HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Hatchery Program:	Skookum Creek Hatchery South Fork Early Chinook Program
Species or Hatchery Stock:	South Fork Early Chinook
Agency/Operator:	Lummi Indian Nation
Watershed and Region:	Nooksack River (WRIA 1) North Puget Sound
Date Submitted:	August 27, 2015
Date Last Updated:	November 25, 2015

Executive Summary

Development of land and resources in the Nooksack River Basin has reduced its capacity to provide a sustainable salmon harvest required to meet the treaty reserved right to take fish. Conservation concerns resulted in the 1999 listing of the Puget Sound Chinook Evolutionarily Significant Unit (ESU) as threatened under the Endangered Species Act (ESA), and the subsequent implementation of ESA Section 4 (d) protections have severely impacted Lummi treaty right fisheries. The SF Early Chinook hatchery program was developed and is overseen by a multi agency, multi-skilled, technical advisory team with the objective of restoring the South Fork Chinook to harvestable levels to meet the treaty reserved right to take fish.

Two naturally spawning early Chinook populations have been identified in the Samish Nooksack region. Both are part of the ESA listed Puget Sound Chinook ESU.

1. A North Fork/Middle Fork Nooksack population is currently designated as *Primary*. Spawning ground numbers have averaged 1,659 adults from 1999 to 2013, mostly of hatchery origin. Abundance of natural origin spawners has declined in recent years. This population is in the preservation phase of recovery (see Tables 3). An integrated hatchery program operated by WDFW supports this population. It is not the subject of this HGMP.
2. A South Fork Nooksack population also designated as *Primary*. Spawning escapement has averaged only 67 adults from 1999 to 2013. The SF Chinook population is in a preservation phase of recovery (see Tables 3), and the hatchery program that supports the population is the focus of this HGMP.

A non-native late timed (fall) Chinook population also currently exists in the Nooksack basin. The population is naturally spawning, and closely resembles Green River stock, but it is not known whether it is self-sustaining. The hatchery stock is not considered to be part of the Puget Sound Chinook ESU or included in NOAA Fisheries Hatchery Listing Policy (NMFS 2005, 2013 78FR38270).

There are also two segregated Chinook hatchery populations, the Lummi Bay and Samish hatchery populations. These populations are not part of the listed ESU. The effects of these programs on stocks of concern are contained in separate HGMPs.

The initial management goals for the Nooksack early Chinook populations are to contribute toward delisting of the Puget Sound Chinook ESU and to achieve an annual average tribal harvest of 1,000 adults, with a second intermediate goal of 3,000 Chinook from natural production. Progress toward these goals will be periodically reviewed to determine whether they are achievable. In the interim, Treaty reserved harvest of hatchery Chinook will be required to meet minimum harvest objectives, while simultaneously ensuring that the SF Chinook population is on a recovery trajectory for eventual delisting of the Puget Sound Chinook ESU.

The purpose of this hatchery program is to contribute toward these goals. After attempts to capture adults for broodstock failed, a captive brood program was developed for the purpose of initiating an anadromous recovery program. Half of the juveniles captured were reared to maturity in freshwater at Kendall Creek, the other half in sea water at NMSF Manchester Laboratory before being transferred to Skookum Creek Fish Hatchery for spawning, rearing and release.

Table 1. Data associated with the Captive Brood Stage of the SF Chinook Hatchery Program

Year	S.F. Nooksack NOR Escapement	Juveniles into Captive Brood	Captive Brood Females spawned	Smolt Numbers from Captive brood Released
2003	69	0	0	0
2004	29	0	0	0
2005	19	0	0	0
2006	61	0	0	0
2007	26	20	0	0
2008	80	414	0	0
2009	45	1,069	0	0
2010	24	760	2	0
2011	81	1,093	15	1,989
2012	121	1,045	91	32,677
2013	10	0	293	155,740
2014	0	0	189	677,410
2015	0	0	--	343,240

The SF Chinook hatchery program will be implemented in four stages. The purpose of the current stage (1a) is to develop broodstock for an anadromous hatchery program. Adults raised in captivity from natural origin juveniles assigned to the South Fork population by DNA analysis provide the brood to produce up to one million sub-yearling smolts for release. As hatchery broodstock use transitions from captive adults to anadromous hatchery origin recruits, the second stage (1b) will be initiated. In all stages, natural origin volunteers that can be assigned to the South Fork Chinook population will be incorporated into the broodstock to maintain genetic diversity. When the broodstock can sustain production between 300,000 and 400,000 sub-yearlings annually (stages 1b-2), up to 200,000 additional sub-yearling will be acclimated in the upper reaches of the South Fork to accelerate the repopulation of these areas as habitat is restored.

Table 2. Implementation stages of the SF Nooksack early Chinook hatchery program.

Stage	Recovery Phase	Brood Stock	Criteria to enter stage (triggers)
1a	Preservation	Captive Brood	
1b	Preservation	Captive and Anadromous HORs	Return of Anadromous HORs
1c	Preservation	Anadromous HORs	Return of Anadromous HORs all ages
2	Colonization	Anadromous HORs and available NORs	Spawning Population >2000 HOS and NOS
3	Local Adaptation	Anadromous HORs and NORs	NOS > 1000, R/S >1.25

Table 3. Target releases and disposition of projected adult returns. Annual releases will vary annually depending on number and access to returns of adults.

Stage	Recovery Phase	Release Target	HOR SAR*	HOR Return*	Terminal Harvest**	HOS*	PNI Criteria*	NOS *	NOR R/S*
1a	Preservation	To 1,000,000	.005	3,000	100	800	NS	100	1.0
1b	Preservation	400,000	.005	2,000	400	1,800	NS	500	1.0
1c	Preservation	400,000	.005	2,000	400	1,800	NS	500	1.0
2	Colonization	400,000	.005	4,000	1,200	2,600	NS	1,000	1.25
3	Adaptation/ Augmentation	200,000	.005	2,000	600	100	0.67	1,500	1.50

NS = Not Specified * General expectations averaged over several years and not annual triggers. ** From South Fork Stock (HOR and NOR)

The key management issues affecting the expected benefits of the program are:

1. Accelerate recovery of the SF Chinook population. Achieve an increasing trend in natural origin spawner abundance, thereby supporting the effort to delist the ESU as whole.

Solutions:

- Adopt a phased recovery approach based on biological triggers for phase shifts. The hatchery program will be sized and managed to:
    - Increase abundance and preserve the genetic identity of the SF population, while it is in the *preservation phase;*
    - Increase abundance, diversity and distribution of the SF population when it enters in the *colonization phase;*
    - Serve as a demographic safety net when the population enters the *local adaptation phase.* As the number of hatchery origin spawners on the spawning grounds decreases and habitat conditions improve, an increasing trend in natural origin spawner abundance and productivity can be expected.
- Implement monitoring programs to evaluate proportions of hatchery origin and natural origin South Fork Chinook in the hatchery, harvest and spawning grounds.

2. Support harvest goals for early Chinook.

Solution:

- Size hatchery programs in each phase to meet harvest as well as conservation goals in the preservation and re-colonization phases. Transition to a fully integrated program in the local adaptation phase and size the program consistent with harvest goals and HSRG standards for a Primary population is expected. This should:
    - Contribute to initial tribal target terminal area harvest greater than 1,000 adults annually;
    - Contribute eventually toward a tribal target terminal area harvest greater than 3,000 adults annually;
    - Contribute toward an increase in the allowable Southern US exploitation rate on Nooksack Chinook to not less than 15%, from the current 7%.

The key management issues affecting the expected risks of this program are:

1. Environmental risks
    - Water withdrawal impact on streams minimized
    - Intakes screened to avoid blockage of adults and entrapment of juveniles
    - Hatchery effluent discharges according to permit standards

    Solution: Monitor withdrawals, screens and discharges and ensure they are operated according to permits.

2. Fish Culture Risks
    - Best fish culture operational standards are met
    - Co-Manager Fish health standards are observed

    Solution: Document hatchery practices and file annual report.

3. Ecological Risks
    - Release timed for rapid downstream migration

    Solution: Volitional release of fully smolted juveniles of appropriate size during periods of natural high river flows.

4. Genetic Risk
    - DNA analysis of genome does not diverge significantly from baseline

    Solution: Sample tissues from natural origin spawners and migrants to evaluate through DNA analysis and incorporate broodstock that represent a natural temporal distribution.

HSRG broodstock management standards for Primary populations apply to the local adaptation phase (stage four of this program). Broodstock standards for contribution of hatchery fish to natural spawning do not apply to the preservation and colonization phases (stages one through three of this program) since preventing demographic extinction is a higher priority than fitness improvement (HSRG 2014).

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

Skookum Creek Hatchery/South Fork Nooksack Early Chinook

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

Nooksack South Fork Early Chinook (*Oncorhynchus tshawytscha).*
A population within the listed Puget Sound Chinook Evolutionarily Significant – Re-affirmed as Threatened in 5 year status review (NMFS, 2011).

1.3) Responsible organization and individuals

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

Agency - Involvement
WA Dept. Fish & Wildlife- Captive Brood Rearing, DNA Stock Identification, Oversight Committee
National Marine Fisheries Service –Captive Brood Rearing, Oversight Committee
Nooksack Indian Tribe - Oversight Committee
Northwest Indian Fisheries Commission - Fish Health, Spawner Pairing, Oversight Committee
US Department of Commerce - Funding Agency
US Department of Interior, BIA - Funding agency

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

Basic Skookum Hatchery operations are funded through the Lummi Indian Nation Natural Resources Program which receives its funding from the US Department of Interior.

There are four full time staff at the Skookum Creek facility. Two employees and their families live on the hatchery site. The hatchery is staffed 24 hours a day, 7 days a week.

The average annual operating budget for this program is $228,373.

The bulk of the funding for this program comes from the Department of Commerce, National Marine Fisheries Service Puget Sound Critical Chinook Program and is an obligation associated with the approval of the 2008 Chinook Annex to the Pacific Salmon Treaty. The cost associated with this program during the captive brood phase of operations was added to current annual operational costs at Skookum Creek Hatchery and is a portion of the $ 1.5 million annual budget submitted for the 10 year program. The funding has declined below expectation in recent years due to budget cuts.

Table 1.4.1: Fiscal year 2012-2015 funding for South Fork Chinook captive brood program.

Program	FY12 Enacted	FY13 Enacted	FY14 Enacted	FY15 Proposed
WDFW	$522,884	$491,903	$287,761	$499,651
NOAA Manchester	$514,599	$508,868	$433,695	$420,132
Stillaguamish Tribe	$287,814	$287,752	$252,616	$276,421
Lummi Tribe	$174,703	$211,477	$269,574	$303,831
Total	$1.5m	$1,424,250*	$1,243,646	$1,500,035

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

Skookum Creek Hatchery (Primary broodstock collection, rearing, and fish release site)
6498 Saxon Road
Acme, WA 98226
South Fork Nooksack River, RM 14.3, Nooksack River Basin, WRIA 1.246, just downstream of the confluence with Skookum Creek.

NOAA Manchester Research Station (Saltwater Captive Broodstock production site)
7305 Beach Dr. East
Port Orchard, WA 98366

Kendall Creek Hatchery (Freshwater Captive Broodstock production site)
6263 Mt Baker Hwy
Deming WA, 98244
Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the NF Nooksack River (WRIA 01.0120) at RM 46, Puget Sound, Washington.

1.6) Type of program.

Integrated Recovery Program (captive broodstock and supplementation) that will transition to an Integrated Harvest Program.

1.7) Purpose (Goal) of program.

Provide sustainable harvest to meet treaty reserved rights to take fish by promoting the recovery of one of two extant Chinook salmon populations native to the Strait of Georgia Biogeographical Region that must be recovered to a viable status before the Puget Sound Chinook ESU can be delisted (Shared Strategy 2005). The program will bolster the abundance and preserve the genetic diversity of South Fork Nooksack Early Chinook. Through the production of smolts, the program will increase adult returns of the natural origin population on the spawning grounds in successive phases that will increase natural production of the stock and eventually provide for increased contribution to the terminal area harvest as indicated below:

Table 1.7.1: Implementation stages of the SF Nooksack early Chinook hatchery program.

Stage	Recovery Phase	Brood Stock	Criteria to enter stage (triggers)
1a	Preservation	Captive Brood	
1b	Preservation	Captive and Anadromous HORs	Return of Anadromous HORs
1c	Preservation	Anadromous HORs	Return of Anadromous HORs all ages
2	Colonization	Anadromous HORs and available NORs	Spawning Population >2000 HOS and NOS
3	Local Adaptation	Anadromous HORs and NORs	NOS > 1000, R/S >1.25

Table 1.7.2: Target releases and disposition of projected adult returns. Annual releases will vary annually depending on number and access to returns of adults.

Stage	Recovery Phase	Release Target	HOR SAR*	HOR Return*	Terminal Harvest**	HOS*	PNI Criteria*	NOS *	NOR R/S*
1a	Preservation	To 1,000,000	.005	3,000	100	800	NS	100	1.0
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1c	Preservation	400,000	.005	2,000	400	1,800	NS	500	1.0
2	Colonization	400,000	.005	4,000	1,200	2,600	NS	1,000	1.25
3	Adaptation/Augmentation	200,000	.005	2,000	600	100	0.67	1,500	1.50

NS = Not Specified * General expectations averaged over several years and not annual triggers. ** From South Fork Stock (HOR and NOR)

As the stages of this implementation plan are achieved, it is expected that the following objectives will be met:

1. Improve SF early Chinook viable salmonid population parameters consistent with criteria to delist the Puget Sound Chinook ESU (Shared Strategy 2005).
2. Support an initial total terminal area tribal harvest of 1,000 Early Chinook.
3. Reduce constraints on Southern US harvest to 15% mortality from the current 7%.
4. Support a terminal area tribal harvest of 3,000 Early Chinook.

If goal 4 is not attainable within 12 years, the goal of supporting fisheries with natural origin early Chinook will be evaluated in light of the need to sustain the reserved right to take fish.

1.8) Justification for the program.

The loss of harvestable surplus naturally origin Early Chinook in the Nooksack Basin due to loss of critical habitat resulting from economic development has contributed to the listing of the Puget Sound Chinook ESU as Threatened under the Endangered Species Act. Protective actions under Section 4d of the ESA have greatly diminished Lummi's Treaty- reserved fishing Rights to take fish by practically eliminating directed harvest and severely reducing harvest opportunity on harvestable salmon surpluses within Lummi's traditional fishing areas. This program is an attempt to determine where a concerted program of supplementation and habitat restoration can restore natural productivity to a level that will support a harvestable surplus or whether supplementation will be required in perpetuity to meet the Treaty-reserved fishing Right. The harvest of hatchery fish from this program is part of the Lummi nation's Federally recognized Treaty Rights. The role of hatcheries associated with Treaty-reserved fishing Rights is to support four basic values recognized by the Federal courts: (1) conservation of the resource, (2) ceremonial, religious, and spiritual values, (3) subsistence values, and (4) commercial values. Until listed wild stocks are fully recovered, Lummi Nation fisheries will continue to depend on harvestable surplus of hatchery Chinook. This program attempts to restore natural production to a level that will support a meaningful Treaty-reserved fishing Right and mitigate for lost natural-origin fish production by producing Chinook salmon for restoration of the population and meaningful commercial, ceremonial and subsistence harvest and provides important population monitoring in marine and fresh waters while minimizing adverse genetic, demographic, or ecological effects on listed fish and other natural populations. This hatchery program is indispensable in the implementation of the Treaty Right to fish in the face of continuing loss of salmon habitat by degradation and climate change. As long as the Nooksack River and adjacent watersheds within the tribe's U&A fishing area are unable to maintain naturally self-sustaining levels of salmon that ensure that the Lummi Nation is able to harvest salmon in traditional areas

in sufficient numbers to carry out the promises of the Treaties fully, and the requirements of United States vs. Washington, this hatchery program will be an integral and indispensable component of our salmon management.

