Endangered Species Act - Section 7 Consultation
and
Magnuson-Stevens Act Essential Fish Habitat Consultation

BIOLOGICAL OPINION ON ARTIFICIAL PROPAGATION IN THE HOOD CANAL AND EASTERN STRAIT OF JUAN DE FUCA REGIONS OF WASHINGTON STATE

Hood Canal Summer Chum Salmon Hatchery Programs
by the U.S. Fish and Wildlife Service and the
Washington Department of Fish and Wildlife
and
Federal and Non-Federal Hatchery Programs
Producing Unlisted Salmonid Species

Agencies:
U.S. Fish and Wildlife Service
Bureau of Indian Affairs (for the Point No Point Treaty Tribes)

Consultation Conducted by:
National Marine Fisheries Service,
Northwest Region

Date Issued:_____

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Introduction

Background

The U.S. Fish and Wildlife Service (USFWS) and the Washington Department of Fish and Wildlife (WDFW) artificially propagate summer chum salmon (*Oncorhynchus keta*) for the purpose of recovering depleted populations in the Hood Canal and eastern Strait of Juan de Fuca regions of Puget Sound, Washington. WDFW and the Point No Point Treaty Tribes (PNPTT) (hereafter, "the co-managers"), and USFWS also operate hatchery programs within the region that propagate unlisted anadromous salmonid species, including fall chinook, coho, pink, and fall-run chum salmon, and steelhead, for fisheries augmentation purposes. Listed spring-run chinook and unlisted, but depleted, pink salmon populations are also reared in regional hatcheries for stock recovery purposes. These fish hatchery programs are included as the artificial propagation component of a resource management plan (the *Summer Chum Salmon Conservation Initiative* (SCSCI) proposed by the co-managers and USFWS, with commensurate habitat and fisheries harvest conservation measures, as a means to recover the listed Hood Canal summer chum salmon evolutionarily significant unit (ESU) (WDFW and PNPTT 2000). The SCSCI defines measures applied in the hatchery programs to preserve and recover listed summer chum salmon populations, while minimizing the risk of deleterious genetic, ecological, and demographic effects to listed fish.

The indigenous populations included in the Hood Canal Summer-Run Chum ESU, and that are the subject of recovery actions proposed in the SCSCI, are listed as "threatened" under the Endangered Species Act (ESA) of 1973 (March 25, 1999; 64 FR 14508). NMFS issued a final ESA 4(d) Rule applying prohibitions enumerated in section 9(a)(1) to this ESU on January 6, 2001 (NMFS 2000a). Within the final 4(d) Rule (July 10, 2000; 65 FR 42422), NMFS did not find it necessary and advisable to apply take prohibitions described in ESA section 9(a)(1)(B) and 9(a)(1)(C) to specified categories of activities that contribute to conserving listed salmonids or are governed by a program that adequately limits impacts on listed salmonids. Among these excepted categories are activities associated with artificial propagation programs provided that a state or Federal Hatchery and Genetics Management Plan (HGMP) for the program has been approved by NMFS as meeting criteria specified in (5)(i)(A)-(K) of the Rule.

This biological opinion (Opinion) is a part of a consultation carried out pursuant to section 7(a)(2) of the ESA and implementing regulations found at 50 CFR Part 402. This Opinion addresses fish hatchery programs in the Hood Canal and eastern Strait of Juan de Fuca region that artificially propagate summer chum salmon to enhance recovery of the species, and the effects of those programs on the listed Hood Canal summer chum salmon and Puget Sound chinook salmon ESUs. This Opinion also addresses hatchery programs in Hood Canal and the eastern Strait of Juan de Fuca that collect, rear, and release unlisted salmonid species, and their effects on the listed Hood Canal summer chum salmon ESU.

Consultation History

In an August 23, 1999 letter to NMFS (Jackson 1999), USFWS requested initiation of formal section 7 consultation under the ESA, concerning the potential effects of Federally funded hatchery programs on naturally produced and listed summer chum and chinook salmon within the geographic boundary of the Hood Canal Summer Chum ESU. These Federally funded hatchery programs, their potential effects on listed summer chum, and measures applied to minimize the risk of any deleterious effects are described in HGMPs submitted for NMFS review (USFWS 1999a; 1999b; 1999c; WDFW 2000e; LLTK 1999a; 1999d; 2000a; 2000b; 2000c). Reference is also made in the USFWS letter to the SCSCI (WDFW and PNPTT 2000), the tenets of which are carried forth in the Federal HGMPs. The co-managers submitted the SCSCI to NMFS on May 9, 2000 for its consideration as a proposed recovery plan, and as the overarching basis for the summer chum hatchery programs, and other artificial propagation programs that are the subject of this consultation. Included in the SCSCI are PNPTT hatchery programs that are Federally funded through the Bureau of Indian Affairs (BIA). In submitting the plan, the co-managers intend to implement its provisions through authorities and responsibilities defined under *U.S. v. Washington* (WDFW and PNPTC 2000). The co-managers also expect that NMFS will review the plan's conservation and recovery provisions, and consider them for compliance with appropriate limits included in the final 4(d) Rule (July 10, 2000; 65 FR 42422), and in developing incidental take permits under sections 7 and 10 of the ESA (WDFW and PNPTC 2000).

NMFS formally acknowledged receipt of the USFWS request for consultation (Robinson 1999), then initiated formal consultation for the Federal hatchery programs on November 17, 1999. The HGMPs submitted by USFWS, and the SCSCI, formed the Biological Assessment (BA) for the proposed Federal (USFWS and BIA funded) actions. These materials were used by NMFS as primary references to evaluate the effects of the proposed hatchery actions on listed summer chum and chinook salmon through this section 7 Opinion.

Overview of Artificial Propagation Issues

Hatchery programs in the Pacific Northwest operated to mitigate for declines in fish runs due to habitat destruction from hydropower construction, human development, resource extraction and over-fishing have primarily been programmed to produce fish for harvest. There is currently a shift occurring in hatchery management from augmenting harvest to restoring, maintaining and conserving natural populations of anadromous salmonids (RASP 1992, NPPC 1994). Within the last decade, hatchery programs have responded to ESA listings and the continuing declines in natural populations by shifting to conservation programs (see Flagg and Nash 1999). The goals of conservation programs are to restore and maintain natural populations. The change to conservation-type hatchery programs has followed a general call for hatchery reform within the Pacific Northwest. The changes proposed are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects to natural populations are minimized.

