releases have been recovered on natural spawning grounds, according to the database.

Under an assumption of a straying rate as large as 1% for project fish, the expected number of stray adults would be <1 fish in 2000, 2 fish each in 2001 and 2002, and <1 fish in 2003.

Levels of take are estimated in Take Table at end of HGMP.

12.10) Alternative methods to achieve project objectives.

Two alternative methods to evaluate inbreeding depression in Pacific salmon exist. One would involve collapsing the study's current design to a completely captive population. In this case, risk to listed fish would be limited to surviving fish that might escape from marine netpens. What would be lost under this scenario is the ability to relate consequences of inbreeding to environmental treatment (anadromous release vs. captive rearing).

The other alternative would involve reinitiating the study with another species or location. Commencing a related study would be valuable, but not at the expense of this one, now in its seventh year and beginning its "production" phase of information.

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

Mortality to listed Puget Sound chinook salmon from ecological interactions between study smolts and pre-adults in the Lake Washington watershed, Puget Sound, and the Pacific Ocean is not expected to be detectable. The number of study smolts released into the Lake Washington watershed is relatively small (less than 100,000 in 1999; next expected release in 2002, composed of similar numbers) and in the 1997 and 1998 broods composed about less than half of total chinook salmon production from the Portage Bay Hatchery.

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.

All project fish are released according to conventional University of Washington hatchery practices and in combination with the annual release of chinook salmon from the hatchery. All project fish will be marked with either coded-wire tags (for smolt releases) or Passive Integrated Transponder tags (for captively reared fish). The coast wide coded-wire tag database will be surveyed annually for recoveries of marked study fish straying to other locations.

SECTION 13. ATTACHMENTS AND CITATIONS

Becker, C.D. 1967. The Green River Hatchery, Washington: a historical and statistical review. Circular No. 67-1. Fisheries Research Institute. College of Fisheries, University of Washington. 37 p.

Hershberger, W.K., and R.N. Iwamoto. 1981. Genetics Manual and Guidelines for the Pacific Salmon Hatcheries of Washington. Univ. of Wash. College of Fisheries. Seattle, Wa. 83 pp.

Hatchery Scientific Review Group. 2004. Hatchery Reform; Principles and Recommendations of the Hatchery Scientific Review Group. Long Live the Kings, 1305 Fourth Avenue, Suite 810, Seattle WA.

Marshall, A., C. Smith, R. Brix, W. Dammers, J. Hymer and L. Lavoy. 1995. Genetic diversity units and major ancestral lineages for chinook salmon in Washington. IN Busack, C. and J. Shaklee (eds.), Genetic diversity units and major ancestral lineages of salmonid fishes in Washington, pp. 111-173. Technical Report # RAD 95-02. Washington Department of Fish and Wildlife. Olympia, WA.

Marshall, Anne R. 1999. Genetic Analysis of Bear Creek/Cottage Lake Creek Naturally Spawning Fall-Run Chinook. Washington Department of Fish & Wildlife Genetics Unit. 8 p.

Puget Sound Technical Recovery Team (PS TRT). 2003. (Draft) Independent populations of chinook salmon in Puget Sound - Puget Sound TRT public review draft (May 18, 2004 version). Northwest Fisheries Science Center, National Marine Fisheries Service. 92p.

Salmon and Steelhead Inventory (SaSI). 2002. Salmon and steelhead inventory - 2002. Introduction, Summary Tables, and North Puget Sound, South Puget Sound, Hood Canal and Strait of Juan de Fuca volumes. Fish Program, Science Division. Washington Department of Fish and Wildlife. Olympia, WA

Seidel, Paul. 1983. Spawning Guidelines for Washington Department of Fish and Wildlife Hatcheries. Washington Department of Fish and Wildlife. Olympia, Wa.

Seiler, D., G. Volkhardt, and L. Kishimoto. 2003. Evaluation of downstream migrant salmon production in 1999 and 2000 from three Lake Washington tributaries: Cedar River, Bear Creek, and Issaquah Creek. Report FPA 02-07. Washington Department of Fish and Wildlife, Olympia, Washington.

Tabor, R. et. al. 2004. Predation of juvenile chinook salmon by predatory fishes in three areas of the Lake Washington Basin. U.S. Fish and Wildlife Service, Lacey, Washington. 86 pp.

Washington Department of Fisheries (WDF). 1939. Annual Report for 1938. Washington Department of Fisheries. Seattle, WA.

Washington Department of Fisheries. 1991. Stock Transfer Guidelines. Hatcheries Program, Washington Department of Fisheries. Olympia, WA.

Washington Department of Fisheries, Washington Department of Wildlife and Western Washington Treaty Indian Tribes. 1992. Washington State Salmon and Steelhead Stock Inventory. Olympia, WA.

Washington Department of Fish and Wildlife. 1996. Fish Health Manual. Hatcheries Program, Fish Health Division, Washington Department of Fish and Wildlife. Olympia, WA.

Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes. 1998. Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Washington Department of Fish and Wildlife. Olympia, WA.

Washington Department of Fish and Wildlife and Puget Sound Treaty Tribes, 2002, "Puget Sound Chinook Salmon Hatcheries, Resource Management Plan", a component of Comprehensive Chinook Salmon Management Plan, August 23, 2002. 103 pages.

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)*-
Activity	UW Portage Bay ChinookFingerling Program
Location of hatchery activity	Portage Bay Hatchery, Lake Union
Dates of activity	September- May
Hatchery Program Operator	UW School of Aquatic and Fishery Sciences

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)	-	-	Less than 3	-
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	-	-

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.