Besides providing fish for harvest, this hatchery program also supports natural resource management responsibilities consistent with Treaty Rights (e.g. US v Washington, PSSMP). The legal basis for Co-management of salmon in Puget Sound is based on the Puget Sound Salmon Management Plan (PSSMP), which was developed by the Co-managers and adopted as an order of the Federal court in 1985 (United States v. Washington, No. 9213 Phase 1 (sub no. 85-2) 1985). This program provides important monitoring, and supplementation of local salmon abundances, and integrates efforts and strategies of the WRIA 1 watershed recovery plan."

In addition to helping to meet treaty-reserved fishing rights and co-management responsibilities, this program will be managed to promote the recovery of ESA-listed Chinook in the Nooksack River basin through the supplementation of spawners on the spawning grounds, protecting the genetic characteristics of the population during the period of habitat restoration while providing provide harvestable surplus during a critical period in traditional fisheries fundamental to the Lummi Schelangen in the area of the Lummi reservation.

Catch objectives were being met when the total hatchery fall Chinook fingerling release in the watershed was between 16 and 20 million annually, with more than 8 million released in the Nooksack Watershed. This production was reduced to one million in the Nooksack watershed and a total of five million fall Chinook in the terminal area as a precautionary measure to reduce interactions with the ESA-listed Chinook. While the reduced production resulted in a significant decline in terminal area harvestable fall Chinook for Lummi, Nooksack and non-tribal fishers, it did not provide a quantifiable positive response (in productivity and abundance) of the listed Chinook populations as expected.

The South Fork Nooksack Early Chinook population is at high risk of extirpation due to low effective spawning population size (2003 – 2013 average 52 adults, range 10-114). The population has been able to maintain its genetic integrity despite sharing the South Fork Nooksack River with natural origin and hatchery origin North/Middle Fork early Nooksack and Samish Hatchery Fall Chinook (WDFW 2008). Both early populations must be on a recovery trajectory to allow the delisting of the Puget Sound Chinook ESU (Shared Strategy 2005).

An initial attempt to capture adult brood stock failed because of the low population abundance. This prompted the development of a captive brood program, using juveniles stock to initiate the program. Juvenile Chinook used for captive brood stock were captured in the South Fork Nooksack and assigned through DNA microsatellite stock identification analysis to the South Fork population. South Fork juveniles were transferred to Kendall Creek Hatchery for initial rearing prior to transferring half of the juveniles to the NMFS Manchester Laboratory for rearing to maturity in sea water while the remainder were raised to maturity in fresh water at the WDFW Kendall Creek Hatchery.

This program will increase the abundance of genetically diverse sub-yearling migrant South Fork Nooksack Chinook smolts. Program smolts will increase the ocean abundance of the stock to buffer predation and incidental fishing pressure on natural production and increase the abundance of prey items for the ESA listed Southern Resident Killer Whale population.

The increased return of the production from this program to the South Fork Nooksack River is expected to increase the proportion of South Fork Population Chinook and eventually displace other Chinook stocks on spawning grounds and rearing areas. An increasingly abundant South Fork Chinook stock will take advantage of gradually improved and restored habitat conditions. That will increase the population's productivity and set the population on a trajectory to recovery as a viable salmonid population capable of supporting a sustainable harvestable surplus.

This program is one of the eight "Early Action Items" in the WRIA 1 Salmon Recovery Plan (WRIA 1 SRB 2005) with the goal of preserving the genetic material of the population against the demographic risk of low population abundance and unforeseen consequences of habitat restoration actions implemented to increase habitat capacity.

1.9) List of program "Performance Standards".

Performance standards for the program are an increasing trend of South Fork Chinook population Natural Origin Recruits (NORs) on the spawning grounds compared with the abundance and spatial distribution on the spawning grounds prior to the initiation of the program. Returning adults from the hatchery program will be genetically similar to the historic/baseline natural population. As the natural spawning South Fork Chinook population achieves an increasing trend line, the co-managers will transition from a recovery hatchery program to an integrated hatchery program to support harvest without impeding recovery. As natural runs rebuild a viable salmonid population capable of a sustainable harvestable surplus, the natural stock restoration and integrated harvest programs would no longer be needed to support directed fisheries on the population.

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

See HGMP Section 11, Monitoring and Evaluation of Performance Indicators for details.

Table 1.10.1: "Performance Indicators" addressing benefits.

Benefits		
Standard	**Indicator**	**Monitor**
Program addresses ESA responsibilities	Approval of 4d Limit (6) exemption	Notification of Limit (6) exemption from Section 9 take prohibitions
Program fish are identifiable	Adipose fin presence, otolith mark, CWT, or genetic stock identification	Annual Report of Release Numbers and Marks
Release Survival Meets Standards	Numbers and proportion of releases that contributes to escapement and fisheries	Analysis of sample results from spawning grounds, hatchery return and all fisheries of program contributions
Program contributes to fulfilling tribal trust responsibility mandate and treaty rights under the Treaty of Point Elliott	Early Chinook spring fishery from April through July meets harvest objectives at program stage.	Total catch and days fishing reported annually.
Increasing numbers of Natural Origin Spawners (NOS) on the spawning ground.	Numbers of (NOS) on the spawning ground.	Annual estimate of the number of NOS on the spawning ground
The number of natural origin South Fork Chinook smolt migrants increases	Number of natural origin smolts	Annual estimates of NOR smolts at the Lower Nooksack smolt trap
Hatchery Origin Spawners (HOS) in the wild produce smolts comparable to Smolts from Natural Origin Spawners	Timing and condition of South Fork natural origin migrant smolts is similar	Annual evaluation of smolt timing and condition of natural origin and hatchery origin smolts at the Lower Nooksack smolt trap
Program eases restrictions in Southern US harvest rates	Southern US exploitation rate of NOR South Fork Chinook	Annual estimates of Southern US exploitation rate on Early Chinook
Effectiveness of Program Operations	Hatchery operations use the best available science to maximize survival and prevent disease Survival rates recorded at each stage of culture	Annual Report of Hatchery activities
Release Survival Meets Standards	Proportion of released production that contributes to escapement and fisheries	Analysis of program contributions to spawning grounds, hatchery return and all fisheries

Table 1.10.2: "Performance Indicators" addressing risks.

Risks		
Standard	**Indicator**	**Monitor**
The program uses standard scientific procedures to evaluate various aspects of artificial propagation.	Best available fish culture standards are utilized to maximize the production of the program and minimize risks associated with improper fish culture practices	Annual Report of Hatchery Operations
Hatchery facilities are operated in compliance with all applicable fish health guidelines and facility operation standards and protocols (Co-manager Fish Health Policy, INAD)	Hatchery records document compliance with applicable standards and criteria.	Annual reports indicating levels of compliance with applicable standards and criteria. Periodic audits indicating level of compliance with applicable standards and criteria.
Effluent from hatchery facility will not Adversely affect the ecosystem.	Discharge water quality meets NPDES permit standards.	Reports as required by NPDES permit in Annual Hatchery Report
Water withdrawals and in-stream water diversion structures for hatchery operation will not prevent access to natural spawning areas, affect spawning behavior of natural populations, or impact juvenile rearing environment.	Water withdrawals are compliant with water rights. Facility operates in compliance with applicable passage and screening criteria for juveniles and adults.	Annual record of water withdrawal and status of passage and screening include in Annual Hatchery Report
Releases do not introduce new pathogens and do not increase the levels of existing pathogens in local populations.	All State and co-manager fish health policies and standards are followed. Certification of fish health during rearing and release.	Report of compliance with fish health policies and fish health certifications contained in the Annual Hatchery Report
Any distribution of carcasses or other spawner products for nutrient enhancement is accomplished in compliance with appropriate disease control regulations and guidelines, including state, tribal and federal carcass distribution guidelines.	All applicable fish disease policies are followed.	Disposition of carcasses reported in Annual Hatchery Report.
The stray rate will not cause a significant change in the genome of the listed Chinook	DNA stock identification compared to the baseline	Statistics comparing stock genomes will not show a significant change
Competition by hatchery origin releases on natural origin salmonids does not significantly reduce numbers of listed natural origin salmonids.	Dates, size and location of release supporting rapid out migration	Records from hatchery operations contained in Annual Hatchery Report. Supplemental information from lower river smolt trap as available.

1.11) Expected size of program.

The current size of the program is determined by the mature captive brood available. The program will transition from captive brood to a brood composed of returning adults. The program is expected to peak at 1,000,000 sub-yearlings and then stabilize at 400,000 sub-yearling smolts until it can be established that natural origin migrants have reached levels that will sustain a viable salmonid population.

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

It is anticipated that the maximum annual brood stock collection will be no larger than 300 adult South Fork Early Chinook salmon (150 females and 150 males) recruiting to the Nooksack River watershed (Table 1.11.1.1).

Table 1.11.1.1: Implementation stages of the SF Nooksack early Chinook hatchery program.

Stage	Brood Stock	Brood stock	Criteria	Stage
1a	Captive NOBs	Original Captive Brood as available		Preservation
1b	Captive NOB and Anadromous HOBs	150 Female, 150 Males	Returning Females available	Preservation
1c	Anadromous NOBs	150 Female, 150 Males	No more captive brood	Preservation
2	Anadromous HOBs	150 Female, 150 Males	NOB as available,	Colonization
3	Anadromous HOBs	150 Female, 150 Males	NOR in brood stock to meet integration standards	Local Adaptation

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

Up to 1,000,000 yearling smolts per year released at RM 14.3 on the South Fork Nooksack River, left bank tributary to the mainstem Nooksack River at RM 36.6 (Table 1.11.1.2).

Table 1.11.1.2: Proposed annual fish release levels (maximum number) by life stage and location.

Stage	Life Stage	Release Location	Annual Release Level	Criteria
1a	Sub-yearling Smolt	RM 14.3 SF Nooksack River	To 1,000,000	Available
1b	Sub-yearling Smolt	RM 14.3 SF Nooksack River	200,000	Available
2a	Sub-yearling Smolt	RM 14.3 SF Nooksack River	200,000-300,000	Available
2b	Sub-yearling Smolt	Upper SF Nooksack River	200,000	Available
3	Sub-yearling Smolt	RM 14.3 SF Nooksack River	200,000	Available

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

This is a new program without sufficient results to project a smolt to adult survival rate.

We have made projections (in italics) of expected releases and returns based of general estimates for Chinook in this system (0.3% SAR, 30% Age-3, 70% Age-4)

Table 1.12.1: Projected releases and returns by age.

Brood Year	Release year	Numbers Released	Expected Return (.3%)	3 Year Old (30%)	4 Year Old (70%)	Catch Year	Expected Return
2010	2011	**1,989**	*6*	*2*	*4*	2014	*34*
2011	2012	**32,677**	*98*	*29*	*69*	2015	*209*
2012	2013	**155,740**	*467*	*140*	*327*	2016	*937*
2013	2014	**677,410**	*2,032*	*610*	*1,423*	2017	*1,732*
2014	2015	**343,294**	*1,030*	*309*	*721*	2018	*1,441*
2015	*2016*	*800,000*	*2,400*	*720*	*1,680*	2019	*1,680*

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

The program started with brood stock collection in 2004-2006, but was unable to collect maturing adults that could be assigned by microsatellite DNA analysis to the South Fork Population. A pilot collection of juvenile Chinook from the South Fork in 2006 assignable to the South Fork Chinook population demonstrated the feasibility of collecting sufficient unrelated individuals to initiate a captive brood program without increasing inbreeding.

Table 1.13.1: Juvenile Chinook Collected in the South Fork by Stock Assignment

Sample Year	North Fork Population	South Fork Population	Fall Population
2007	11	20	67
2008	769	414	2,211
2009	1,079	1,069	1,145
2010	771	760	3,565
2011	1,189	1,093	1,715
2012	1,551	1,045	1,300
Total	**5,370**	**4,401**	**10,003**

1.14) Expected duration of program.

The duration of the program depends on the achievement of the triggers for each stage of the program and upon the ability of the habitat to increase the productivity of the hatchery origin

spawners and the natural origin South Fork Early Chinook to a level that will produce a viable salmonid population concurrent minimal incidental harvest initially and to a sustainable level that will meet treaty reserved fishing rights.

The program is currently under the oversight of a Technical Advisory Team composed of fisheries managers, fisheries biologists, hatchery managers, and will be continuously evaluated as the program advances. As the program progresses and more information comes available, the Team will examine the available data and determine the most effective manner to proceed with the hatchery program to achieve the objective of a viable salmonid population that meets the trust responsibility for meaningful treaty rights fisheries.

1.15) Watersheds targeted by program.

Nooksack River, WRIA 1.246

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

Reduction in Harvest has not increased abundance or productivity.
Tribal harvest in the terminal areas has been restricted to the maximum extent possible since 1977, and other Southern US fisheries have been successively restricted with no discernible increase in the Early Chinook returning to the Nooksack River.

It has not been possible to reduce Canadian and Alaskan fishery exploitation rates to a point that will increase the abundance of Early Chinook to the terminal area.

The effects of all fisheries affecting listed Chinook salmon and steelhead in Puget Sound have been previously evaluated through a separate ESA consultation process (NMFS 2015).

Habitat Protection and Restoration has not been able to increase abundance or productivity.
Legacy effects of timber harvest, agriculture, the transportation network, and flood control have modified the ecosystem processes needed to create and maintain properly functioning Chinook habitat to sustain a viable salmonid population capable of meeting trust responsibility for sustainable treaty right fisheries.

Major limiting factors in the South Fork include high temperature, fine sediment and poor habitat diversity (WRIA 1 SRB 2005). The WRIA 1 Salmon Recovery Board has been coordinating habitat improvements to reduce the effects of these and other habitat limiting factors.

Reduction of Hatchery Programs has not increased abundance or productivity.
Fall Chinook releases from the river were stopped in 1999 and the terminal area fall Chinook hatchery programs were reduced by 66% with no quantifiable increase in the Early Chinook abundance or productivity.

Coho hatchery programs in the Nooksack and the terminal area were reduced by 75% without a quantifiable increase in the Early Chinook abundance or productivity.

The North Fork/ Middle Fork Early Chinook program was reduced by 50% and the release

strategies were changed to reduce straying of program fish into the South Fork, however there has been no quantifiable increase in the South Fork Early Chinook abundance or productivity.

A regular integrated program has not been possible to sustain.
The abundance of natural origin South Fork Early Chinook in the South Fork is too low to support a regular hatchery program.

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

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

None currently in hand specifically for the hatchery program. This HGMP is submitted to NOAA Fisheries for ESA consultation and determination regarding compliance of the plan with ESA section 4(d) rule criteria for joint state/tribal resource management plans relative to hatchery actions affecting listed Chinook salmon and steelhead.

The effects of all fisheries affecting listed Chinook salmon and steelhead in Puget Sound have been previously evaluated through a separate ESA consultation process (NMFS 2015).

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

2.2.1) Description of NMFS ESA-listed salmonid population(s) affected by the program.
- Identify the NMFS ESA-listed population(s) that will be directly affected by the program.

The South Fork Nooksack Early Chinook Population will be directly affected by this program and is one of two populations in the Strait of Georgia Biological Region that must be on a recovery trajectory before the ESU can be delisted.

Puget Sound Chinook (*Oncorhynchus tshawytscha*): The Puget Sound Chinook ESU was listed as Threatened on March 24, 1999 (NMFS 1999); Threatened status reaffirmed on June 28, 2005 (NMFS 2005); reaffirmed Threatened by five-year status review, completed August 15, 2011 (NMFS 2011). The Puget Sound Chinook salmon ESU is composed of 38 historically quasi-independent populations, of which 22 have been identified although they may not represent the population that used to be there historically. (Ruckelshaus et al., 2006). The ESU includes all naturally-spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Strait of Juan De Fuca from the Elwha River eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington, as well as twenty-six artificial propagation programs (Ford 2011). In the Nooksack basin, the TRT has identified populations in the North/Middle Fork Nooksack and South Fork Nooksack River (Ruckelshaus et al. 2006).

- Identify the NMFS ESA-listed population(s) that may be incidentally affected by the program.