A significant number of scientific papers have examined the potential beneficial effects and risks to natural salmon populations posed by artificial propagation operations and fish production (for example, Lichatowich and McIntyre 1987; Hard et al. 1992; Witty et al. 1995; Waples 1999). In

particular, the benefits and risks associated with the use of hatchery-based supplementation to augment and recover depleted salmon populations, as proposed for the summer chum programs reviewed in this Opinion, has recently received extensive attention in the literature (for example, Steward and Bjornn 1990; Cuenco et al. 1993; Busack and Currens 1995; Waples 1996; Bugert 1998; Flagg and Nash 1999). Within the action area for this Opinion, the co-managers and USFWS have assessed the benefits and risks of summer chum supplementation programs, and of hatchery programs producing other salmonid species, on listed natural summer chum salmon populations within the SCSCI (WDFW and PNPTT 2000).

Drawing from the above literature, following is an overview of benefits and risks to natural salmonid populations that may be associated with artificial propagation programs evaluated in the Opinion, with a focus on the listed Hood Canal Summer Chum ESU populations.

Benefits

Hatchery-based supplementation programs (defined as the use of hatchery fish to increase natural production in the wild) may provide benefits to listed populations by:

· Using the hatchery to reduce the risk that a population on the verge of extirpation will be lost by expeditiously boosting the number of emigrating juveniles in a given brood year.
· Preserving or increasing the abundance of salmonid populations while other factors causing decreased abundances are addressed.
· Accelerating the recovery of populations by increasing abundances in a shorter time frame than may be achievable through natural production.
· Increasing the "nutrient capital" in the freshwater ecosystem supporting natural salmonid populations by increasing the numbers of decomposing supplementation program-origin salmonid carcasses in a watershed (Cederholm et al. 1999).
· Establishing a reserve population for use if the natural population suffers a catastrophic loss.
· Reseeding vacant habitat by reintroducing populations to streams where indigenous populations have been extirpated while the causes of extirpation are being addressed.
· Using hatchery programs to collect and provide new scientific information regarding the use of supplementation in conserving natural populations.

Among the hatchery programs considered in this Opinion, the USFWS's Quilcene National Fish Hatchery (QNFH), and jointly operated, "cooperative" projects on Lilliwaup Creek, Hamma Hamma River, Union River, Salmon Creek, and Jimmycomelately Creek rear indigenous summer chum to benefit recovery of the listed ESU through natural-origin stock supplementation. The two other summer chum directed programs considered in this Opinion (Chimacum Creek and Big Beef Creek) are reintroduction efforts, designed to reintroduce listed summer chum salmon to streams with extirpated populations. Critically depressed and depressed native pink, chinook, and coho salmon stocks are also supplemented in the eastern Strait of Juan de Fuca region through WDFW hatchery programs centralized within the Dungeness Hatchery Complex.

Hatchery programs producing unlisted salmonid species may be used to benefit fisheries. As described and evaluated in this Opinion, many artificial propagation programs are implemented in the action area to provide surplus fish for harvest in commercial, tribal, and recreational fisheries. These unlisted fish production programs are also used to meet international harvest objectives set forth under the Pacific Salmon Treaty agreement, and to mitigate for natural salmonid production losses due to habitat blockage and degradation.

Risks

The development of extensive artificial propagation programs for anadromous fish, the increasing dependence on artificial propagation to support fisheries and compensate for habitat destruction and the potentially adverse effects of these programs on native, naturally producing anadromous fish has been well documented. The following reviews (focusing on artificial propagation in the Columbia River Basin), present important perspectives regarding hatchery effects, and the programmatic need for changes in how hatcheries are operated commensurate with natural salmonid population preservation objectives: *Upstream: Salmon and Society in the Pacific Northwest* (NRC 1996); *Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem* (ISG 1996); *Review of Salmonid Artificial Production in the Columbia River Basin: As a Scientific Basis for Columbia River Production Programs* (ISAB 1998); *Artificial Production Review - Report and Recommendations of the Northwest Power Planning Council* (NPPC 1999); and *A Conceptual Framework for Conservation Hatchery Strategies for Pacific Salmonids* (Flagg and Nash 1999). In general the potential effects of artificial propagation on naturally-produced populations that were identified include effects on the genetic and ecological health of natural populations, effects of fisheries management and the potential to mask the status of naturally producing stocks which effects public policy and decision making. In this Opinion these effects of artificial propagation on natural populations have been separated into 11 generic effects related to:

1. Operation of Hatchery Facilities
2. Broodstock Collection
3. Genetics
4. Disease
5. Competition/Density Dependant Effects
6. Predation
7. Residualism
8. Fisheries
9. Masking
10. Nutrient Cycling
11. Monitoring and Evaluation

These effects of artificial propagation are discussed in greater detail in Section V.A. and include those management actions that are designed to minimize these effects.

Reform

The intent of hatchery reform is to strive to reduce negative effects of artificial propagation on natural fish populations while retaining its proven production and potential conservation benefits. For example, hatchery programs in the Pacific Northwest are in the process of phasing out use of improper broodstocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations. Producing fish that are better suited for survival in the wild is now an explicit objective of many salmon hatchery programs. Hatchery programs are also incorporating improved production techniques, such as NATURES-type rearing protocols and limits on the duration of conservation hatchery programs. The basic thrust of many of these reforms has been to produce fish that pose less risk to natural populations, either by minimizing interactions with natural populations or by making hatchery fish more compatible with them. Hatchery reform is needed not only to address artificial propagation's effects on listed fish but also to improve the overall success of artificial propagation programs.

The recovery of listed fish cannot be achieved simply by releasing more hatchery-produced fish in natural production areas, regardless of their ancestry or how they are produced. Hatcheries cannot provide the productive conditions necessary to restore self-sustaining populations in their natural habitats. Some artificial programs and facilities could be further reformed because they still have deleterious effects on natural populations and/or mask their status. The overarching goal of the reforms described here is to reduce or eliminate adverse biological, and management effects of artificial propagation on natural populations while retaining and enhancing the potential of hatcheries to contribute to regional objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also include an increased emphasis on conservation and recovery, a mission for which many older hatchery facilities were not designed. Reforms of existing hatchery programs and facilities that began several years ago must be accelerated and broadened to apply a variety of new and improved artificial propagation techniques that include supplementation, captive brood stock, and other strategies designed to minimize the risk of artificial propagation and/or maximize its conservation benefits.

These reforms may require substantial and costly changes in existing programs and facilities, beginning with a rigorous review of their goals and objectives. Because there is a range of scientific and policy opinions regarding the purpose and appropriate application of artificial propagation in specific circumstances, a number of strategies, coupled with an adaptive management approach, are warranted. These strategies are supported by the hatchery management agencies, and are proposed in the SCSCI (WDFW and PNPTT 2000) and in HGMPs reviewed in this Opinion.

In applying the ESA to listed species, NMFS has focused on the biological requirements of the species. NMFS' understanding of these requirements derives from many sources, including the general conservation literature, specific studies of salmon by NMFS and others, and recommendations of the Tribes, state, and other Federal fish and wildlife agencies and experts. NMFS recently published a compilation of scientific information relating to salmon conservation needs in "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units"

(McElhany et al. 2000). This document identifies criteria and guidelines relevant to the needs of healthy salmonid populations. Hatchery programs can affect these biological needs. Accordingly, subsequent to salmon ESA listings, NMFS began to address the effects of salmon hatcheries in biological opinions issued or still in progress under Sections 7 and 10 of the ESA, or more recently, through Section 4(d) Rule evaluation documents for newly listed, threatened salmon populations. Through these documents, NMFS evaluates the deleterious effects of artificial propagation on listed species. Deleterious effects must be eliminated or reduced enough to avoid jeopardizing listed species and to provide for their survival and recovery.

In determining the extent of necessary reforms of hatchery programs, and the rate at which they must occur, NMFS has considered a number of factors. These include, but are not limited to, the amount of benefit to listed fish accruing from the proposed reform, the extent of improvement already achieved from earlier reforms, the cost of the reforms (both economic and in terms of impacts on other goals and objectives), how quickly they can be implemented, how soon they will produce results, and how well the benefits to the fish can be measured. While all these factors must be considered in hatchery biological opinions, a consistent approach to hatchery reforms should be employed throughout the Pacific Northwest region, always with the result being a determination that each proposed hatchery program will be operated in a way that does not jeopardize listed fish.

Scientific knowledge regarding the benefits and risks of artificial propagation is incomplete, but improving. Artificial propagation measures have proven effective in many cases at alleviating near-term extinction risks, yet the potential long-term benefits of artificial propagation as a recovery tool for depleted salmon populations are unclear. Scientific uncertainty remains about whether and to what extent hatcheries, as they are currently operated, pose a continuing risk to natural populations. The hatchery management agencies conduct monitoring and evaluation activities to address these issues and to evaluate the success of artificial propagation programs.

A number of studies and reviews of artificial propagation have occurred in recent years (see list above). Although their scope is different from NMFS' focus under the ESA, their findings and recommendations generally are consistent with the reform measures identified here. In general, the standards and guidelines that emerge from these reviews are aimed at improving the effectiveness of artificial propagation programs, minimizing deleterious impacts on natural populations, meshing hatchery propagation and policies with harvest objectives, and increasing accountability and efficiency in hatchery programs. Integrating hatchery and harvest policies is especially important to meeting obligations for tribal and non-tribal fisheries.

Studies and reviews of artificial propagation have identified a number of major hatchery-specific reforms that include:

· Development of new, local broodstocks (eliminating inappropriate broodstocks).
· Construction of acclimation facilities for existing propagation programs.
· Construction of broodstock collection facilities or modifications to current facilities.
· Marking of all hatchery fish with appropriate internal and/or external marks.

· Development of HGMPs with prescribed protocols.
· Reducing the numbers and locations of hatchery fish releases.

The rate of implementation of hatchery program reforms are dependant on a number of factors. These factors include the availability of immediate funds, available broodstock, or the reform requires major hatchery facilities modifications. Some reforms can be implemented quickly including changing the number of hatchery fish released, altering the location of release to minimize ecological impacts to listed populations and preventing the transfer of inappropriate stocks to minimize genetic effects.

Current hatchery practices and reform measures proposed by the action agencies for hatchery programs covered in this Opinion will be reviewed to evaluate their consistency with the ESA.

ESU-Wide Conservation Responses
The effects of hatchery program activities in the Hood Canal summer chum ESU boundary were cited within the NMFS West Coast chum salmon stock ESA status review as potential factors for the decline of ESA-listed natural-origin summer chum salmon stocks (Johnson et al. 1997). Possible competition for food resources posed by hatchery fall chum salmon juveniles, and incidental harvest in Washington fisheries targeting more abundant salmonid species commingled with summer chum in migration areas were identified as of particular concern regarding the status of summer chum. Current commercial and recreational fisheries in which summer chum are taken are focused on other adult salmon species, including those produced in Puget Sound hatcheries. However, the volume of hatchery salmonid production, the physical location and operation of hatchery facilities, and fisheries enabled by hatchery production were considered risks to the Hood Canal summer chum salmon ESU in the NMFS status review document.

The co-managers and USFWS began development of the SCSCI in 1993 to integrate hatchery, harvest, and habitat management strategies, with the goal of recovering Hood Canal summer chum to healthy abundance levels. Consistent with the summer chum recovery objective, the plan was crafted to address hatchery-induced factors for decline identified by NMFS, and other concerns regarding the need for hatchery reform to protect natural summer chum populations. Major elements of the SCSCI, including supplementation and hatchery reform strategies aimed at recovering and conserving summer chum, have been implemented by the co-managers.

The summer chum salmon supplementation strategies implemented through the SCSCI are consistent with plan criteria defining: 1) when to supplement or reintroduce, including an initial project selection process and a discussion of benefits and risks; 2) when to modify or stop a supplementation program; 3) how to supplement under the plan; and 4) monitoring and evaluation objectives, and needed research associated with the supplementation programs. Hatchery reform measures implemented under the plan are based on a risk assessment process directed at all hatchery programs producing other salmonid species within the listed summer chum salmon ESU. Species programs judged to pose a moderate or high risk of adverse effects to summer chum through this process are being modified through application of specific risk

aversion measures defined in the plan. The potential risk of adverse effects associated with unlisted fish production programs are being reduced through this process.

The SCSCI was completed and formally submitted to NMFS on May 9, 2000 as the co-managers' proposed recovery plan for the listed Hood Canal summer chum salmon ESU. The plan has been provided to the NMFS Puget Sound /Olympic Peninsula Technical Review Team (TRT) responsible for developing consensus salmon recovery plans within the region. NMFS and the TRT have yet to comment to the co-managers regarding the acceptability of the plan.

Biological Opinion

Scope of Biological Opinion

This Opinion evaluates whether the effects of Federal (USFWS and BIA-funded) hatchery programs that collect, rear, and release listed summer chum salmon for the purposes of supplementation and reintroduction will reduce the likelihood of survival and recovery of listed Hood Canal summer chum salmon and Puget Sound chinook salmon. This Opinion also evaluates whether the Federal hatchery programs that collect, rear, and release unlisted hatchery salmon and steelhead will reduce the likelihood of survival and recovery of listed Hood Canal summer chum salmon. The effects of unlisted salmon and steelhead hatchery programs located within the summer chum salmon ESU action area on listed chinook salmon will be evaluated in a separate section 7 consultation. This latter consultation will programmatically evaluate the effects of unlisted salmonid hatchery programs on listed chinook salmon across an expanded action area; the geographical extent of the Puget Sound chinook salmon ESU.