Puget Sound Chinook (*Oncorhynchus tshawytscha*): The Puget Sound Chinook TRT identified 20 Chinook populations outside of the Strait Of Georgia Biological Region, they include the following:

Lower Skagit River
Upper Skagit River
Cascade River
Lower Sauk River
Upper Sauk River
Suiattle River
North Fork Stillaguamish River
South Fork Stillaguamish River
Skykomish River
Snoqualmie River
Sammamish River
Cedar River
Duwamish/Green River
White River
Puyallup River
Nisqually River
Skokomish River
Mid-Hood Canal Rivers
Dungeness River
Elwha River

Puget Sound Steelhead (*Oncorhynchus mykiss*): Were listed as Threatened under the ESA on May 11, 2007 (NMFS 2007) reaffirmed Threatened by five-year status review, completed August 15, 2011 (NMFS 2011). The DPS includes all naturally spawned anadromous winter-run and summer-run *O. mykiss* (steelhead) populations, below natural migration barriers in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington (Ford 2011). This DPS is bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), and also includes the Green River natural and Hood Canal winter-run steelhead hatchery stocks. In the Nooksack Basin, the TRT has preliminarily delineated one DIP of winter steelhead in the Nooksack River and one DIP of summer steelhead in the South Fork Nooksack River (PSSTRT 2013).

Natural-origin North Fork Spring Chinook, South Fork Nooksack Spring Chinook, Nooksack basin bull trout and Nooksack basin steelhead may be incidentally affected by the program. Incidental effects may include: genetic diversity reduction, competition, predation and hatchery screening-related effects. The extent to which listed Chinook salmon, steelhead and bull trout will be incidentally affected through these mechanisms by the hatchery program is not well understood.

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

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

All Puget Sound Chinook salmon populations are well below escapement abundance levels identified as required for recovery to low extinction risk in the recovery plan (Shared Strategy for Puget Sound. 2005). In addition, most populations are consistently below the productivity goals identified in the recovery plan as necessary for recovery. Although trends vary for individual populations across the ESU, most populations have declined in total natural origin recruit abundance since the last status review; and natural origin recruit escapement trends since

1995 are mostly stable (Ford, 2011). Several of the risk factors identified in the previous status review (Good et al. 2005) are still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat (Ford, 2011).

The hatchery stock propagated in the proposed HGMP is considered part of the listed South Fork Nooksack population, included in Puget Sound Chinook salmon ESU, and protected with the natural-origin component of the population under ESA provisions (NMFS 2014). NMFS (1999) considered the Kendall Creek hatchery stock to be part of the ESU, and listed with natural-origin Chinook salmon that are part of the North/Middle Fork Nooksack population (NMFS 2004; NMFS 2005). The hatchery program was started with natural-origin fish from the North Fork Nooksack River. The Kendall Creek Hatchery North/Middle Fork early Chinook supplementation program has increased abundance and distribution of spawners and comprises the majority of the North Fork population. The hatchery program has dramatically increased hatchery-origin Chinook natural spawner abundances, but natural-origin spawners have not steadily increased. A reasonable conclusion is that the main limiting factor for this population is poor habitat.

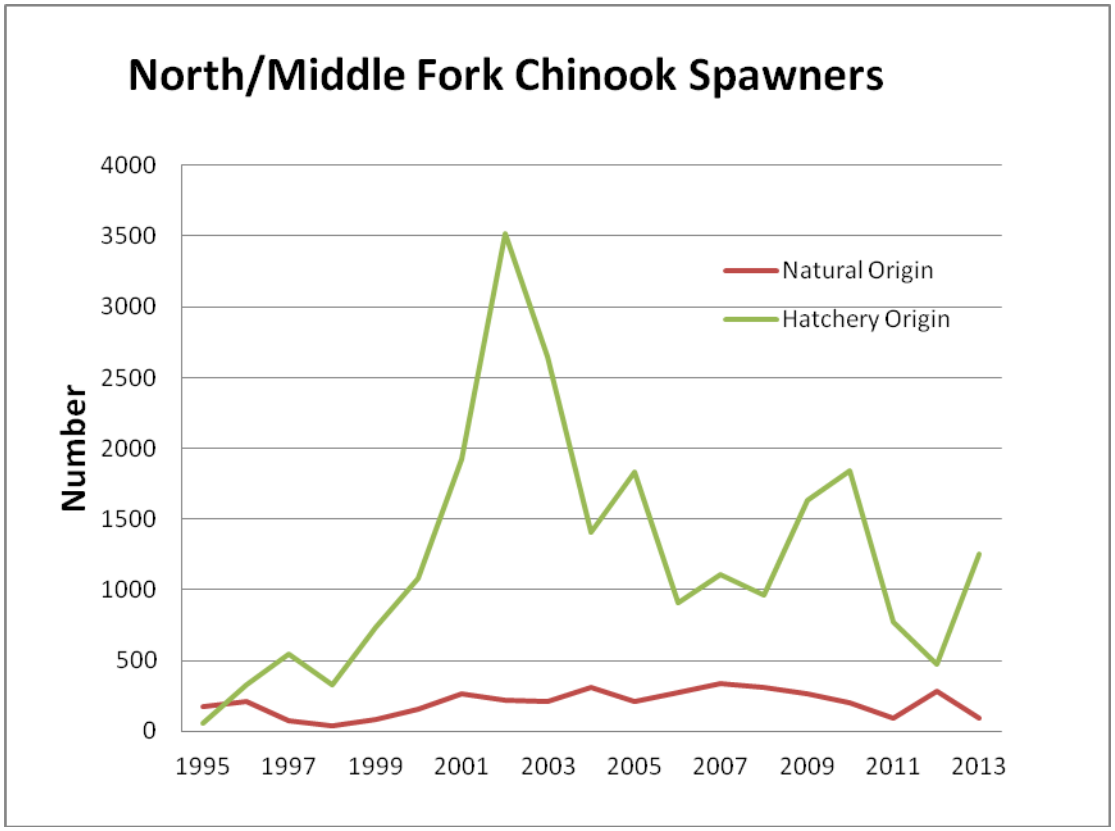

Figure 2.2.2.1: Natural origin spawners and hatchery origin spawners 1995-2013.

Driven by chronically low natural escapements, a restoration program for this locally indigenous population was developed using a strategy of increasing the numbers of juveniles released and subsequently increasing the number of returning spawners. Recent numbers of natural-origin spawners have been extremely low which emphasizes the importance of the hatchery component of this program as a reservoir for the genome while habitat is recovering. Since that time, the program has relied totally on volunteer returns to the hatchery. In the past, hatchery and wild fish were not entirely differentiated with distinguishing marks, so it was possible that wild fish

contributed to the broodstock at some level. Most North/Middle Fork Chinook salmon spawned in recent years have been of hatchery-origin. The proportion of natural-origin fish typically used in the broodstock is low and averaged 3.2 Chinook per brood year (WDFW unpublished otolith data). Recent escapement levels (2000-2011) have averaged 1,793 natural spawners in the North/Middle Fork Nooksack River DIP.

The South Fork Nooksack early Chinook population has averaged 52 (2003 – 2013 range 10-114) in recent years.

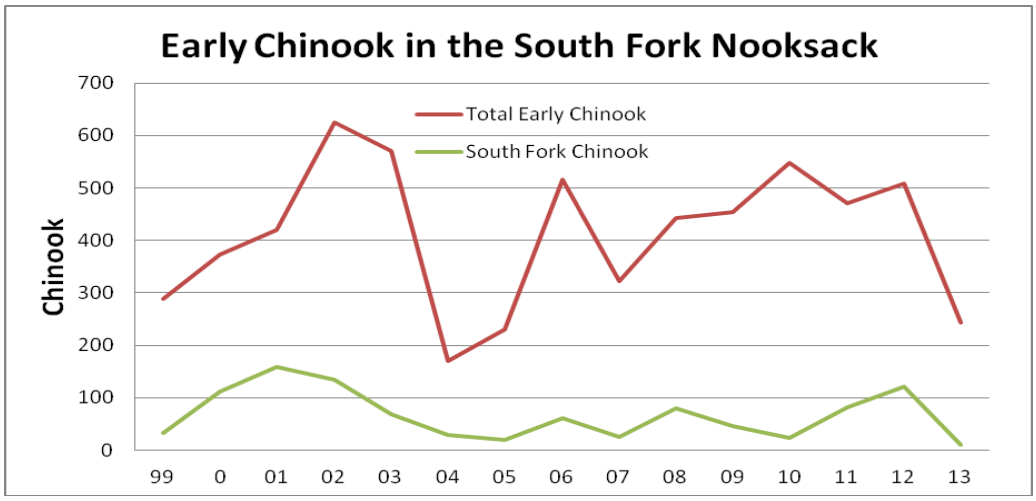

Figure 2.2.2.2: Natural origin South Fork Chinook relative to total early Chinook 1999-2013.

Nooksack System Steelhead: (*Oncorhynchus mykiss*) In 1996, the National Marine Fisheries Service (NMFS) listed a declining trend in the Nooksack River system of total escapement of –11.6 to –7.0, where trend is defined as percent annual change in total escapement or an index of total escapement (Busby et al. 1996). More recent expanded surveys conducted in this basin in 2003-2004, 2009/2010 & 2010/2011 indicated that a comparatively strong winter steelhead population exists (see escapement below). Summer steelhead spawn in the upper SF Nooksack River including upstream from RM 30.4, and are native with natural production and an unknown status (PSSTRT 2013; WDFW 2012). The level of hatchery winter run steelhead spawners in the Nooksack River is unknown, but thought to be low, as the program is modestly sized and there are no off station releases. Due to spawn timing differences between early Chambers stock steelhead and a majority of the existing wild winter population (being later February – June), interaction on the spawning grounds is unclear. Due to temporal and spatial separation from South Fork summer run steelhead, the potential for spawning ground interactions is even lower. There is little evidence of genetic introgression from Chambers and Skamania steelhead to natural origin Nooksack summer or winter steelhead (Warheit 2014).

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

Table 2.2.2.1: Nooksack early Chinook population average productivity for five-year intervals measured as recruits per spawner (R/S) and spawners per spawner (S/S). Trend over the intervals is also given.[a]

Brood Years	1982-1986		1987-1991		1992-1996		1997-2001		2002-2006		Trend	
Populations	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**
North + Middle Fork Nooksack	*5.56*	*2.52*	*2.83*	*1.28*	*0.61*	*0.39*	*0.55*	*0.31*	*0.32*	*0.11*	*-1.28*	*-0.58*
South Fork Nooksack	*2.01*	*0.93*	*1.3*	*0.62*	*1.6*	*0.99*	*1.66*	*0.94*	*2.99*	*0.92*	*0.23*	*0.03*
ESU	***9.57***	***2.19***	***5.05***	***0.96***	***3.01***	***1.24***	***2.70***	***1.19***	***1.67***	***0.67***	***-1.81***	***-0.28***

[a]This is from analyses reported by Ford (2011). These analyses incorporate assumptions for years where escapements were not sampled for hatchery: natural-origin ratios, and are not necessarily agreed to by WDFW and co-managers.

- Provide the most recent 12 year annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.

Conditions in the spawning areas the North/Middle Fork and South Fork Chinook spawning grounds make precise and accurate spawning ground estimates difficult. The co-managers have developed protocols for each population to provide spawning ground abundance estimates for each population. There are continuing efforts to identify new methodologies to relate the current estimates to a more accurate estimate of the spawning populations.

Table 2.2.2.2: Early Chinook Escapement 1999- 2013

Return Year	Chinook Escapement	
	SF Nooksack [b]	**NF/MF Nooksack (NOR+HOR)**
1999	32	823
2000	111	1,242
2001	159	2,185[a]
2002	135	3,741
2003	69	2,857
2004	29	1,719
2005	19	2,047
2006	61	1,184
2007	26	1,438
2008	80	1,266
2009	45	1,903
2010	24	2035
2011	81	865
2012	121	758
2013	10*	1347
Average	**67**	**1,659**

Source: Lummi Compilation of co-manager Data

[a]Additionally, 4,765 hatchery Chinook were returned to the N.F. Nooksack River.

[b]Represents S.F. native NORs only

* Represents a minimum estimate

Table 2.2.2.3: Lummi Hovander Trap Catch of Natural Origin Chinook 2006-2014

Year	Effort (min)	Zero	Yearling
2006	44,386	1,297	24
2007	58,724	365	23
2008	53,634	1,324	2
2009	43,006	877	64
2010	53,683	517	35
2011	60,522	1,659	15
2012	101,874	3,956	44
2013	106,104	2,415	92
2014	172,670	1,118	51

Source:Lummi Natural Resources data

Nooksack System Steelhead (*Oncorhynchus mykiss*): Fisheries co-managers revised the Nooksack winter steelhead escapement methodology in 2009. Glacial conditions make surveys difficult in the mainstem of the North Fork. A combination of aerial and ground survey are conducted to develop the estimate.

Table 2.2.2.4: Nooksack River winter steelhead escapement 2004-2014.

Return Year	Escapement
2004	1,574
2005	NA
2006	NA
2007	772
2008	NA
2009	NA
2010	1901
2011	1774
2012	1747
2013	1805
2014	1521
Average	**1585**

- 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.

Table 2.2.2.5: Short and long-term population trend and growth rate estimates for the Nooksack Early Chinook populations.

Regions and Populations	Years	Trend Natural Spawners w/Cl	Hatchery Fish Success = 0 Lambda w/Cl	p>1	Hatchery Fish Success = 1 Lambda w/Cl	p>1
Lower-North Fork-Middle Fork Nooksack Spring Run	1995-2009	1.092 (1.023 - 1.165)	1.082 (0.622 - 1.884)	0.84	0.607 (0.232 - 1.589)	0.05
	1984-2009	1.049 (0.995 - 1.106)	1.032 (0.909 - 1.172)	0.74	0.729 (0.571 - 0.93)	0.01
South Fork Nooksack River Spring Run	1995-2009	1.05 (0.995 - 1.107)	1.068 (0.507 - 2.251)	0.77	0.938 (0.388 - 2.269)	0.26
	1984-2009	1.006 (0.976 - 1.038)	1.009 (0.883 - 1.154)	0.57	0.927 (0.825 - 1.041)	0.07

Source Data: Ford 2011.

[a]This is from analyses reported by Ford (2011). These are based on analyses reported by Ford (2011) that are not necessarily agreed to by WDFW and the co-managers. "Lambda" is a measure of population growth rate. See Ford (2011) for explanation of the meaning of the columns.

Table 2.2.2.6: North/Middle Fork Nooksack early Chinook spawning escapements (*Oncorhynchus tshawytscha*) from 1998-2010.

Year	NF/MF Nooksack River		
	Natural-Origin	Hatchery-Origin	% of Natural Origin
1998	37	333	10%
1999	85	738	10%
2000	160	1,082	13%
2001	240	2,185*	12%
2002	224	3,517	6%
2003	210	2,647	7%
2004	318	1,746	18%
2005	210	1,837	10%
2006	275	909	23%
2007	334	1,104	23%
2008	307	959	24%
2009	269	1,634	14%
2010	204	1,840	10%
2011	96	769	11%
2012	281	477	37%
2013	91	1254	7%
Average	**210**	**1402**	**11.7**

Source: WDFW 2002, WDFW 2012, and Natasha Geiger WDFW 2012.

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

There are three Chinook stocks encountered during spawning ground surveys in the South Fork Nooksack River. The estimates are broken into hatchery and natural origin based on CWT and/or adipose fin clip, and the natural origin Chinook are further estimated by stock by DNA microsatellite tissue assignment.

Table 2.2.2.7: Estimated escapement of Chinook into the South Fork Nooksack by origin and stock.

Return Year	South Fork NOR	North Fork NOR	Fall NOR	Kendall Creek Hatchery	Other Hatchery	Total Natural
1999	32	0	127	90	39	288
2000	111	42	132	74	15	373
2001	159	51	65	138	8	420
2002	135	55	98	289	47	625
2003	69	0	150	210	162	591
2004	29	29	88	14	12	172
2005	19	56	56	32	70	233
2006	62	104	192	84	90	532
2007	29	44	128	112	35	348
2008	83	106	126	109	23	447
2009	45	58	187	128	38	456
2010	24	49	123	299	58	552
2011	81	82	114	172	32	481
2012	121	165	93	97	38	514
2013	10	30	22	162	19	243

Preliminary co-manager Data

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

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

Broodstock collection: Currently the brood stock is primarily provided by the captive brood that originated as juveniles collected from 2006 through 2011 that were assigned to the South Fork Chinook population. The captive brood is being supplemented by returning volunteers recruited to the hatchery holding area from the South Fork Nooksack River. Volunteers identified by DNA stock assignment to the South Fork population will be retained and PIT tagged for later identification. Volunteers identified by DNA stock assignment as the North/Middle Fork Chinook population NORs will be made available to the Kendall Creek North/Middle Fork Chinook program or transported to the Middle Fork Nooksack River and released to spawn there. Take will occur through broodstock recruitment, holding, handling and spawning. Effects will also include intentional lethal take for all adult fish retained as broodstock. To date, few natural origin adult SF Chinook have returned to the hatchery, but if encountered, those will also be included as broodstock.

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

fish (Steward and Bjornn 1990). Any potential impacts are addressed by rearing the Chinook at lower densities, within widely recognized guidelines, continuing well-developed monitoring, diagnostic, and treatment programs already in place (WDFW WWTIT 2006).

Juvenile releases (predation/competition): Potential take issues associated with hatchery juvenile Chinook released into the Nooksack River basin each year could include competition with, and predation on, naturally produced juvenile Chinook salmon or steelhead. The extent of any take is unknown, however, juvenile spring Chinook salmon are released through the program at life stages and sizes that are very similar to co-occurring wild smolt out-migrants, decreasing the likelihood for predation. Salmonid predators are generally thought to be able to prey on fish 1/3 or less their length (USFWS 1994). Chinook salmon are released in May as smolts to foster rapid migration to minimize freshwater residence time and potential competition with listed fish (Steward and Bjornn 1990). Additionally, hatchery reared chinook are unaccustomed to wild prey when released. Flagg et al. (2000), in reviewing the work of others, found that starvation is a primary cause of post-release survival in hatchery released salmonids. As discussed in Flagg et al. 2000, Myers (1980) found that hatchery chinook, examined shortly after release, were inept foragers compared to wild fish. They were also non-selective feeders, with most stomachs containing indigestible algae. The diets of wild and hatchery chinook only converged after extended residence in the estuary.

Genetic effects: The program has taken great care in founding the program from fish representing a number of families and reducing the potential for the program to reduce the genetic diversity of the population. The objective is to consistently meet broodstock requirements and have additional program fish return to spawn naturally consistent with the objectives of sustaining the minimum hatchery program until it is no longer needed. The genetic risks due to current population demographics are far greater than the genetic risks of the hatchery program. The Skookum Creek Captive Brood was derived from juveniles captured from the wild and genetically assigned to many different families. All captive brood mature Chinook are identified by a PIT-tag that is linked to the DNA microsatellite information that has been assigned to sibling relationships. After maturation is verified, a spawning matrix is constructed from candidates to maximize genetic distance between mating pairs and to avoid inbreeding. Adult Chinook that recruit back to Skookum Creek will be included for spawning with captive brood, and will also be evaluated for family relationships with the captive brood until no longer practical due to the abundance of returning HOB or lack of captive brood.

Monitoring effects: The Lummi smolt trap operation in the lower Nooksack River below Ferndale is considered in the monitoring plan, but is not specifically part of this program. It is currently operated under an ESA tribal Limit 7 permit.

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

The collection of juveniles involved capture by seine net in the South Fork Nooksack River and transport to the Skookum Creek hatchery where they were retained in holding troughs, then measured, tissue sampled and put in a numbered DNA vial, and fish held in a coded individual container until the results of the stock assignments were known (see WDFW 2008). Juveniles assigned to the South Fork early Chinook population were transported to the Kendall Creek Hatchery for initial rearing until half of them achieved a size suitable for transfer to the NOAA Manchester Research Station for rearing to maturity in sea water or retention on station at Kendall to be reared to maturity in fresh water. Juveniles assigned to other populations were released into the Nooksack.

South Fork Origin Early Chinook Brood Data

Table 2.2.3.1: Skookum Creek Hatchery Early Chinook Production

Year	Juveniles into Captive Brood	Captive Brood Females Spawned	Smolt Numbers from Captive brood Released
2003	0	0	0
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	20	0	0
2008	414	0	0
2009	1,069	0	0
2010	760	2	0
2011	1,093	15	1,984
2012	1,045	91	32,350
2013	0	293	154,840
2014	0	189	677,540
2015	0	0*	343,240

* 2015 Spawning data not yet available.

Table 2.2.3.2: Survival of Program Fish at Kendall Creek Hatchery (As of 12/2014)

BY	Juveniles received	Initial Mortalities	Manchester Transfers	After Transfer	Later Mortality	Mature fish	On Hand	Survival
06	24	0	0	24	3	21		87.5%
07	488	27	255	206	46	128	34	85.5%
08	1,017	28	508	481	13	373	60	92.5%
09	596	2	350	244	72	117	35	84.2%
10	1,081	35	442	604	359	57	132	58.4%
11	984	13	440	531	3	39	489	98.4%
Total	**4,190**	**105**	**1,995**	**2,090**	**496**	**735**	**750**	

Table 2.2.3.3: Survival of Program Fish at Manchester Laboratory (As of 12/2014)

BY	Smolt Stage	Smolts	Mortality	Matures	Estimate Remain	Actual N Remain	Survival
07	Zeros	53	33	20	0	0	37.7%
07	Yearlings	203	82	123	-2	5	59.6%
08	Zeros	259	87	159	13	6	66.4%
08	Yearlings	265	115	95	55	59	56.6%
09	Zeros	239	33	164	42	44	86.2%
09	Yearlings	175	45	112	18	19	74.3
10	Zeros	442	275	46	121	112	37.8
11	Zeros	440	239	10	191	192	45.7

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

Annual take levels of the listed fish are primarily associated with the spawning of NOB captive brood fish and NOB volunteers to the Skookum Creek Hatchery, with approximately 3-500 depending on program stage. Assuming that program fish will be added as ESA listed Chinook, there will be an expectation of 5-10% mortality of holding adults, and 10% mortality from the egg to juvenile stage.

- 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.

Hatchery practices will be continually monitored and adjusted according to outcomes according to best management practices.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1) Describe alignment of the hatchery program with any ESU-wide hatchery plan or other regionally accepted policies. Explain any proposed deviations from the plan or policies.

Lummi hatchery programs in Puget Sound operate under and adhere to *U.S. v Washington* that provides the legal framework for coordinating these programs, defining artificial production; objectives *Comprehensive Management Plan for Puget Sound Chinook* (WDFW/PSTT 2004).

This program one of the high priority early actions included in the WRIA 1 Salmonid Recovery Plan, to accelerate the restoration of the South Fork Early Chinook population (WRIA 1 SRB 2005). The WRIA 1 plan is integrated into the regional salmon recovery plan, the official NOAA Puget Sound ESU recovery plan (Shared Strategy 2005).

Hatchery Reform- Principles and Recommendations of the Hatchery Scientific Review Group. Lummi programs have considered suggestions this report provided, in 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) (see also HGMP section 6.2.3) have been incorporated into hatchery operations where appropriate.

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

This hatchery program and all other Lummi anadromous salmon hatchery programs within the Puget Sound Chinook ESU, operates under *U.S v Washington* (1974) and the *Puget Sound Salmon Management Plan* (PSSMP 1985), which provides the legal framework for coordinating these programs, defining artificial production objectives, and maintaining treaty-fishing rights.

Hatchery salmon and steelhead production levels are detailed in the Equilibrium Brood Document.

There are informal agreements between project partners on project operation and coordination. A Technical Advisory Committee composed of fisheries managers and biologists, hatchery managers, geneticists, and fish pathologists from all cooperating agencies (Lummi, Nooksack, WDFW, NOAA, and the NWIFC) meet quarterly to coordinate operations and ensure that the program is operated using the best available science.

See also HGMP section 3.1.

3.3) Relationship to harvest objectives.

The fish propagated through this program are primarily produced for population preservation purposes, and are not intended to enhance fisheries harvest beyond incidental harvests in limited culturally significant spring fisheries until the viability status of the South Fork Nooksack Chinook population improves. The effects of all fisheries affecting listed Chinook salmon and steelhead in Puget Sound have been previously evaluated through a separate ESA consultation process (NMFS 2015).

Tribal and non-Tribal fisheries directed at Chinook and other species produced through Lummi hatchery releases will be managed to minimize incidental effects to listed Chinook salmon. There is no directed harvest on the natural origin North/Middle Fork Chinook or South Fork Chinook salmon population in the terminal area. The in river terminal area harvest of Nooksack Early Chinook, will be restricted to surplus hatchery origin production until harvest can be supported by natural production. There is a mark-selective sport fishery in mixed stock areas.

Table 3.3.1: Target releases and disposition of projected adult returns. Annual releases will vary annually depending on number and access to returns of adults.

Stage	Recovery Phase	Release Target	HOR SAR*	HOR Return *	Terminal Harvest**	HOS*	PNI Criteria*	NOS*	NOR R/S*
1a	Preservation	To 1,000,000	.005	3,000	100	800	NS	100	1.0
1b	Preservation	400,000	.005	2,000	400	1,800	NS	500	1.0
1c	Preservation	400,000	.005	2,000	400	1,800	NS	500	1.0
2	Colonization	400,000	.005	4,000	1,200	2,600	NS	1,000	1.25
3	Adaptation/ Augmentation	200,000	.005	2,000	600	100	0.67	1,500	1.50

The Nooksack Early Chinook contribute to multiple fisheries in Alaska, Canada and the Southern US managed under the Chinook Annex of the Pacific Salmon Treaty (WDFW & PSTT, 2010). Based on coded wire tag recoveries and analyses the proportion of the exploitation rate in each fishery or group of fisheries can be estimated. The North/Middle Fork Chinook hatchery production is the indicator stock for Nooksack Early Chinook. Estimates of total exploitation rates for Nooksack early Chinook by calendar year are developed from the post-season Fisheries Regulation Assessment Model validation estimates. The current management regime sets an exploitation rate ceiling for Nooksack early Chinook in Southern U.S. fisheries set at 7%, though once in five years the Southern US exploitation rate identified in preseason planning may increase from 7% to 9%. Exploitation has averaged 3% to 4% in Southern U.S. fisheries (WDFW & PSTT 2010).

Table 3.3.2: Calendar year North/Middle Fork Chinook exploitation rate estimates by fishery

Year	Total	North	Pre-Terminal Southern US	Terminal Southern US
2001	22%	17%	2%	2%
2002	19%	17%	2%	0%
2003	19%	16%	2%	2%
2004	20%	16%	2%	2%
2005	21%	17%	2%	2%
2006	16%	11%	2%	2%
2007	20%	15%	2%	2%
2008	14%	11%	1%	2%
Average	**19%**	**15%**	**2%**	**2%**

Data Source: WDFW and PSTT 2010.

Each year, state, federal and tribal fishery managers plan the Northwest's recreational and commercial salmon fisheries to meet conservation and allocation objectives. The pre-season planning process, known as the North of Falcon (NoF) process involves a series of public meetings between federal, state, tribal and industry representatives and other concerned citizens. NoF coincides with meetings of the Pacific Fishery Management Council, which sets the ocean salmon seasons at these meetings based on needs for internal fisheries and escapements.

3.3.1) Describe fisheries benefitting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years, if available.

The program is not mature enough to support harvest, although this is anticipated to change in stages as the population increases. Although there is currently no directed commercial harvest on Nooksack early Chinook, there are fisheries (below) that benefit from the program. The long-term objective of the program is to recover the population's VSP parameters sufficiently to support sustainable tribal and non-Indian fisheries harvest. The current fisheries management objective is to minimize incidental harvest to a level that does not impede recovery. Catch is incidental in the Puget Sound sport fishery (<4%), net fishery (<2%), Canadian fisheries (<10%) and Alaska fisheries. There is a small selective fishery in the river that harvests approximately 300 early Chinook surplus to the needs of the Kendall Creek Program while releasing all natural production. Very conservative mortality rates for fish handled in the selective fishery are used to project mortalities to ensure that the impacts on the listed populations are within the agreed

range. A smaller non-selective fishery targeting surplus Kendall Creek Hatchery returns has a small incidental harvest of NOR Chinook.

Kendall Creek Hatchery Sub-yearling Early Chinook contributions to fisheries are used to estimate impacts on the South Fork Early Chinook population.

Table 3.3.1.1: Kendall Creek Hatchery Sub-yearling Spring Chinook Fishery Contributions.

Brood Years: 2000-2004 Fishery Years: 2004-2008		
	Average SAR%[a]	**0.30**
Agency	***Non-WA Fishery***	***% of total Survival***
ADFG	All	*2.9*
CDFO	All	*45.6*
NMFS	All	*0.0*
Agency	***WA Fishery***	***% of total Survival***
WDFW	10- Ocean Troll	*0.1*
WDFW	15- Treaty Troll	*1.1*
WDFW	23- PS Net	*1.4*
WDFW	42- Ocean Sport- Private	*0.3*
WDFW	45- PS Sport	*2.5*
WDFW	46- Out of Basin Freshwater Sport (Strays)[b]	*0.2*
WDFW	50- Hatchery Escapement	*26.2*
WDFW	50- Out of Basin Hatchery Escapement (Strays)[c]	*0.1*
WDFW	52- Out of Basin Fish Trap (Strays)[d]	*0.1*
LUMM	54- Spawning Grounds	*0.4*
WDFW	54- Spawning Grounds	*18.9*
WDFW	54- Out of Basin Spawning Grounds (Strays)[e]	*0.3*
	Total	***100.0***

Source: RMIS 2012. ; based off of expanded CWT data

[a] Average SAR% = (tags recovered/tags released)

[b] Freshwater Sport based on RMIS CWT data and is unlikely to fully represent the contribution to this fishery. Strays recovered in the Skagit River.

[c] Strays recovered at Marblemount and Wallace River Hatcheries.

[d] Strays recovered at the Baker River Trap.

[e] Strays recovered on spawning grounds in WRIA 4.

3.4) Relationship to habitat protection and recovery strategies.

The WRIA 1 Salmon Recovery Plan -The WRIA 1 Salmon Recovery Board was identified as the Lead Entity in the Nooksack River basin, with the passage of resolutions by the Nooksack Tribe, Lummi Nation, Cities of Ferndale, Everson, Lynden, Sumas, Nooksack, Blaine and Bellingham; and Skagit and Whatcom counties. The WR1A 1 SRFB has developed a long-term strategy to ensure the protection and restoration of healthy salmon populations. The WRIA 1 Salmon Recovery Plan (WRIA 1 SRB 2005) is integrated into the regional salmon recovery plan (Shared Strategy for Salmon Recovery). This "Shared Strategy" is the official ESA recovery plan (Shared Strategy 2005). This plan provides hypotheses on what is limiting our Chinook population productivity and abundances, identifies restoration actions to address these (with emphasis on

near term improvements given small population sizes) and identifies the need for regulations to hold our existing environmental baseline (WRIA 1 SRB 2005).

The WRIA 1 Salmonid Recovery Plan is undergoing a monitoring and adaptive management program to evaluate the progress to date and suggests changes in strategy as may be required. The focus in the first 10 years of the program operation has been to focus on addressing the limiting habitat factors in the Nooksack River basin through regulatory protection and implementing projects with near term benefits to restore habitat.