The action area for this Opinion is that portion of the range of the listed summer chum salmon that is directly and indirectly affected by hatchery operations within freshwater and nearshore marine areas included as designated critical habitat by NMFS (February 16, 2000; 65 FR 7764). Included are freshwater migration, spawning and incubation areas, nearshore marine areas used as adult migration staging and juvenile rearing areas, terminal area marine waters used for summer chum migration and juvenile rearing, and ocean habitat in the Strait of Juan de Fuca (Figure 1).

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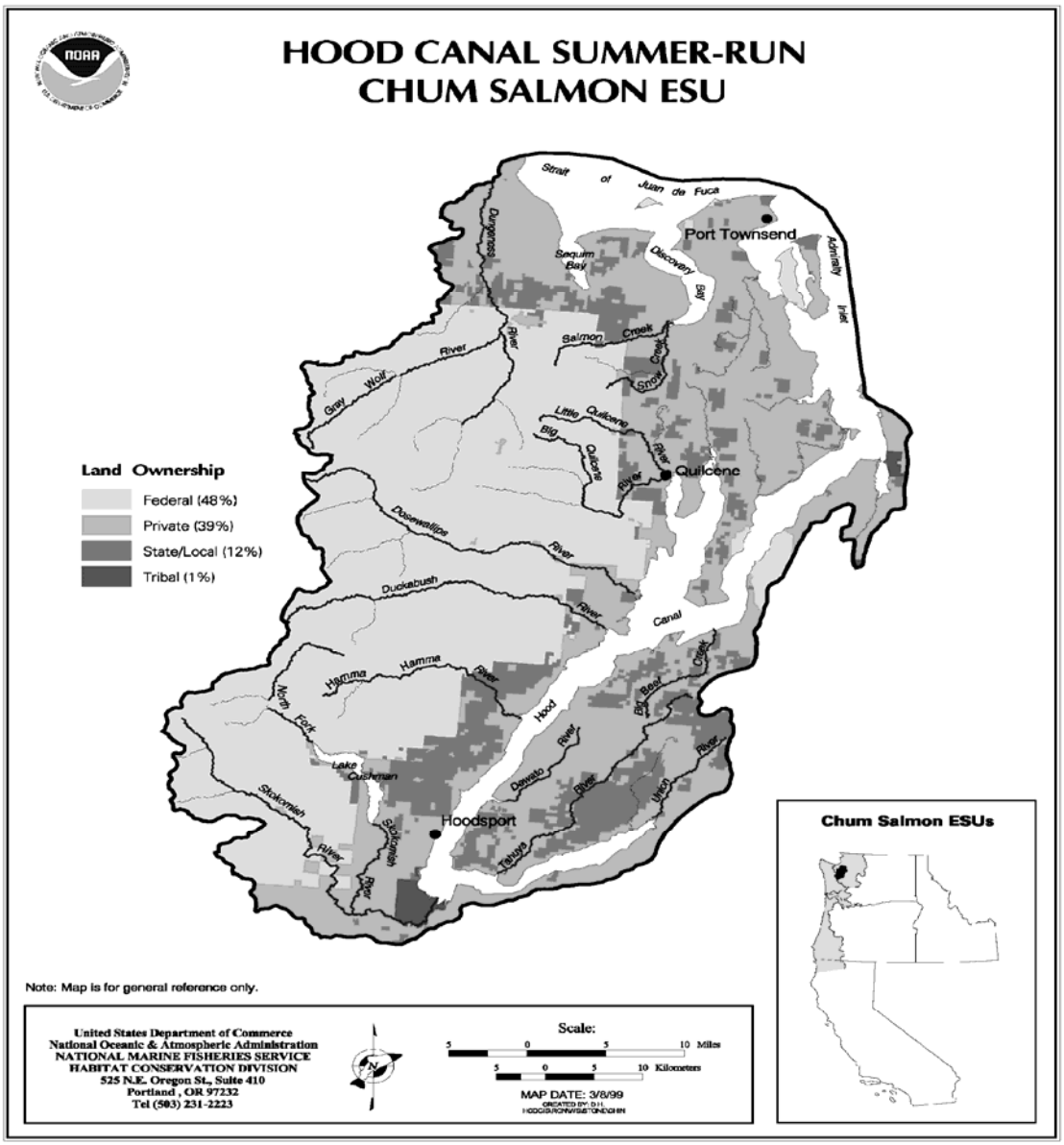


Figure 1. Hood Canal Summer-Run Chum Salmon ESU.

HGMPs submitted by the applicants are the main biological assessment documents used for evaluating the proposed Federal hatchery programs, and for making jeopardy determinations regarding their effects. The "Artificial Propagation" and "Ecological Interaction" sections of the SCSCI (WDFW and PNPTT 2000) are also used as biological assessment sources.

Within the action area of this Opinion, there are hatchery programs producing summer chum salmon and other, unlisted salmonid species that are not Federally funded, but funded and administered by WDFW. These WDFW-funded and administered hatchery programs are interrelated and interdependent with the Federal hatchery actions under consideration in this Opinion. The WDFW (or "non-Federal") hatchery programs producing summer chum and unlisted salmon species are not operated or managed by the co-managers or USFWS independently from the proposed Federal summer chum salmon programs. Salmon production from all hatchery programs in the action area is coordinated through the Future Brood Planning process pursuant to the *U.S. v. Washington* fisheries management framework. The Federal and non-Federal summer chum programs coordinated under this framework within the action area are conducted for the specific purpose of recovering the listed Hood Canal summer chum salmon ESU through joint recovery planning and management by the co-managers and USFWS. The Federal and non-Federal programs are interrelated through their joint focus on preserving and rebuilding individual summer chum populations that together comprise the listed ESU. In addition to coordination through the Future Brood Planning process, all of the Federal and non-Federal hatchery programs in the action area were planned, evaluated, and proposed for implementation under the co-managers' SCSCI. The current hatchery programs implemented in the action area comprise the artificial propagation component of this comprehensive resource management plan. The individual and cumulative effects of Federal and non-Federal hatchery programs in the action area were fully considered by the co-managers and USFWS in developing the Federally funded summer chum and unlisted salmon hatchery actions considered in this Opinion.

The effects of interrelated and interdependent non-Federal hatchery programs will therefore also be evaluated in this Opinion. Evaluation of the non-Federal hatchery programs in the Opinion will allow for the assessment of the cumulative effects of all hatchery programs in the action area that are encompassed under the *U.S. v. Washington* Future Brood Planning process, and as the artificial propagation component of the co-managers' SCSCI. HGMPs and the SCSCI were provided as the biological assessment materials for the non-Federal hatchery programs. Impacts of the non-Federal hatchery actions will be included as part of the environmental baseline for this Opinion.

I. Proposed Actions

The proposed action reviewed in this Opinion is the Federal funding by USFWS and BIA of summer chum salmon and/or unlisted salmon hatchery programs described in this section. As

noted above, interrelated and interdependent non-Federal hatchery programs are included in evaluating the effects of the proposed Federal action, and are also described below. The Federally funded and non-Federal hatchery programs evaluated in this Opinion are identified in Table 1. Agencies or groups responsible for funding, administering and operating each hatchery program are noted in the table.