The Technical Recovery Team recommended that a South Fork Early Chinook hatchery program be developed similar to the North Fork Chinook program at the Kendall Creek hatchery to ensure that the gene pool of the population, which was at a significant threat of extirpation, was preserved while crucial habitat restoration was being implemented. (PSTRT, 2005) The Skookum Creek Chinook gene bank and supplementation program was one of the eight early actions identified in the WRIA 1 Recovery Plan Near-Term (10 Year) Salmon Recovery Actions (WRIA 1 SRB 2005).

3.5) Ecological interactions. [Please review Addendum A before completing this section. If it is necessary to complete Addendum A, then limit this section to NMFS jurisdictional species. Otherwise complete this section as is.]

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

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

Holding and migrating adult Chinook originating from the program may also serve as prey for large, mammalian predators in marine areas, nearshore marine areas and in the Nooksack River to the detriment of population abundance and the program's success in recovery. Species that may negatively impact program fish through predation may include:

- Orcas
- Sea lions
- Harbor seals
- River otters

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

- Puget Sound Chinook
- Puget Sound steelhead
- Puget Sound bull trout
- Puget Sound Coho

(3) *Salmonid and non-salmonid fishes or other species that could positively impact the program* - Fish or other species that could positively impact the program may include other salmonid species and trout present in the Nooksack watershed through natural and hatchery production. Juvenile fish of these species may serve as prey items for the Chinook during their downstream migration in freshwater and into the marine area. These fish may also reduce predation on Chinook by providing alternate prey for the predators.

Many watersheds in the Pacific Northwest appear to be nutrient-limited (Gregory et al. 1987; Kline et al. 1997) and salmonid carcasses can be an important source of marine derived nutrients (Levy 1997). Carcasses from returning adult salmon have been found to elevate stream productivity through several pathways, including: 1) the releases of nutrients from decaying carcasses has been observed to stimulate primary productivity (Wipfli et al. 1998); 2) the decaying carcasses have been found to enrich the food base of aquatic invertebrates (Mathisen et al. 1988); and 3) juvenile salmonids have been observed to feed directly on the carcasses (Bilby et al. 1996). Addition of nutrients has been observed to increase the production of salmonids (Slaney and Ward 1993; Slaney et al. 2003; Ward et al. 2003). With integrated spawning and any carcass seeding efforts, 2,000 adult Chinook carcasses (escapement goal) could contribute, assuming average size of adult Chinook is 18 pounds, approximately 36,000 pounds of marine derived nutrients to organisms in the river.

(4) *Salmonid and non-salmonid fishes or other species that could be positively impacted by the program.* - The Chinook program could positively impact freshwater and marine fish species that prey on juvenile and adult fish. Nutrients provided by decaying Chinook carcasses are also expected to benefit fish and wildlife. These species include:

- Southern Resident Killer Whale
- Black and Grizzly Bears
- Mink
- Otters
- Seals
- Northern pikeminnow
- Cutthroat trout
- Bull trout
- Steelhead
- Coho salmon
- Pacific staghorn sculpin
- Numerous marine pelagic fish species

SECTION 4. WATER SOURCE

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

Manchester Research Station

South Fork Chinook will be captive reared at the NMFS Manchester Research Station. The high quality seawater environment, combined with a 250-m pier made available to the station by the EPA Region X Laboratory, make the Manchester Research Station an excellent site for the culture of anadromous salmonids during their marine life history phase. Clam Bay is a major tidal mixing zone between Sinclair and Dyes Inlets to the west and waters of central Puget Sound to the east. Annual seawater temperature at the site normally ranges between 7-15°C and salinity ranges between 28-30 ppt.

A constant source of processed seawater is supplied to captive rearing tanks. Two 60 hp centrifugal pumps supply approximately 8,000 Lpm (2,100 gpm) of seawater through a 700 m long pipeline from the east end of the pier to the Station's land based facilities. The system is outfitted with a two back-up 50-hp pumps in case of primary pump failure. An alarm system monitors the pumps and electrical supply and is tied into an automatic dialer system linked to cellular telephones. Redundant emergency generators (330 KW each) are automatically serially activated in the event of a power failure.

The seawater supplied to the station is processed to prevent naturally occurring bacterial pathogens and parasites from entering the rearing tanks. Primary filtering consists of nine 1.9 m^2 deep-bed fiberglass sand filters. The filters use either a number 20-grade sand or number 25 glass micro beads as filter media. The sand filters remove all materials greater than 20 microns in size, and a portion of smaller materials. Immediately after leaving the sand filters the seawater enters six cartridge filter systems, which contain a total of 182 cartridge filters ensuring a filtration rate of 5 microns. To control for pathogens the seawater next passes through stainless steel UV chambers where it is irradiated with a UV dosage of 55,000 to 90,000 micro-Watts per second per cm^2. After UV irradiation, seawater goes directly to rearing tanks. Sensors monitor water flow and pressure through the seawater filtration system.

A secured rearing area containing 16.5 ft diameter circular tanks (with about 1,100 ft^3 of rearing space each) is available for use in the South Fork Nooksack River Chinook salmon project. Twelve tanks will be used. Juvenile South Fork Chinook fry transferred to the research facility from Kendall Creek hatchery will be acclimated with a mixture of fresh water and seawater. Chinook will be reared at a density not to exceed 0.5 pounds/ft^3.

Kendall Creek Hatchery

Kendall Creek Hatchery is supplied with well water at a constant year-round temperature 47°F. The South Fork Chinook are reared in pathogen-free well water that is a constant 47° F with a dissolved oxygen concentration of 11 mg/L. Well water passes through a packed column degasser filled with plastic bio-rings that break up the water to boost dissolved oxygen levels. The water right permit #s are G1-10562c and G1-2361c. The WDOE surface water right permit number is S1-00317.

Skookum Creek Hatchery

Skookum Creek Hatchery derives its water from two sources: Skookum Creek and ground water. Skookum Creek is the primary source of water, and is drawn into the hatchery by a screened diversion intake approximately 1,000 feet above the creek's confluence with the South Fork. A Washington State water right permit (WDOE #22899, 1983) allows the withdrawal of 40cfs from the Creek. Under the permit, minimum flows for Skookum Creek are 26cfs. Water flows from the diversion structure by gravity to a settling pond through a 36-inch underground pipe and then into the hatchery facility.

Water quality of Skookum Creek is variable through the year. The temperature of Skookum Creek water flowing to the hatchery typically ranges from 32°-65°F. High turbidity and low temperatures during the spring and fall months may limit use for incubation and early rearing purposes.

Four operational groundwater wells provide a secondary source of water to Skookum Creek hatchery. Total available ground water flow is limited to 480 gpm, which is far below the optimal level required by the hatchery. Ground water is used primarily for incubation and secondarily for early rearing.

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.

Manchester Research Station

The seawater supplied to the station is processed to prevent naturally occurring bacterial pathogens and parasites from entering the rearing tanks. Primary filtering consists of six 1.9 m^2 deep-bed fiberglass sand filters. The filters use either a number 20-grade sand or number 25 glass micro beads as filter media. The sand filters remove all materials greater than 20 microns in diameter, and a portion of smaller materials. Immediately after leaving the sand filters the seawater enters two filter systems, which contain a total of 148 cartridge filters ensuring a filtration rate of 5 microns. To control for pathogens the seawater next passes through stainless steel UV chambers where it is irradiated with a UV dosage of 55,000 to 90,000 micro-Watts per second per cm^2. After UV filtration, seawater goes directly to rearing tanks. Sensors monitor water flow and pressure through the seawater filtration system.

The facility complies with Washington State Department of Fish and Wildlife (WDFW) quarantine certification standards by depurating all effluent from the captive broodstock rearing areas by ozone treatment.

Kendall Creek Hatchery

A variety of preventative measures are in place to safeguard against catastrophic loss of SFNSC fish resulting from hatchery facility or operational failure. All rearing units have alarms that will alert staff of water loss and the hatchery facility is equipped with multiple back-up generators to provide power and water in the event of an outage. Kendall Creek Hatchery is staffed full time by personnel that live on the property, providing immediate response in the event of an emergency and offering protection from vandalism or theft. Fish are handled and transported according to the disease prevention and control standards set forth in the WDFW Fish Health Manual (1996). Biosecurity measures and sanitation procedures are followed to prevent the transfer and incidence of diseases.

Skookum Creek Hatchery

Skookum Creek where surface water is withdrawn does not harbor any listed fish populations, and no effects on listed fish associated with water withdrawal activities are expected. Regardless, screens at the intake at Skookum Creek are designed to avoid entrainment of juvenile fish. By 2018, new NOAA-approved fish screens will be installed once a funding source has been identified.

Waste water generated during pond cleaning and drawdown is routed to a series of pollution abatement ponds. Hatchery effluent is monitored according to current NPDES regulation and conforms to all permit requirements.

SECTION 5. FACILITIES

5.1) Broodstock collection facilities (or methods).

Returning adult broodstock are trapped and collected in Skookum Creek Hatchery's brood pond. Brood voluntarily enter the hatchery outflow channel from the river and ascend a short fish ladder to enter the brood pond. Brood are contained within a 90-foot long by 9-foot 6-inch wide pen until they are manually crowded and sorted into gender specific pens.

In the event that there are not enough volunteers from the returning captive brood stock production entering the hatchery to support the preservation and supplementation goals of the program, the option for collection of adults in the South Fork Nooksack will be evaluated. If there is agreement to proceed, protocols will be developed and implemented.

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

Captive brood are transported from captive brood rearing facilities at NMFS Manchester Laboratory and the Kendall Creek Hatchery in WDFWs 1,000 gallon transport truck and Lummi Nation's 1,000 gallon transport truck. Both vehicles are classified as 2 ½-ton vehicles and are equipped with bottled oxygen. Lummi Nation's truck is equipped with two 5 horse power water pumps which re-circulate water through sprayer bars located above the water line inside the tank.

5.3) Broodstock holding and spawning facilities.

Broodstock are held within gender specific pens in the brood pond until sexually mature. A 70-foot by 25-foot pole building at the top of the brood pond functions as the spawning facility. The spawning building provides cover for hatchery staff and provides a secure storage area for spawning and sorting equipment and materials, tag reading equipment, fish totes, and other related materials and equipment. Captive and returning broodstock may be held in the outdoor circular tank partial reuse system. This option will be employed to address over-crowding in the main brood pond, disease prevention or for improved control of water temperature (see section 5.3).

Accumulation of blood, eggs, milt, or other potential pathogen sources are washed into a drain that runs the length of the spawning building floor which empties to a septic system.

5.4) Incubation facilities.

The incubation facility at Skookum Creek Hatchery is separated into two isolated sections. The first incubation section houses 24 vertical incubation tray stacks for spring Chinook incubation and hatching. The second section houses 18 Nopad commercial incubators for coho production.

Both sections allow the use of creek or ground water, but creek water is used only for backup purposes. Quality of incubation water is monitored with a stationary YSI 5200A monitor/data logger. All head boxes contain low water alarm sensors which are tied into the hatchery's general alarm switchboard.

5.5) Rearing facilities.

Manchester Research Station

Rearing at the Manchester facility will extend from the fingerling and yearling stage to mature (3-8 year old) adult stage. Land-based seawater captive broodstock rearing will be conducted in a secured building with 7,100ft^2 of floor space for fish rearing tanks. The 7,100ft^2 seawater laboratory contains Twelve 16.5ft diameter circular fiberglass tanks for rearing of South Fork Nooksack Chinook captive broodstock. Water depth in the 16.5ft tanks is generally maintained at 5ft.

Before entering fish rearing tanks, the processed seawater passes through packed column degassers which are filled with plastic bio-rings that break up the water boosting dissolved oxygen levels and allowing excess nitrogen to off-gas, which can be present in pumped water situations. Water leaving the packed columns goes directly to individual tanks within the captive broodstock rearing building. In addition, each tank is directly supplied with oxygen to maintain life support in the event of an interruption in water flow. Seawater lines that have been inactive are thoroughly flushed for 24 hours before being used to supply water to culture tanks. This practice eliminates harmful metabolites that can develop in the lines when they are inactive.

Effluent seawater from rearing tanks is treated before it is returned to Puget Sound. MRS complies with Washington State Department of Fish and Wildlife (WDFW) quarantine certification standards by depurating all effluent from the captive broodstock rearing areas by ozone treatment. The ozone treatment system consists of four parts, 1) a below ground 3-chamber 25,000 gallon concrete depuration tank, 2) a recirculation pump system to move water from the depuration tank through the ozone building where the water is injected with ozone gas, 3) an air-cooled 6-module ozone generator capable of producing 360 g/hr of ozone, and 4) an ozone destruct system to control ozone off-gassing.

Kendall Creek Hatchery

Juvenile rearing - Upon arrival at Kendall Creek Hatchery, the South Fork Nooksack Natural Spring Chinook (SFNSC) juveniles were separated according to brood year. Groups of newly arrived fish were quarantined in a series of small aquaria and closely monitored for potential disease issues. The fish were immediately introduced to a diet of BioVita Starter, a high quality fish feed produced by Bio-Oregon. If the fish were healthy and eating well after two weeks, they were combined with the rest of their brood year in intermediate sized rearing vessels. Those intermediate vessels included a 200-gallon aquarium and four 6-foot diameter fiberglass tanks. Approximately one half of the fish in each brood year were transferred to the Manchester Research Station, some as sub-yearling age fish and the rest as yearlings.

Long-term freshwater rearing - SFNSC fish that remain at Kendall Creek Hatchery until maturation are reared in large outdoor fiberglass circular tanks. There are two 20-foot diameter and eight 16-foot diameter circular tanks that were installed specifically for the SFNSC captive brood program. The 20-foot circular tanks have 1,250 square feet of rearing space and the 16-foot tanks have 800 square feet of rearing space. Delays in permitting and construction resulted in the brood year 2006 and 2007 fish remaining in intermediate sized rearing units for longer than ideal. Maynard et al. (2012) stated that it is critical to rear captive broodstock Chinook in large units and at low densities in order to achieve high survival rates. Kendall Creek Hatchery staff observed higher growth rates and improved health upon transferring the SFNSC to the large circular tanks. The density index in the large SFNSC rearing units is kept at an average of 0.015. Flows range from 60 to 100 gpm in the circular tanks, depending on the size and number of fish in each tank.

Skookum Creek Hatchery

Rearing may occur in up to 4 locations on the hatchery complex: Indoor early rearing tanks adjacent to the egg incubation and hatching sections, outdoor concrete linear raceways, outdoor partial reuse circular tanks, and large outdoor grow out ponds.

Twelve 4'x4'x12' indoor rearing tanks are used to start fry on feed. Groundwater is exclusively used in early rearing to take advantage of low turbidity and warmer temperatures compared to water sourced from Skookum Creek.

Fifteen 8'x90' linear raceways are used primarily for coho rearing but have been used for spring Chinook rearing in the past and may be considered for future Chinook rearing if necessary. Ground water and Skookum Creek water are available in varying volumes for all raceways.

Twelve 5'x20' circular tanks are currently used exclusively for spring Chinook rearing. These circular tanks are operated on a partial reuse system that allows water to be delivered from ground water and Skookum Creek sources in variable volumes.

5.6) Acclimation/release facilities.

The program sub-yearlings are currently acclimated and released exclusively at Skookum Creek Hatchery. When sufficient South Fork Chinook stock return to the hatchery to support the supplementation program (150 pair), the Technical Advisory Committee will develop, for NOAA consideration, an off station sub-yearling acclimation/de-stressing program for implementation in the upper reaches of the South Fork to increase the likelihood of re-colonizing suitable spawning and rearing habitat throughout the system.

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

In 2014, 161 captive brood died at Skookum Creek Hatchery within 3 weeks of transfer from Manchester Research Station and Kendall Creek Hatchery. This mortality was attributed to a brood pond expansion project that resulted in uneven water flow through the pond, which resulted in inadequate formalin exposure in some parts of the pond. This issue has since been corrected.

There have been several instances of unexplained mortality events at Manchester Research Station. Extensive port-mortem examinations during these events have linked mortalities to

marine sponge colonies inside plumbing and tanks. Spicules released by sponges are thought to cause severe gill irritation resulting in death due to respiratory distress. Mortality rates of up to 30% for two different captive brood years occurred.

At present, two of the six total brood year populations have suffered losses due to BKD. Survival rates for the SFNSC fish reared at Kendall Creek Hatchery ranged from 63.5% in the brood year 2010 fish (which have experienced loss from BKD) to 99.4% for the brood year 2011 fish.

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.

Manchester Research Station

The Manchester Research Station is staffed full-time. The facility complies with Washington State Department of Fish and Wildlife (WDFW) quarantine certification standards by depurating all effluent from the captive broodstock rearing areas by ozone treatment. The ozone treatment system consists of four parts:

1) A below ground three-chamber 25,000-gallon concrete depuration tank,
2) A recirculation pump system to move water from the depuration tank through the ozone building where the water is injected with ozone gas,
3) An air-cooled six-module ozone generator capable of producing 360g/hr of ozone, and
4) An ozone destruct system to control ozone off-gas.

Security measures to protect all fish and property on the station include water flow, fire, and intruder alarms. Alarms are monitored through a security system linked to home and cellular telephones. A back-up generator automatically activates during power failures. Backup pumps are in place to maintain life support should a primary pump fail.

Kendall Creek Hatchery

A variety of preventative measures were enacted in order to safeguard against catastrophic loss of SFNSC fish resulting from hatchery facility or operational failure. All rearing units have alarms that will alert staff of water loss and the hatchery facility is equipped with multiple back-up generators to provide power and water in the event of an outage. Kendall Creek Hatchery is staffed full time by personnel that live on the property, providing immediate response in the event of an emergency and offering protection from vandalism or theft. Fish are handled and transported according to the disease prevention and control standards set forth in the WDFW Fish Health Manual (1996). Biosecurity measures and sanitation procedures are followed to prevent the transfer and incidence of diseases.

Skookum Creek Hatchery

The hatchery is staffed full-time with four full-time permanent employee and one half-time employee. Two permanent employees reside on-station in employee housing. All significant electrical water pumps, including well pumps and reuse pumps, are connected to failure alarms. Low water alarm probes tied to the central alarm panel are located in all head boxes and reuse sumps. Continuous temperature, pH and dissolved oxygen monitoring and data logging is located in the incubation, indoor early rearing and the partial reuse sections.

All incubators, raceways, tanks, and rearing ponds at the hatchery have been designed to operate with either ground water or gravity-fed Skookum Creek water allowing full operation of the hatchery in the event of a power outage. An 80kW backup diesel generator supplies power for all necessary electrical demand in the event of power outages.

Facilities on the hatchery complex are not located in areas subjected to flood events. A fish health specialist regularly monitors the health of fish held in the facilities and recommends prophylactic treatments to minimize loss and avoid pathogen transmission to natural origin fish in the watershed. Hatchery discharge is monitored according to NPDES permits.

SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

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

6.1) Source.

Only Chinook captured from the South Fork Nooksack River or its tributaries and identified through DNA analysis as having a high probability of being native South Fork Nooksack Early Chinook stock (WDFW 2008) will be used for broodstock.

6.2) Supporting information.

6.2.1) History.

The brood stock source comes from juveniles captured in the South Fork Nooksack River and identified through DNA analysis with a high probability of being native South Fork Nooksack Early Chinook stock. All NOR and HOR Chinook entering the hatchery grounds that are assigned to the South Fork Nooksack Early Chinook stock are added to the brood stock. All adults used as broodstock are natural-origin or hatchery-origin fish that are part of the listed South Fork Nooksack Chinook population.

Table 6.2.1.1: Transfer of South Fork Juveniles to Kendall Creek Hatchery.

Juvenile South Fork Chinook	
Brood Year	**Transferred to Captive Rearing**
2006	29
2007	447
2008	1,050
2009	696
2010	1,077
2011	1,044
Total	**4,343**

6.2.2) Annual size.

Initially the majority of the brood stock will come from the captive brood being raised at the WDFW Kendall Creek Hatchery and the NMFS Manchester Laboratory. Volunteer returning

South Fork Chinook entering Skookum Creek hatchery, identified through CWTs or DNA analysis as having a high probability of being native South Fork Nooksack Early Chinook stock will be included as they return and as the captive brood source declines. The preponderance of volunteers are expected to be from the returning hatchery releases, but both hatchery and natural origin volunteers will be included. The maximum number of 300 adults (150 females and 150 males), is expected to be required to meet a target release of 400,000 sub-yearlings. It is too early to project the proportion of the returning hatchery production that will enter the hatchery. All NOR volunteers or adults from the river to be included in the brood stock will have to be screened to ensure their South Fork Chinook identity.

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

The captive brood originated from the natural stock and the spawning protocols are designed to maximize genetic diversity. The Technical Advisory Committee will propose any actions required to include natural origin SF Chinook into the brood stock. Significant numbers of NOR South Fork Chinook are not expected to be important until returning captive brood stock progeny make up a significant portion of the natural spawning population in the South Fork. All NOR volunteers or adults from the river to be included in the brood stock will have to be genetically screened to ensure their South Fork Chinook identity.

6.2.4) Genetic or ecological differences.

The juveniles forming the captive brood were identified through DNA analysis with a high probability of being native South Fork Nooksack Early Chinook stock (WDFW 2008). The spawning protocols have been designed to maximize the diversity of the progeny in the sub-yearling release. All HOR and NOR volunteers or adults from the river to be included in the brood stock will have to be screened to ensure their South Fork Chinook identity. In the final stage of the program, it will operate as an integrated harvest program to avoid genetic divergence between natural and hatchery production.

6.2.5) Reasons for choosing.

The brood stock has been selected because of its high probability of being native South Fork Nooksack Early Chinook stock, which is the target stock for preservation and restoration.

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.

Broodstock for this program were founded from a large number of juveniles representing a diversity of families identified through DNA analysis with a high probability of being native South Fork Nooksack Early Chinook stock. Because the genetic profiles and family origins of all captive brood, identified by unique PIT tags, are available, a computer database will assign spawning matches to ensure the greatest genetic diversity at the time of spawning. The risk of genetic diversity loss during the captive brood phase of the program will be reduced by using genetic data to ensure that siblings and half siblings are not spawned together. Broodstock collection of returning adults will occur in a manner that is representative of the overall age and temporal distribution of all fish that have returned that are identified through mark recovery or genetic analyses as being South Fork Nooksack Chinook salmon. When necessary, the Technical

Advisory Committee, in consultation with NOAA, will develop the protocols to ensure that South Fork Chinook in excess to broodstock requirements are returned to the river in a manner that will maximize their contribution to the natural spawning population.

SECTION 7. BROODSTOCK COLLECTION

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

Sub-yearling and yearling juveniles were collected to establish and continue captive brood program.

As the program matures, HOR and NOR adult South Fork Chinook returning to the hatchery will be collected and used for broodstock. If necessary HOR or NOR South Fork Chinook may be collected in-river to supplement the program broodstock according to recommendations of the Technical Advisory Committee.

7.2) Collection or sampling design.

The captive brood portion of the program was established from Chinook juveniles collected in the South Fork Nooksack and assigned to the South Fork Chinook population by DNA microsatellite analysis (WDFW 2008). Returning progeny of the captive brood entering into the hatchery facility are expected to provide the broodstock to continue the supplementation program, with contingency provided for collecting adults from the South Fork, if necessary. All HOR and NOR volunteers or adults from the river to be included in the brood stock will be identified with real time CWT reads or genotyping to ensure their South Fork Chinook identity.

In the future when broodstock can be comprised exclusively from returning volunteers, the collection will take place throughout the return time to represent the entire run.

7.3) Identity.

All adults included in the broodstock will be identified through tissue DNA microsatellite stock assignment or CWT-tagged fish with an intact adipose fin. Real time reading of CWTs from broodstock post-mortem but prior to fertilization will assure that Samish fall Chinook double index tag group strays are not inadvertently included in the brood stock. NOBs will be identified with a DNA microsatellite stock assignment to avoid the incorporation of North/Middle Fork Chinook.

7.4) Proposed number to be collected:

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

The current size of the program is determined by the mature captive brood available. The program will transition from captive brood to a brood composed of returning adults. The program is expected to peak at 1,000,000 sub-yearlings and then stabilize at 400,000 sub-yearling smolts until it can be established that natural origin South Fork Chinook spawners have reached levels that will sustain a viable salmonid population. The maximum number of 300 adults (150 females and 150 males), is expected to be required to meet a target annual release of 400,000 sub-yearlings after the exhaustion of the captive brood.

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

Table 7.4.2.1: South Fork Origin Early Chinook Brood Data

	Captive Brood	Hatchery Adults			Juveniles Into Captive Brood
Year	**Females**	**Females**	**Males**	**Jacks**	
2007					20
2008					414
2009					1,069
2010	2				760
2011	15				1,093
2012	91				1,045
2013	293				No capture
2014	189		5		No capture

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

At this time no surplus broodstock exist. If program success results in surplus broodstock, adults trapped at the hatchery facility will be returned to the South Fork Nooksack River for natural spawning.

7.6) Fish transportation and holding methods.

Chinook juveniles were caught in the South Fork Nooksack for evaluation as potential members of the captive brood. They were transported from the catch site over trails to the truck on the nearest road in insulated 5 gallon buckets. The buckets were then capped, supplied with aeration and placed inside an insulated tote for transport to the hatchery. At the hatchery, juveniles were transported into rearing tanks supplied with a continuous flow of mixed creek and well water, which allowed separation of groups according to location of capture. Each Monday, all juveniles from the previous week were processed to collect a tissue for DNA microsatellite stock assignment and placed in a size appropriate numbered perforated container and which was then placed in a specific tray in a standard Heath Incubator stack supplied with the same mix of creek and well water. After 3 days, WDFW genetics lab stock assignments were provided for each tissue sample, and each tissue sample was associated with a specific container in a specific tray in the Heath stack. SF Chinook juveniles were transported to Kendall Creek Hatchery in covered, insulated, aerated buckets of water.

Surplus adults, if encountered, will be returned to the river directly from the hatchery or they may be transported by truck in tubes submerged in an insulated tote of oxygenated water to upper portions of the South Fork consistent with *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State, 2006* guidelines. Adult transfers are expected to require no more than 3 hours for transport. Drug use on relocated adults is not anticipated at this time.

7.7) Describe fish health maintenance and sanitation procedures applied.

Manchester Research Station and Kendall Creek Hatchery

The broodstock fish are handled as infrequently as possible and staff endeavor to minimize stress in the fish at all times. Wild fish may be more sensitive to stress than their hatchery counterparts. Cohorts raised in a hatchery displayed increased blood cortisol levels due to stress from handling. (Salonius & Iwama, 1993). Handling of SFNSC broodstock was also reduced because of the increased risk of disease outbreaks that result from handling events (Pickering, 1988; Stickney, 1983). Frequent sampling led to elevated stress and decreased growth in the Grand Ronde Basin spring Chinook captive broodstock and decreasing the frequency of sampling and combining handling activities, such as inoculations and tagging appears to have increased egg survival in the program (Hoffnagle *et al*., 2003).

Skookum Creek Hatchery

A formalin drip treatment may be administered in brood ponds at frequencies up to three times per week at concentrations of up to 167ppm for the control of *Saprolegnia*. Antibiotics may be administered to control or prevent bacteria-related disease. Fish health is visually inspected daily by hatchery staff. Fish pathology assessment is performed at least twice a month by a NWIFC fish pathologist. Necropsies are performed by a fish health specialist for the detection and prevention of disease and parasites. Disease treatment and prevention and sanitation are performed under the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW 2006) and Food and Drug Administration guidelines and regulations.

7.8) Disposition of carcasses.

Captive brood carcasses are currently disposed of into an approved septic tank due to routine formalin treatment. If formalin treatment is not required in the future for returning adults, carcasses will be used for nutrient enhancement to contribute to natural origin population productivity consistent with *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State, 2006* guidelines.

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

Risk aversion measures to minimize the likelihood for adverse genetic or ecological effects will be based upon spawning only South Fork Chinook, mating recommendations by fisheries geneticists when sibling relationships are known, and including representation of all age and migration timing groups entering the hatchery. While collection of broodstock in the river is not anticipated at this time, the Technical Advisory Committee will consult with NOAA if adults returning to the hatchery are not sufficient to meet brood stock objectives.

SECTION 8. MATING

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

8.1) Selection method.

Spawners are chosen as they ripen. Because the genetic profiles and family origins of all captive brood, identified by unique PIT tags, are available, a computer database will assign spawning matches to ensure the greatest genetic diversity at the time of spawning. The mating selection is formulated by the number of ripe spawners at the time of spawning. This method of mating selection will continue as long as captive brood are available for broodstock and as long as resources are available to identify volunteers' profiles and family origins. The Technical Advisory Committee will review the need to continue the computer assisted mating when captive brood are no longer available.

All identified South Fork Chinook, both HOR and NOR entering the facility will be incorporated into the broodstock collection until such time as there is a surplus of South Fork Chinook entering the facility, when the brood stock will be selected to represent the entire range of age and entry timing.

8.2) Males.

Backup males are not used during fertilization. Due to the possibility of a lower proportion of captive brood males to females, the appropriate number of randomly selected males may be spawned with two different females if the mating cross is acceptable. This process will continue until the volunteers produce sufficient males to fertilize the available females and provide for backup males when available.

8.3) Fertilization.

1:1 sex ratios are currently used for spawning captive brood and the adult returns. Factorial mating of 2:2 or 3:3 may be considered in future years. After fertilization, eggs are placed into incubators and water hardened for one hour in a PVP-iodine solution at a concentration of 100ppm.

8.4) Cryopreserved gametes.

Cryopreservation of milt may be considered for brood year 2015 and beyond if warranted, however specific details for cryopreservation have not yet been developed.

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

Spawners are selected from the captive brood and South Fork Chinook volunteers to maintain the highest possible genetic integrity and diversity of the population.

This program is currently in a preservation stage of the indigenous spring Chinook population of the South Fork Nooksack, and all efforts are made to minimize the likelihood for adverse genetic or ecological effects on natural origin South Fork Chinook. Hatchery practices focus on maximizing the genetic diversity of the program fish.

SECTION 9. INCUBATION AND REARING -

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

success of meeting the desired hatchery goals.

9.1) Incubation:

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

The extreme caution in handling the eggs and juveniles has precluded collection of precise data on survival rates. Analysis of survival rates on the limited data currently available is currently in process. More data will be available as the program continues.

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

There are no surplus eggs at this time. Annual egg take goals from volunteers will be calculated to meet stage release objective with a provision for expected mortality. In the event that survival to the time of smolt release is higher than anticipated, all fish from the cohort will be released.

9.1.3) Loading densities applied during incubation.

The number of eggs per pound has averaged 1,650 with some variation due to the significantly variable body size of females from captive brood. All fertilized eggs are incubated in vertical Heath tray stacks with an initial green-egg stage flow of 3.0 gpm loaded at 3.5 lbs. per tray. After shocking and picking, eyed eggs are reloaded into trays with Vexar® mesh at 3.0 lbs. per tray with flows of 4.0 gpm.

9.1.4) Incubation conditions.

Eggs are reared and hatched on pathogen-free ground water with a near-constant temperature of 51°F and a dissolved oxygen content averaging 10.5 mg/L. Water quality is constantly monitored and data logged with a YSI-5200A multi parameter water quality monitor.

If water shortages are encountered during incubation due to the volume of Chinook and coho eggs and hatchlings in incubation at the facility, a partial reuse system is available to provide additional water for the Chinook. Reused incubation water is filtered through a 40µm filter and treated with UV-sterilization at a minimum rate of 60µJ/cm³. Intra-species cross contamination of water does not occur during operation of the incubation reuse system.

9.1.5) Ponding.

Ponding occurs when fry are at least 90% buttoned-up. Ponding weight has averaged 1,300 fish per pound over four years and typically occurs the last week of December to the first week of February. Ponding is forced.

9.1.6) Fish health maintenance and monitoring.