Table 1. Federally funded and interrelated and interdependent non-Federal summer chum salmon and unlisted salmon hatchery programs evaluated in this Opinion.

Hatchery Program	Funding Agency/Group	Administration	Primary Operator 1/
Federal Programs			
Summer Chum Salmon:			
Quilcene NFH	USFWS	USFWS	USFWS
Hamma Hamma	USFWS, private	WDFW	Long Live The Kings, HCSEG
Lilliwaup Hatchery	USFWS, private	WDFW	Long Live The Kings, HCSEG
Union River	USFWS, WDFW, private	WDFW	HCSEG
Unlisted Salmon:			
Quilcene NFH	USFWS	USFWS	USFWS
Hamma Hamma	USFWS, private	WDFW	Long Live The Kings, HCSEG
Duckabush	USFWS, private	WDFW	HCSEG
Enetai Hatchery	BIA	Skokomish Tribe	Skokomish Tribe
Port Gamble Hatchery	BIA	Skokomish Tribe	Skokomish Tribe
Quilcene Net-pens	BIA	Pt Gamble Tribe	Pt Gamble Tribe
Port Gamble Net-pens	BIA	Pt Gamble Tribe	Pt Gamble Tribe
Non-Federal Programs			
Summer Chum Salmon:			
Big Beef Creek	WDFW	WDFW	WDFW, UW, HCSEG
Salmon Creek	Private, WDFW	WDFW	WOS, NOSC
Chimacum Creek	Private, WDFW	WDFW	NOSC, WOS
Jimmycomelately Creek	WDFW, private	WDFW	NOSC, WOS, WDFW
Unlisted Salmon:			
Hoodsport Hatchery	WDFW	WDFW	WDFW
George Adams Hatchery	WDFW	WDFW	WDFW
McKernan Hatchery	WDFW	WDFW	WDFW
Dungeness Complex	WDFW	WDFW	WDFW
Eells Springs Hatchery	WDFW	WDFW	WDFW
Private/Volunteer Co-Ops	Private	WDFW	HCSEG, other private orgs.

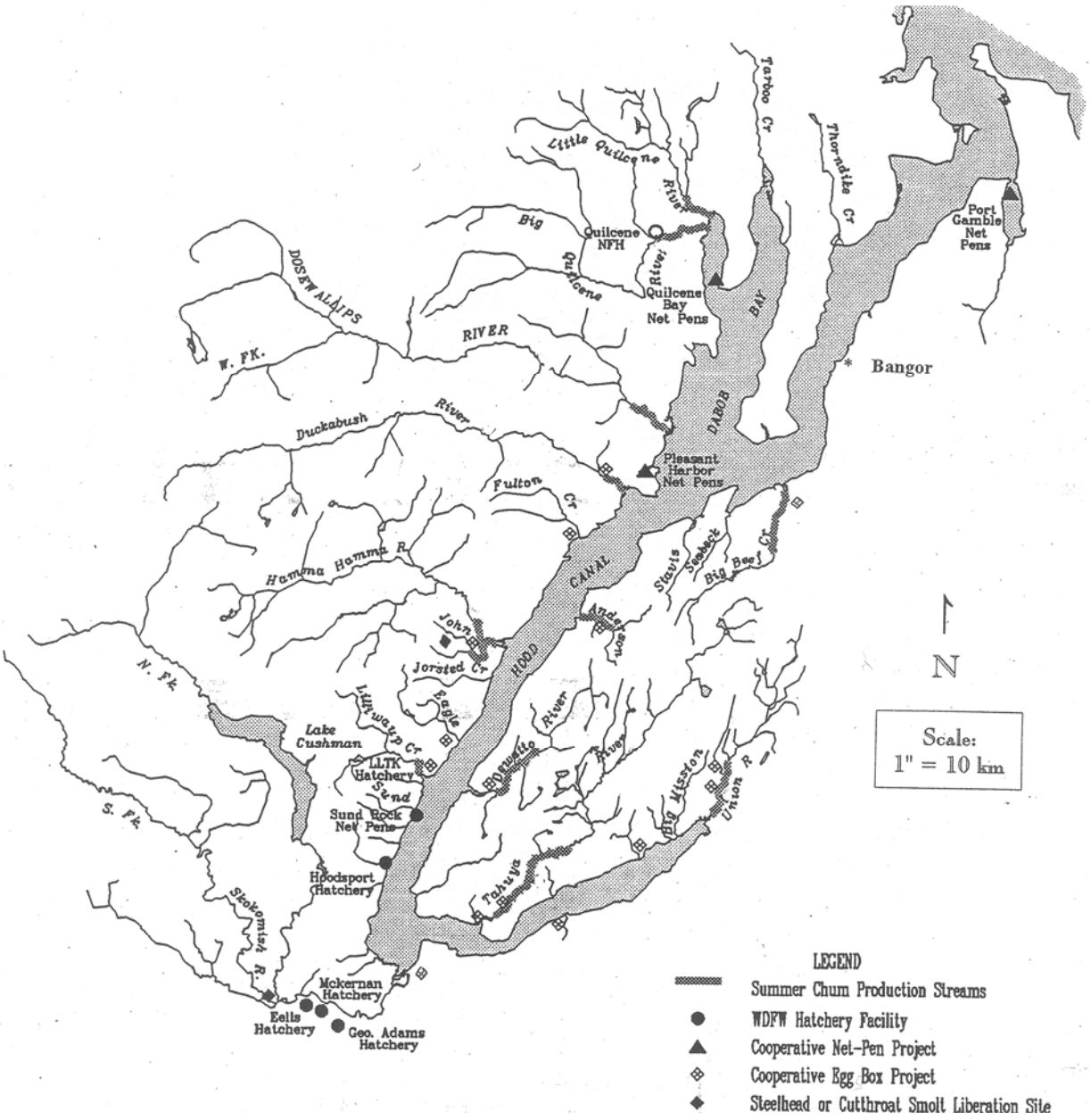
1/ Abbreviations: "HCSEG" is Hood Canal Salmon Enhancement Group; "WOS" is Wild Olympic Salmon; and "NOSC" is North Olympic Salmon Coalition.

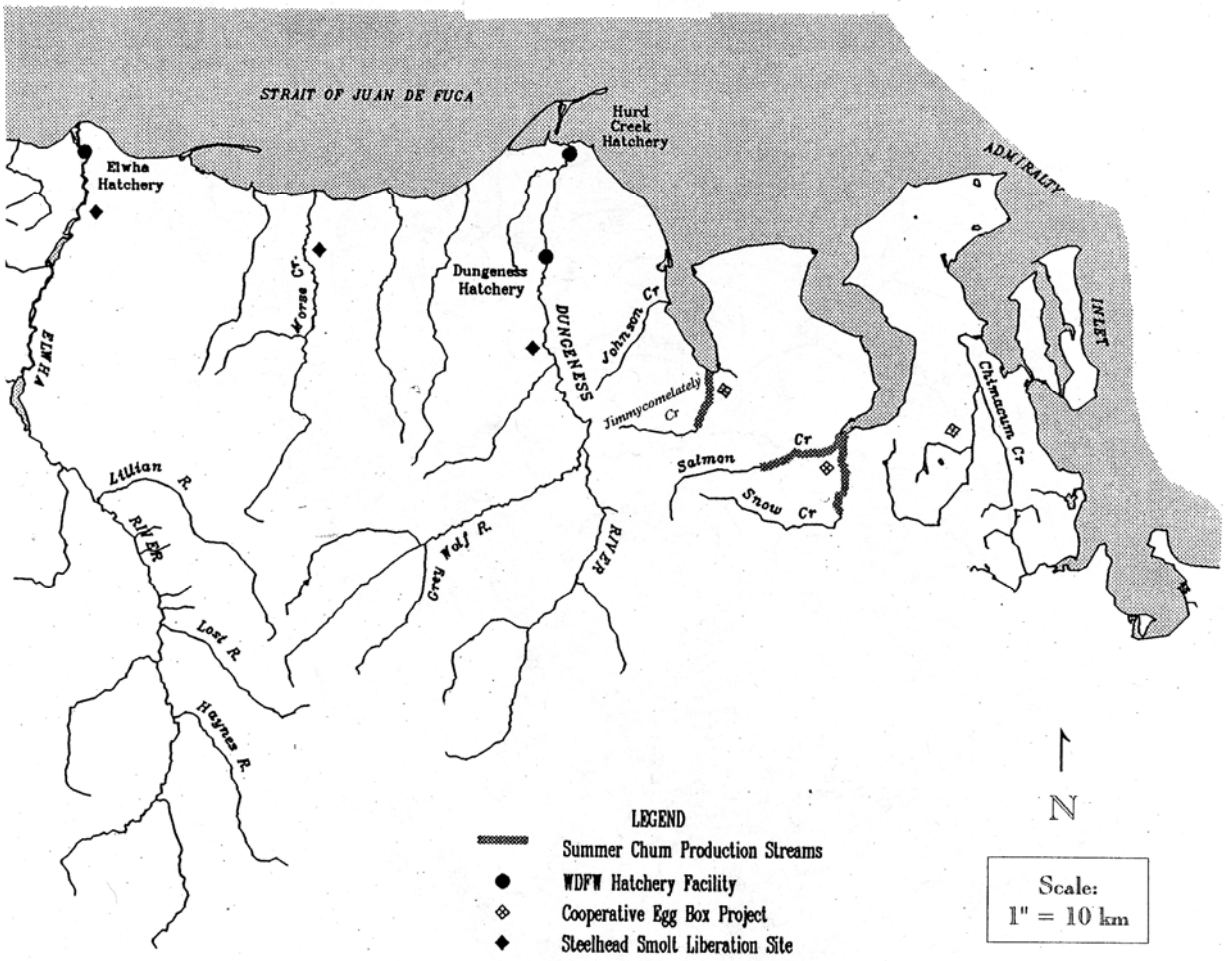
The funding agencies for the above hatchery programs provided HGMPs and/or the SCSCI to describe their programs and how the programs are operated, and to indicate how they will

address risks to listed fish. The HGMPs and the SCSCI contain detailed information about the hatchery programs that are the subject of this Opinion.

Section A of this part ("Hood Canal Summer Chum Salmon Supplementation and Reintroduction Programs") describes hatchery programs that propagate summer chum salmon for conservation purposes. These actions are considered in this Opinion because they are likely to adversely affect listed fish included in the Hood Canal summer chum salmon and Puget sound chinook salmon ESUs. Section B generally describes hatchery programs within the action area that propagate unlisted salmon species for fisheries harvest augmentation purposes and, for two other depleted species, for stock recovery purposes. Actions described in Section B are considered in this Opinion because they are likely to adversely affect listed Hood Canal summer chum salmon ESU populations. The discussion for each hatchery action describes the program for the purposes of this Section 7 consultation. HGMPs providing information for the following action discussions also describe the summer chum salmon programs for evaluation under the NMFS 4(d) Rule, limit 5 criteria. NMFS does not find it necessary and advisable to apply take prohibitions to activities associated with artificial propagation programs provided that a state or Federal HGMP for the program has been approved by NMFS as meeting criteria specified in (5)(i)(A)-(K) of the Rule.

The action area generally includes freshwater areas that are accessible to anadromous salmon, and nearshore marine waters in the Hood Canal and eastern Strait of Juan de Fuca regions of the State of Washington. Figures 2 and 3 identify the locations of hatchery programs evaluated in this Opinion.


Little Quilcene River
Big Quilcene River
Quilcene NFH
Quilcene Bay Net Pens
Tarboo Cr
Thorndike Cr
Port Gamble Net Pens
DOSEWALLIPS
W. FK.
RIVER
Bangor
DABOB BAY
Duckabush River
Pleasant Harbor Net Pens
Fulton Cr
Hamma Hamma R.
HOOD CANAL
Skokomish
Seabeck
Big Beef Cr
Anderson
Johns Cr
Jorsted Cr
N. Fk.
Eagle
Lilliwaup Cr
Lake Cushman
LLTK Hatchery
Dewatto River
Big Mission
Union R
Sund
Sund Rock Net Pens
S. Fk.
Hoodsport Hatchery
Tahuya River
Skokomish R.
Mckernan Hatchery
Eells Hatchery
Geo. Adams Hatchery
N
Scale:
1" = 10 km
LEGEND
Summer Chum Production Streams
WDFW Hatchery Facility
Cooperative Net-Pen Project
Cooperative Egg Box Project
Steelhead or Cutthroat Smolt Liberation Site



A. <u>Hood Canal Summer Chum Salmon Artificial Propagation Programs</u>.

Federally Funded Programs

1. Quilcene National Fish Hatchery

a. *Location, Operator, Goals, and Objectives*

Quilcene National Fish Hatchery (QNFH) is operated by the U.S. Fish and Wildlife Service. The hatchery is located at river mile (RM) 2.8 on the left bank of the Big Quilcene River, a tributary to Hood Canal in Jefferson County, Washington. USFWS submitted a completed HGMP to NMFS describing the summer chum program, including risk minimization measures applied to protect the listed population (USFWS 1999a). The hatchery program is consistent with the Co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000).