A treatment using buffered PVP iodine is used daily to within six days of hatching for the control of fungus. At the eyed stage, eggs are shocked and picked, and egg mortalities are removed daily until hatching.

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

Eggs are incubated in pathogen free well water to minimize the risk of catastrophic loss due to siltation and disease. Water sources are continuously monitored and alarms are armed and operational during incubation.

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.

Manchester Research Station

Table 9.2.1: Survival of Program Fish at Manchester Laboratory (As of 12/2014)

BY	Smolt Stage	Smolts	Mortality	Matures	Estimate Remain	Actual N Remain	Survival
07	Zeros	53	33	20	0	0	37.7%
07	Yearlings	203	82	123	-2	5	59.6%
08	Zeros	259	87	159	13	6	66.4%
08	Yearlings	265	115	95	55	59	56.6%
09	Zeros	239	33	164	42	44	86.2%
09	Yearlings	175	45	112	18	19	74.3
10	Zeros	442	275	46	121	112	37.8
11	Zeros	440	239	10	191	192	45.7

Kendall Creek Hatchery

Table 9.2.2: Survival of Program Fish at Kendall Creek Hatchery (As of 12/2014)

BY	Juveniles received	Initial Mortalities	Manchester Transfers	After Transfer	Later Mortality	Mature fish	On Hand	Survival
06	24	0	0	24	3	21		87.5%
07	488	27	255	206	46	128	34	85.5%
08	1,017	28	508	481	13	373	60	92.5%
09	596	2	350	244	72	117	35	84.2%
10	1,081	35	442	604	359	57	132	58.4%
11	984	13	440	531	3	39	489	98.4%
Total	**4,190**	**105**	**1,995**	**2,090**	**496**	**735**	**750**	

Skookum Creek Hatchery

Fry to fingerling survival has averaged 92% from 2011-2014.

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

Manchester Research Station
At Manchester Research Station, rearing density will be maintained under 8 kg/m 3 (0.5 lbs/ft^3) during most of the juvenile-to-adult period. However, as the fish approach maturity, rearing densities may be allowed to increase to 15 kg/m^3 (1.0 lbs/ft^3) as this is when maturing fish stop feeding. Based on practical experience and published literature, loading densities for Chinook salmon captive broodstocks maintained at Manchester Research Station will not exceed 0.84 kg/lpm (7 lbs/gpm), except for non-feeding maturing adults with oxygen supplementation. The most rapid turnover rate for the 4.1-m diameter circular tanks is calculated at 0.80 times/hour. When the tanks are lightly loaded the turnover rate can be as low as one third of this value.

Kendall Creek Hatchery
The density index in the large SFNSC rearing units is kept at an average of 0.015. Flows range from 60 to 100 gpm in the circular tanks, depending on the size and number of fish in each tank.

Skookum Creek Hatchery
Actual maximum rearing density in the outside partial reuse system is 1.5lbs/ft^3. If linear flow-through raceways are used for rearing, actual maximum density is approximately 0.5lbs/ft^3.

9.2.3) Fish rearing conditions

Manchester Research Station
At Manchester Research Station, the fish will be reared in a 7,100ft^2 fish culture room containing Twelve 16.5ft diameter circular fiberglass tanks. Water depth in the 16.5ft tanks is generally maintained at 5ft. During most of the juvenile-to-adult rearing period density will be maintained under 8 kg/m^3 (0.5 lbs/ft^3). Tanks will be completely covered with a taut 2.5 x 2.5 cm or smaller mesh nylon netting to prevent fish from escaping. The nylon mesh minimizes injuries that might occur to fish when they leap against it. In addition to the mesh covering, half of each tank will be covered with solid black fabric that provides a shaded area for fish to take refuge when disturbed.

Kendall Creek Hatchery
Juvenile rearing - Upon arrival at Kendall Creek Hatchery, the South Fork Nooksack Natural Spring Chinook (SFNSC) juveniles were separated according to brood year. Groups of newly arrived fish were quarantined in a series of small aquaria and closely monitored for potential disease issues. The fish were immediately introduced to a diet of BioVita Starter, a high quality fish feed produced by Bio-Oregon. If the fish were healthy and eating well after two weeks, they were combined with the rest of their brood year in intermediate sized rearing vessels. Those intermediate vessels included a 200-gallon aquarium and four 6-foot diameter fiberglass tanks. Approximately one half of the fish in each brood year were transferred to the Manchester Research Station, some as sub-yearling age fish and the rest as yearlings.

Long-term freshwater rearing - SFNSC fish that remain at Kendall Creek Hatchery until maturation are reared in large outdoor fiberglass circular tanks. There are two 20-foot diameter and eight 16-foot diameter circular tanks that were installed specifically for the SFNSC captive brood program. The 20-foot circular tanks have 1,250 square feet of rearing space and the 16-

foot tanks have 800 square feet of rearing space. Delays in permitting and construction resulted in the brood year 2006 and 2007 fish remaining in intermediate sized rearing units for longer than ideal. Maynard et al. (2012) stated that it is critical to rear captive broodstock Chinook in large units and at low densities in order to achieve high survival rates. Kendall Creek Hatchery staff observed higher growth rates and improved health upon transferring the SFNSC to the large circular tanks. The density index in the large SFNSC rearing units is kept at an average of 0.015. Flows range from 60 to 100 gpm in the circular tanks, depending on the size and number of fish in each tank.

Skookum Creek Hatchery

Within the partial reuse system, water quality is constantly monitored for dissolved oxygen, temperature and pH. Un-ionized ammonia is tested once daily with a test kit. Dissolved oxygen is managed for a minimum concentration of 9.0 mg/L and temperature is managed for a minimum of 47°F and a maximum temperature of 60°F.

The partial reuse system is operated for self-cleaning abilities which limits the requirement for vacuuming. Circular tank walls and drains are brushed on a daily basis. If juvenile Chinook are reared in linear raceways, the floors are vacuumed of waste every other day. Mortalities are removed and enumerated on a daily basis in circular tanks and raceways.

Bi-monthly necropsies are performed by a fish health specialist for the detection and prevention of disease and parasites.

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

Not available.

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

Table 9.2.5.1: Average Monthly Growth Rates at Skookum Creek Hatchery

Month	Size (fpp)	Energy Reserve
January	1125	No Data
February	830	No Data
March	655	No Data
April	340	No Data
May	145	No Data
June	76	No Data

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*).

Manchester Research Station

At Manchester Research Station, fish will be reared on commercial feeds produced by BioOregon or Skretting1. Beginning with seawater entry, fish will be reared on a semi-moist starter diet fed by a combination of hand feeding and automatic feeders. When ready, the fish will be transitioned through standard pelleted semi-moist or dry grower feeds and progressed through "brood" ration sizes (6 mm, 9 mm). Fish will be transitioned to dry diets dispensed by automated feeders as they grow. The pellet size fed will follow the feed manufacturer's recommendations, based on current guidelines for commercial aquaculture and guidance provided in Fowler (1989). However, pellet size is adjusted from the recommendation to ensure that the smallest fish in the population are able to feed. Daily ration may range from 5.6% body weight per day for fry that are being transitioned to seawater down to 0.4% body weight per day for pre-spawning adults, all dependent upon fish size and water temperature (Iwama 1996).

Kendall Creek Hatchery

The SNFSC captive broodstock fish are fed a portion of their daily ration by hand each morning which gives the fish culturists a chance to observe the fish's feeding behavior and the flow conditions in each tank. The remainder of the daily ration is fed utilizing belt type clockwork feeders installed on each tank. SFNSC broodstock are fed Bio-Oregon BioVita Fry diet according to the manufacturer's guidelines regarding feed size and rate. Once the entire population in a pond has achieved an average weight of 100 g, the fish are fed Bio-Oregon's BioBrood diet. BioBrood is formulated with premium fish oil and fishmeal as well as a mixture of minerals and vitamins formulated to improve brood health, fecundity, sperm motility, and egg quality. The SFNSC fish are administered prophylactic antibiotic treatments three times per year in an effort to prevent or control an outbreak of bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*. At present, two of the six total brood year populations have suffered losses due to BKD. Survival rates for the SFNSC fish reared at Kendall Creek Hatchery ranged from 63.5% in the brood year 2010 fish (which have experienced loss from BKD) to 99.4% for the brood year 2011 fish.

Skookum Creek Hatchery

Food is administered by hand 6 times per day for the first 8-9 weeks of feeding and eventually decreased to 2 feedings per day by the time of fish release. Fish are typically fed at a rate of 2% body weight per day however this rate may be slightly increased or decreased to meet fish size objectives. Food Conversion Rate (FCR) ranges from 1.05 – 1.2.

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

Manchester Research Facility

Fish health is visually inspected daily by hatchery staff. NWIFC and/or NOAA fish health professionals provide support as requested by staff. The SFNSC fish are administered prophylactic antibiotic treatments three times per year in an effort to prevent or control an outbreak of bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*.

Kendall Creek Hatchery
Fish health is visually inspected daily by hatchery staff. WDFW pathologists conduct regular evaluations and respond to any issues reported by staff. The SFNSC fish are administered prophylactic antibiotic treatments three times per year in an effort to prevent or control an outbreak of bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*.

Skookum Creek Hatchery
Fish health is visually inspected daily by hatchery staff. Fish pathology assessment is performed at least twice a month by a NWIFC fish pathologist. Bi-monthly necropsies are performed by a fish health specialist for the detection and prevention of disease and parasites. Disease treatment and prevention and sanitation are performed under the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW 2006) and Food and Drug Administration guidelines and regulations.

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

Not applicable. Smoltification is determined by physical appearance and fish behavior.

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

Natural settings are not currently used for rearing. However, a major emphasis is placed upon the physical conditioning of Chinook in the reuse circular tanks by forcing fry and fingerlings to constantly swim against a current of up to three body lengths per second.

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.

Because the genetic profiles and family origins of all captive brood, identified by unique PIT tags, are available, a computer database will assign spawning matches to ensure the greatest genetic diversity at the time of spawning. The mating selection is formulated by the number of ripe spawners at the time of spawning. This method of mating selection will continue as long as the captive brood dominates the spawners and as long as resources are available for volunteers' profiles and family origins. The Technical Advisory Committee will review the need to continue the computer assisted mating when the captive brood is exhausted.

Rearing protocol for the prevention of disease is the highest priority and disease prevention treatment is followed under guidelines established by the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State*, (WDFW 2006). Fish are released when they display indications of smoltification and at an average size which will minimize the potential for predation upon ESA-listed natural origin juvenile salmonids.

SECTION 10. RELEASE

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

At present, sub-yearling fingerlings are released from Skookum Creek Hatchery. When sufficient numbers of South Fork Early Chinook return to the hatchery to support the supplementation program, the Technical Advisory Committee will develop for NOAA consideration an off station acclimation/de-stressing program for implementation in the upper reaches of the South Fork to increase the likelihood of re-colonizing suitable spawning and

rearing habitat throughout the system.

10.1) Proposed fish release levels.

Table 10.1.1: Proposed fish release levels.

Stage	Age Class	Annual Release Level	Size (fpp)	Release Date	Location
1a	**Sub-Yearling Fingerling**	1,000,000	80	5/25-6/10	R.M. 14.3 S.F. Nooksack
1b	**Sub-Yearling Fingerling**	200,000	80	5/25-6/10	R.M. 14.3 S.F. Nooksack
2a	**Sub-Yearling Fingerling**	200,000-300,000	80	5/25-6/10	R.M. 14.3 S.F. Nooksack
2b	**Sub-Yearling Fingerling**	100,000-200,000	80	5/25-6/10	>R.M. 18 S.F. Nooksack
3	**Sub-Yearling Fingerling**	200,000	80	5/25-6/10	R.M. 14.3 S.F. Nooksack

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

Stages 1, 2a, 3 Sub-Yearling Smolt Release Site

Stream, river, or watercourse: South Fork Nooksack River (WRIA 1)
Release point: Skookum Creek Hatchery, RM 14.3, tributary to the mainstem Nooksack River at RM 36.6

Major watershed: Nooksack River
Basin or Region: Puget Sound

Stages 2b, Sub-Yearling Smolt Release Site

Stream, river, or watercourse: South Fork Nooksack River (WRIA 1)
Release point: Skookum Creek Hatchery, > RM 18
Major watershed: Nooksack River
Basin or Region: Puget Sound

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

Table 10.3.1: Actual numbers and sizes of fish released by age class for release years 2011-2015.

Release Year	Fingerling	Size (fpp)	Release Location
2011	1,964	112	Skookum Creek Hatchery
2012	32,350	94	Skookum Creek Hatchery
2013	154,840	76	Skookum Creek Hatchery
2014	677,540	80	Skookum Creek Hatchery
2015	343,240	77	Skookum Creek Hatchery
Average	241,986	87.8	

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

Actual dates of release of subyearlings into the South Fork Nooksack River have ranged from the third week in May through the first week in June (Table 10.4.1).

Table 10.4.1: Actual dates of release and description of release protocols for release years 2011-2015

Release Year	Release Dates	Release Type	Rationale	Culling Procedure
2011	May 20	Forced	Physical Appearance/Behavior	None
2012	June 4 - June 5	Volitional	Physical Appearance/Behavior	None
2013	June 3 - June 7	Volitional	Physical Appearance/Behavior	None
2014	June 2 - June 5	Volitional	Physical Appearance/Behavior	None
2015	May 20 – June 4	Volitional	Physical Appearance/Behavior	None

Lummi Natural Resources

10.5) Fish transportation procedures, if applicable.

There is currently no transportation of the juvenile program fish. When there is significant abundance of program juveniles to consider. The Technical Advisory Committee will develop the detailed protocols for transportation.

10.6) Acclimation procedures.

There is currently no off-station acclimation activity or procedure. When hatchery production stabilizes, acclimation in the waters of the upper South Fork will be considered to ensure that the full watershed is seeded.

When program juveniles exceed the 300,000 release potential, up to 200,000 juveniles will be uniquely identified by CWT and/or otolith mark and transported to one or more acclimation sites in the upper watershed, for a period of 4 days to 2 weeks. The Technical Advisory Committee will develop the detailed protocols for selecting the appropriate location for acclimation, the configuration of the acclimation site, and the protocols for operation.

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

Currently, all program fish are tagged with CWTs. Program fish are the only sub-yearling Chinook in the Nooksack Basin with a CWT and an intact adipose fin. This will allow non-lethal identification of program fish the smolt trap.

It is anticipated that when the program has stabilized with the return of program adults to the hatchery and spawning grounds, that the stock will be incorporated into the PSC indicator stock program for a period of time that would allow a comparison between the estimates of exploitation rates in PSC fisheries between the South Fork and the North/Middle Fork Nooksack Chinook population.

It may be necessary to consider otolith marking to identify program fish if providing numbered CWTs is no longer feasible or when an additional need for identification is warranted.

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

Because of the low numbers of adults currently in the program, it is not expected that there will be surplus smolts at time of release in the near future. Egg takes will provide for an average survival from green egg to release. In the event that survival to the time of smolt release is higher than anticipated, all fish from the cohort will be released.

10.9) Fish health certification procedures applied pre-release.

The release group receives a fish health determination within one week of release by a NWIFC fish pathologist.

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

The elevation of Skookum Creek Hatchery is such that there has been no incidence of flooding in 40 years of operation. A water system or electrical failure can be prevented or mitigated through the availability of several separate water sources (Skookum Creek intake and multiple groundwater wells), a backup generator, an alarm system and on-site hatchery staff. If all redundancies fail and fish must be released, fish can be released from the hatchery from any location within 30 minutes.

This program's fish are the highest priority of fish reared at the facility. All program fish during incubation, initial rearing and final rearing are held in reuse systems that can operate on power provided by the back-up generators.

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.

Program fish are intended to be as representative of the listed South Fork early Chinook population as possible. Sub-yearling Chinook volitionally leave the hatchery as smolts to ensure rapid emigration to the marine area and at a size and condition that avoids fresh water limiting factors and prepares them for transition to the marine habitat. As the program develops, it is anticipated that up to 200,000 fingerlings will be released from acclimation or de-stressing facilities in the upper sections of the river to encourage returning fish to move up the entire river to seek out suitable properly functioning habitat as it is restored.

Information on the potential interaction between program fish and listed steelhead are not well known at present. The volitional release of the sub-yearling Chinook is to ensure rapid emigration to the marine area. The bulk of the young of the year steelhead appear in the Skookum area after the Chinook have left the facility. Predation on steelhead is not expected to be significant.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

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

The purpose of the monitoring program is to identify and evaluate the benefits and risks that may derive from the hatchery program. The monitoring program is designed to answer questions of whether the hatchery is providing the benefits intended, while also minimizing or eliminating the risks inherent in the program. A key tool in any monitoring program is having a mechanism to identify each hatchery production group.

Program fish are currently identified with coded wire tags. In the future other technologies such as otolith marking, adipose fin clips, or other new identification methods may be employed. This will allow for 1) selective harvest on hatchery stocks when appropriate; 2) monitoring of interactions of hatchery and wild fish wherever they co-mingle in riverine, estuarine and marine habitats; and 3) assessment of the status of the target population. Through annual spawning ground surveys, the co-managers will sample the Chinook salmon escapement within the watershed and sample carcasses for tags, adipose fin clips, otoliths and tissue for DNA stock identification that will allow the estimation of the abundance of spawning Chinook by origin and release strategy. The co-managers will sample the harvest of Chinook in terminal area fisheries for identifiable program fish. The identification of program fish in the harvest samples will allow estimation of the contribution of program fish to the harvest and assist in estimation of the survival of program releases.

In addition, another important aspect of hatchery management is the monitoring and evaluation of the genetic profile of hatchery stock(s) and of nearby natural stock(s). There is an ongoing monitoring need to evaluate changes in the genetic structure of both hatchery and natural populations and the amount, in geographic extent, of gene flow between them.

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

Continue to coded-wire tag all program Chinook to allow identification at the hatchery rack and on the spawning grounds. As numbers increase, and resources become available, adipose fin clips will be considered to allow independent estimate of harvests and exploitation rates in PSC fisheries. Otolith marking might be considered to eliminate CWTs as the sole means of identification of HOR fish on the spawning grounds.

The co-managers will monitor Chinook escapement in the Nooksack basin to estimate the total escapement and the proportion of tagged, untagged and marked fish present on the spawning grounds each year by stock, origin and age or release date to allow a basis for evaluation of the population dynamic statistics for hatchery programs and natural populations.

All volunteers to the hatchery are evaluated for marks and tissue will be taken for DNA stock assignment to the South Fork Early Chinook, and as appropriate, for the evaluation of sibling relationships. South Fork Chinook will be PIT tagged for later sibling relationships and held in facilities separate from the mature captive brood. Natural origin North/Middle Fork Chinook are made available for inclusion in the Kendall Hatchery program transported by truck in tubes submerged in a tote of oxygenated water to the Middle Fork for release. Hatchery origin

North/Middle Fork Chinook will be similarly transported to the Middle Fork for release. Fall Chinook are sacrificed.

The co-managers will sample the terminal areas fisheries for CWTs, otolith samples and tissue to allow estimation of the total catch of Chinook by hatchery, origin and year of release. Fisheries beyond the terminal area will be sampled according to the PSC coast wide protocols for CWTs to allow the estimation to the total CWTs in the each fishery. The CWT recoveries estimated in all non-terminal fisheries plus the terminal area estimates, spawning ground estimates and hatchery returns of stock, origin, release year and location will allow the evaluation of the program success and the fisheries that benefitted. The development of Parental Based Tagging might provide better estimates of fisheries contributions by hatchery and stock and better estimates of natural spawning populations by stock.

The basic information on the hatchery release numbers, mark status, release location and date will be reviewed by the co-managers and posted with RMIS within a year. The CWT information collected in the terminal area will be prepared by and reviewed by the co-managers to meet the requirements of the PST.

Estimates of the composition of the terminal area catch, the hatchery return and the spawning ground abundance by stock, origin and release strategy will be available within 18 months, and the basis for the estimates of the stock composition by origin from coast wide fisheries that will allow a complete evaluation of adult production from each release is dependent on international teams and may take more than 2 years.

Exhaustive sampling of juvenile Chinook salmon from the South Fork Nooksack has made clear the amount of genetic variation used to found the captive brood program. This initial measure of genetic diversity will be compared to that found in returning generations of spawners both to the hatchery and to natural reproduction in the river to measure the amount of genetic diversity retained by the captive brood program.

Best management practices will be followed in hatchery operations and records will be kept to monitor performance. Results will be reported annually.

The co-managers will regularly meet to evaluate monitoring results and develop action plans where necessary to ensure programs are producing the expected outcomes, or to evaluate whether we are able to move up to the next level.

Table 11.1.1.1: "Performance Indicators" addressing benefits.

Benefits		
Standard	**Indicator**	**Monitor**
Program addresses ESA responsibilities	Approval of 4d Limit (6) exemption	Notification of Limit (6) exemption from Section 9 take prohibitions
Program fish are identifiable	Adipose fin presence, otolith mark, CWT, or genetic stock identification	Annual Report of Release Numbers and Marks
Release Survival Meets Standards	Numbers and proportion of releases that contributes to escapement and fisheries	Analysis of sample results from spawning grounds, hatchery return and all fisheries of program contributions
Program contributes to fulfilling tribal trust responsibility mandate and treaty rights under the Treaty of Point Elliott	Early Chinook spring fishery from April through July meets harvest objectives as program phase.	Total catch and days fishing reported annually.
Increasing numbers of Natural Origin Spawners (NOS) on the spawning ground.	Numbers of (NOS) on the spawning ground.	Annual estimate of the number of NOS on the spawning ground
The number of natural origin South Fork Chinook smolt migrants increases	Number of natural origin smolts	Annual estimates of NOR smolts at the Lower Nooksack smolt trap
Hatchery Origin Spawners (HOS) in the wild produce smolts comparable to Smolts from Natural Origin Spawners	Timing and condition of South Fork natural origin migrant smolts is similar	Annual evaluation of smolt timing and condition of natural origin and hatchery origin smolts at the Lower Nooksack smolt trap
Program eases restrictions in Southern US harvest rates	Southern US exploitation rate of NOR South Fork Chinook	Annual estimates of Southern US exploitation rate on Early Chinook
Effectiveness of Program Operations	Hatchery operations use the best available science to maximize survival and prevent disease Survival rates recorded at each stage of culture	Annual Report of Hatchery activities
Release Survival Meets Standards	Proportion of released production that contributes to escapement and fisheries	Analysis of program contributions to spawning grounds, hatchery return and all fisheries

Table 11.1.1.2: "Performance Indicators" addressing risks.

Risks		
Standard	Indicator	Monitor
The program uses standard scientific procedures to evaluate various aspects of artificial propagation.	Best available fish culture standards are utilized to maximize the production of the program and minimize risks associated with improper fish culture practices	Annual Report of Hatchery Operations
Hatchery facilities are operated in compliance with all applicable fish health guidelines and facility operation standards and protocols (Co-manager Fish Health Policy, INAD)	Hatchery records document compliance with applicable standards and criteria.	Annual reports indicating levels of compliance with applicable standards and criteria. Periodic audits indicating level of compliance with applicable standards and criteria.
Effluent from hatchery facility will not Adversely affect the ecosystem.	Discharge water quality meets NPDES permit standards.	Reports as required by NPDES permit in Annual Hatchery Report
Water withdrawals and in-stream water diversion structures for hatchery operation will not prevent access to natural spawning areas, affect spawning behavior of natural populations, or impact juvenile rearing environment.	Water withdrawals are compliant with water rights. Facility operates in compliance with applicable passage and screening criteria for juveniles and adults.	Annual record of water withdrawal and status of passage and screening include in Annual Hatchery Report
Releases do not introduce new pathogens and do not increase the levels of existing pathogens in local populations	All State and co-manager fish health policies and standards are followed. Certification of fish health during rearing and release.	Report of compliance with fish health policies and fish health certifications contained in the Annual Hatchery Report
Any distribution of carcasses or other spawner products for nutrient enhancement is accomplished in compliance with appropriate disease control regulations and guidelines, including state, tribal and federal carcass distribution guidelines.	All applicable fish disease policies are followed.	Disposition of carcasses reported in Annual Hatchery Report.
The stray rate will not cause a significant change in the genome of the listed Chinook	DNA stock identification compared to the baseline	Statistics comparing stock genomes will not show a significant change
Competition by hatchery origin releases on natural origin salmonids does not significantly reduce numbers of listed natural origin salmonids.	Dates, size and location of release supporting rapid out migration	Records from hatchery operations contained in Annual Hatchery Report. Supplemental information from lower river smolt trap as available.

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 standard of the monitoring is related to the resources available to it. Basic status quo monitoring is available for hatchery operations. Basic tagging, fin clipping, and otolith marking are funded. The spawning ground characterization requires substantial additional funding to identify the total abundance and the proportion from different stocks origins, date and release strategies. The resources for timely analysis of sample data from the spawning grounds and fisheries is not steady and may delay analyses for up to a year.

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.

Spawning ground surveys will employ measures to ensure that effects on the survival of the listed Chinook salmon population are insignificant. Chinook redds will not be disturbed during surveys and sampling.

The operation of the Lummi smolt trap in the lower river is monitored in variable time periods related to the expected abundance of juveniles passing the site to minimize the duration of holding and risk of harm to ESA listed Chinook and steelhead. It samples the out-migrations of juveniles to provide estimates of salmon abundance by species, origin, and age to provide a baseline for evaluation of the production per spawner, and marine survival.

SECTION 12. RESEARCH

There is currently no research programs conducted in direct association with the hatchery program described in this HGMP.

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SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the information provided 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:_____

Table 1. Estimated listed salmonid take levels of by hatchery activity.

Listed species affected: Chinook *(Oncorhynchus tshawytscha)*	**ESU/Population:** Puget Sound/ South Fork Nooksack Chinook	**Activity:** Skookum Creek Spring Early Chinook Program
Location of hatchery activity: Skookum Creek Hatchery, SF Nooksack (01.0272)	**Dates of activity:** January-December	**Hatchery program operator:** Lummi Natural Resources

Type of Take	**Annual Take of Listed Fish By Life Stage *(Number of Fish)***			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	-	-	400-3000	0
Collect for transport b)	0	0	-	-
Capture, handle, and release c)	-	-		
Capture, handle, tag/mark/tissue sample, and release d)	-	-		-
Removal (e.g. broodstock) e)	-	-	Up to 300	-
Intentional lethal take f)	-	-	600	-
Unintentional lethal take g)				-
Other Take (specify) h)	-	Unknown (ecological impacts)	-	-

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.

Instructions:

1. An entry for a fish to be taken should be in the take category that describes the greatest impact.
2. Each take to be entered in the table should be in one take category only (there should not be more than one entry for the same sampling event).
3. If an individual fish is to be taken more than once on separate occasions, each take must be entered in the take table.

Attachment 1. Definition of terms referenced in the HGMP template.

Augmentation - The use of artificial production to increase harvestable numbers of fish in areas where the natural freshwater production capacity is limited, but the capacity of other salmonid habitat areas will support increased production. Also referred to as "fishery enhancement".

Critical population threshold - An abundance level for an independent Pacific salmonid population below which: depensatory processes are likely to reduce it below replacement; short-term effects of inbreeding depression or loss of rare alleles cannot be avoided; and productivity variation due to demographic stochasticity becomes a substantial source of risk.

Direct take - The intentional take of a listed species. Direct takes may be authorized under the ESA for the purpose of propagation to enhance the species or research.

Evolutionarily Significant Unit (ESU) - NMFS definition of a distinct population segment (the smallest biological unit that will be considered to be a species under the Endangered Species Act). A population will be/is considered to be an ESU if 1) it is substantially reproductively isolated from other conspecific population units, and 2) it represents an important component in the evolutionary legacy of the species.

Harvest project - Projects designed for the production of fish that are primarily intended to be caught in fisheries.

Hatchery fish - A fish that has spent some part of its life-cycle in an artificial environment and whose parents were spawned in an artificial environment.

Hatchery population - A population that depends on spawning, incubation, hatching or rearing in a hatchery or other artificial propagation facility.

Hazard - Hazards are undesirable events that a hatchery program is attempting to avoid.

Incidental take - The unintentional take of a listed species as a result of the conduct of an otherwise lawful activity.

Integrated harvest program - Project in which artificially propagated fish produced primarily for harvest are intended to spawn in the wild and are fully reproductively integrated with a particular natural population.

Integrated recovery program - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as "supplementation".
Isolated harvest program - Project in which artificially propagated fish produced primarily for harvest are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Isolated recovery program - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), but the fish produced are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Mitigation - The use of artificial propagation to produce fish to replace or compensate for loss of fish or fish production capacity resulting from the permanent blockage or alteration of habitat by human activities.

Natural fish - A fish that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Synonymous with *natural origin recruit (NOR).*

Natural origin recruit (NOR) - See *natural fish* .

Natural population - A population that is sustained by natural spawning and rearing in the natural habitat.

Population - A group of historically interbreeding salmonids of the same species of hatchery, natural, or unknown parentage that have developed a unique gene pool, that breed in approximately the same place and time, and whose progeny tend to return and breed in approximately the same place and time. They often, but not always, can be separated from another population by genotypic or demographic characteristics. This term is synonymous with stock.

Preservation (Conservation) - The use of artificial propagation to conserve genetic resources of a fish population at extremely low population abundance, and potential for extinction, using methods such as captive propagation and cryopreservation.

Research - The study of critical uncertainties regarding the application and effectiveness of artificial propagation for augmentation, mitigation, conservation, and restoration purposes, and identification of how to effectively use artificial propagation to address those purposes.

Restoration - The use of artificial propagation to hasten rebuilding or reintroduction of a fish population to harvestable levels in areas where there is low, or no natural production, but potential for increase or reintroduction exists because sufficient habitat for sustainable natural production exists or is being restored.

Stock - (see "Population").

Take - To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Viable population threshold - An abundance level above which an independent Pacific salmonid population has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame.

Attachment 2. Age class designations by fish size and species for salmonids released from hatchery facilities.

(generally from Washington Department of Fish and Wildlife, November, 1999).

	SPECIES/AGE CLASS	SIZE CRITERIA Number of fish/pound	SIZE CRITERIA Grams/fish
X	Chinook Yearling	<=20	>=23
X	Chinook (Zero) Fingerling	>20 to 150	3 to <23
X	Chinook Fry	>150 to 900	0.5 to <3
X	Chinook Unfed Fry	>900	<0.5
X	Coho Yearling 1/	<20	>=23
X	Coho Fingerling	>20 to 200	2.3 to <23
X	Coho Fry	>200 to 900	0.5 to <2.3
X	Coho Unfed Fry	>900	<0.5
X	Chum Fed Fry	<=1000	>=0.45
X	Chum Unfed Fry	>1000	<0.45
X	Sockeye Yearling 2/	<=20	>=23
X	Sockeye Fingerling	>20 to 800	0.6 to <23
X	Sockeye Fall Releases	<150	>2.9
X	Sockeye Fry	> 800 to 1500	0.3 to <0.6
X	Sockeye Unfed Fry	>1500	<0.3
X	Pink Fed Fry	<=1000	>=0.45
X	Pink Unfed Fry	>1000	<0.45
X	Steelhead Smolt	<=10	>=45
X	Steelhead Yearling	<=20	>=23
X	Steelhead Fingerling	>20 to 150	3 to <23
X	Steelhead Fry	>150	<3
X	Cutthroat Trout Yearling	<=20	>=23
X	Cutthroat Trout Fingerling	>20 to 150	3 to <23
X	Cutthroat Trout Fry	>150	<3
X	Trout Legals	<=10	>=45
X	Trout Fry	>10	<45

1/ Coho yearlings defined as meeting size criteria and 1 year old at release, and released prior to June 1st.
2/ Sockeye yearlings defined as meeting size criteria and 1 year old.