1) Intent of program - The goal of this program is to aid in the conservation and recovery of threatened summer chum salmon that are indigenous to the Big Quilcene River, and in Big Beef Creek, an eastside Hood Canal tributary where the indigenous summer chum population was

extirpated. The specific objectives of the program are to rebuild the Big Quilcene River summer chum run to 1974-78 average levels (3,024 naturally spawning adults), and to provide sufficient progeny of Big Quilcene River summer chum to restore a summer chum population in Big Beef Creek to1974-78 average levels (838 naturally spawning adults).

2) Performance objectives - The program is designed to produce adults that will return to successfully spawn in the natural environment. An additional desired result is to conserve the genetic and life history diversity of the target population. Monitoring and evaluation proposed for the program will determine the need and methods for improvement of supplementation or reintroduction operations or, if warranted, the need to discontinue the program. In particular, information on adult returns is collected and evaluated as the basis for determining when to stop the supplementation or reintroduction program.

b. *Hatchery Facilities*

1) Water source, permitted amount - The hatchery has three water sources for fish production, Big Quilcene River, Penny Creek, and a saltwater well. Maximum withdrawals from each source
are regulated by the Washington State Department of Ecology under surface water rights certificates: # S2-07466C for 15 cubic feet per second (cfs) from the Big Quilcene, # S2-28179 for 25 cfs from the Big Quilcene River, # S2-01218C for 10 cfs from Penny Creek, # S2-10233 for 15 cfs from Penny Creek, and ground water right # G2-28147 for 185 gallons per minute from a salt well.

Penny Creek, a tributary to the Big Quilcene River that is not used by natural summer chum for spawning, is used for incubation and early rearing. Later hatchery rearing stages, in the weeks before release, are completed on mixed Big Quilcene/Penny Creek water. Water temperature measurements were made in 1992 to compare the hatchery water source with the temperature in the river. From September 1 through November 30, the hatchery supply averaged 10.67 °C (SD = 2.40) and the mean Big Quilcene River temperature measured at the hatchery and at Linger Longer Bridge averaged 9.80 °C (SD = 2.33).

2) Broodstock collection, transportation, holding, and spawning - Adult salmon migrating up the Big Quilcene River enter the fish hatchery via a concrete fish ladder supplied by water that is leaving the hatchery after use for fish rearing. The ladder entrance is positioned at the end of a graduated field electric weir that spans the river. The weir was constructed by Smith-Root Co. in 1989 and forms an electro-mechanical barrier to fish passage. Summer chum broodstock staging for entry into the Big and Little Quilcene rivers are also collected from Quilcene Bay, in marine waters near the bay terminus, during tribal and non-Indian commercial beach seine fisheries directed at commingled coho salmon. The majority of summer chum used for the program are procured in this manner, with most captured immediately adjacent to mouth of the Big Quilcene River. The coho salmon-directed commercial seine fisheries are required to release all summer chum. Summer chum captured incidentally with coho salmon are removed by USFWS personnel from the seines and loaded into 4'x3'x3' floating net-pens. The fish are then transferred into perforated 8" diameter by 3' PVC tubes to contain the fish safely for transport in

fish totes to a waiting tank truck on shore. The summer chum are then trucked to the hatchery for release into covered, 8'x80' adult holding raceways at Quilcene NFH.

Summer chum adults are segregated by sex and held in the 8'x80' raceways until ready for spawning. Spawning is accomplished in a temporary building positioned next to the raceways.

3) Incubation, rearing, and release - Fertilized eggs are incubated to the eyed stage in wire baskets suspended in hatching troughs. Once eyed, the eggs are shocked, picked, and incubated to swim-up in vertical stack Heath incubators. When the hatched fry reach the swim-up stage, marking full absorption of the yolk-sac, the fry are placed in rectangular fiberglass rearing troughs. Feeding is initiated using automatic belt feeders, which reduces human contact. When the fry have grown large enough for adipose fin marking, they are processed through a marking trailer and are moved outdoors to 8'x80' rearing ponds for final rearing. Water is delivered to the raceways by underground piping that feeds a headbox at the upper end of each bank. Wooden dam-boards at the head of each raceway regulate the water height in the headbox. Holes drilled in the upper dam-boards serve as water entry points to the raceway. Flows into the raceways are determined by the number of holes in the dam-board and the water depth in the headbox. Water exiting the raceways spills over dam-boards at the tail end into a collection box that receives water from all raceways in a bank. From the collection box the water can be re-used on lower groups of raceways or returned to the river via a drain line.

c. *Broodstock Collection Protocols, including Risk Minimization Measures Applied.*
1) History and source, including viability status - The QNFH summer chum supplementation program began in 1992 with 100% natural indigenous broodstock. Returns of hatchery-released adult summer chum began in 1995. The source of broodstock used in the program remains indigenous summer chum adults returning to Quilcene Bay or the Big Quilcene River. Through the 1999 brood year return, brood composition has not been positively identifiable by origin (hatchery vs. natural), nor reliably estimated. Beginning in 2000, all hatchery-origin, three year old summer chum returning to the river will bear an adipose clip, allowing the visual distinguishment of the hatchery fish from natural-origin fish. The annual broodstock collection goal for the program is 500 adult fish including 250 males (200 from the bay fishery, 50 from the hatchery rack) and 250 females (200 from the bay fishery, 50 from the hatchery rack).

The Quilcene summer chum stock, which includes fish returning to the Big and Little Quilcene rivers, was designated as “depressed” in status by the Co-managers (WDFW and PNPTT 2000). As a supplementation effort, use of natural broodstocks through the QNFH program will intentionally increase the numbers of summer chum returning to the Big Quilcene River, resulting in recovery of the population. Prior to initiation of the supplementation program, the stock was rated as at high risk of extinction. However, based on an increasing escapement trend and recent large escapements attributable in large part to the success of the hatchery program, the current extinction risk for this stock is low (WDFW and PNPTT 2000).

2) Methods - Summer chum adults are collected from Quilcene Bay and the hatchery rack across the breadth of the identified terminal area and freshwater return period in upper Quilcene Bay and the Big Quilcene River (mid August through October 15). Summer chum salmon are collected at weekly levels proportional to average escapement timings for the returning population. Methods used to collect broodstock are snorkel survey/block seine collection within freshwater fish migration and holding areas; selective fishery (e.g., beach seine) removal in the targeted stream, or in extreme terminal marine areas *immediately adjacent* to the mouth of the target stream; and voluntary entry to the hatchery via the weir and fish ladder.

During all capture, holding and handling phases, fish are handled to insure that harm to the fish, including the duration that chum are out of water, is kept to a minimum. As noted previously, summer chum broodstock staging for entry into the Big and Little Quilcene rivers are collected from Quilcene Bay, in marine waters near the mouth of the river, during tribal and non-Indian commercial beach seine fisheries directed at commingled coho salmon. The majority of summer chum used for the program are procured in this manner. These commercial seine fisheries are required to release all summer chum. Summer chum captured incidentally with coho salmon removed from the seines are loaded into 4'x3'x3' floating net-pens. The fish are then transferred into perforated 8" diameter by 3' PVC tubes to contain the fish safely for transport in fish totes to a waiting tank truck on shore. The summer chum are then trucked to the hatchery for release into covered, 8'x80' adult holding raceways. As an additional broodstock collection method, summer chum adults migrating upstream in the Big Quilcene River are blocked by a concrete, electrified fish weir at RM 2.8, which directs fish into the QNFH fish ladder. From the river, the ladder terminates at the base of the hatchery ponds, where the fish are sorted by sex and transferred by hand into one of the covered 8'x80' holding ponds. Adult fish held in the ponds are checked three times weekly for maturity, and spawned when ripe. Beach seine captures depend on the local coho salmon fishery which begins the last week of August. The collection of broodstock from the fishery extends through September. The hatchery weir is in continuous operation from mid-August through December for summer chum, coho, and fall chum broodstock collection.

Risk aversion measures applied in the broodstock collection and mating program are designed to minimize the risk of injury and mortality to listed summer chum, and adverse genetic effects to the natural population including within and among population genetic diversity loss. At least half of the adults returning to Quilcene Bay in any given year are allowed to escape to spawn naturally to help maintain the genetic diversity of the natural-origin population. Adults captured for broodstock are collected so that they represent an unbiased sample of the naturally spawning donor population with respect to run timing, size, age, sex ratio, and any other traits identified as important for long term fitness. Special emphasis is placed on ensuring that the age group structure and sex ratio of collections are as similar as possible to those of adult returns of the founding population for the given week of the run. Spawning protocols, including collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of at least 1:1 male-female mating schemes, and avoidance of intentional selection for any life history or morphological trait, are applied that insure that hatchery broodstocks represent natural-origin stock diversity. Spawning protocols

will equalize as much as possible the contributions of parents to the next breeding generation. Returning adults produced by the supplementation program are used, with natural chum, as broodstock over the duration of the program (9 years post initial return of three year olds). The three generation limit for the duration of a program is intended to address the concern that repeated enhancement of the same population segment will result in a decrease in effective population size. It also limits to a few generations, the exposure of natural fish to the selective effects of hatchery conditions (i.e. domestication effects). All brood stock are sampled for genetic stock identification (GSI), scales, other biological characters, and for disease assessment purposes.

3) Fish Health Protocols - Fish health monitoring is conducted by USFWS fish health specialists. Significant fish mortalities to unknown causes are sampled for histopathological study.
The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998).

d. *Hatchery Operational Protocols, Including Risk Minimization Measures Applied*.
1) Water withdrawal method and effluent discharge practices - Penny Creek is the only water source for incubation and early rearing in the hatchery building. Water is obtained from a small dam and two intake structures. One intake feeds a 24" pipeline to a distribution manifold in the hatchery building. The other intake structure feeds a 30" pipeline supplying Penny Creek water to the raceway banks. Big Quilcene River is the primary water source for outdoor rearing in the raceways. Two intake structures 0.5 mile upriver from the hatchery supply water via a 30" pipeline to a sediment settling basin and rotating drum screens that exclude gravel, leaves, and fish from the raceway supply piping. First-pass Big Quilcene River water is available for all raceways. Through a combination of overflow collection boxes and valving, water previously used in raceway banks can be re-used in several combinations. The saltwater well supplies only a limited amount of water and is used in the fall and springtime to alleviate stress as the fish approach smoltification.

Fish waste is removed from the raceways by lowering water levels and brushing pond bottoms. Water drained during this process is removed via a drain piping system separate from the rearing water outfall that conveys waste water to a retention and settling basin. Waste water discharges are monitored and controlled for settleable solids and suspended solids, as specified under National Pollutant Discharge Elimination System (NPDES) permit # WA-187-2.

2) Annual target production goal (life stage, disposition of surplus) - The annual target fish production level for the Big Quilcene River is a maximum of 373,000 fed summer chum salmon fry at an average size of 1.0 gram released on-station. In addition, a maximum of 103,000 fed fry equivalents are produced for transfer as eyed eggs to Big Beef Creek. The production of surplus eggs or fish is avoided to the extent feasible by limiting the number of adult summer chum secured through broodstock collection operations. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - At spawning, ripe fish are randomly paired. Adults that swim into the hatchery rack are purposely mated with adults captured in Quilcene Bay to reduce the risk of mating hatchery-origin fish with hatchery-origin fish. Backup males are not used. Repeat spawning and matrix spawning are used only when insufficient numbers of adults are present to achieve one-on-one spawning. The main goals for the breeding of summer chum are for every adult to contribute, and for the genetic contribution from each fish to the population to be as equal as possible (Phelps 1993). These goals include the desire to minimize loss of alleles and to maintain the heterozygosity present in the existing natural-origin populations. In meeting these goals, spawning protocols are applied that insure that contributing broodstocks are representative of natural-origin stock diversity. Fish spawned represent the breadth of the summer chum return, in timing and proportion by timing. The entire August through October span of the return is represented in spawning, to the extent feasible. Mating schemes used in all summer chum supplementation programs have the objective of incorporating at least 1:1 male-female spawning ratios. Given the preceding goals, and the parameters regarding run timing representation, all matings are randomized with respect to fish age, size, and phenotypic traits. Intentional selection of any particular trait in the use of spawners, including age, size, and other morphological characters, is avoided.

Fertilized eggs are water hardened and surface disinfected for 30 minutes in 75 ppm iodophore solution. They are initially incubated in baskets set in troughs located inside the hatchery building on ambient Penny Creek water, which ranges in temperature seasonally from 6° to 12°C. The fertilized eggs are incubated to the eyed stage in wire baskets suspended in hatching troughs. Once eyed, the eggs are shocked, picked, and incubated to swim-up in vertical stack Heath incubators. Incubator trays contain substrate to support the sac-fry during yolk-sac absorption. Heath trays are loaded at a maximum density of 4,000 eyed eggs. Flows into Heath stacks are maintained at 4 gallons per minute to provide the most suitable environment to reduce bacterial loads.

4) Rearing methods, including densities - Summer chum fry are ponded for rearing approximately two months after hatching in during January. Once they reach the swim-up stage, the fry are moved from the Heath stack incubators to indoor tanks for initial feeding. After initial feeding is established, the fry are moved to outdoor raceways for further growth.

To allow for estimation of spawning ground return rates, contribution rates to extreme terminal area fisheries, and differentiation from natural-origin fish, all summer chum released at Quilcene NFH are marked with an adipose fin clip. Marking will occur at least one week before release. The fry are moved from the indoor tanks, through a tagging trailer for removal of the adipose fin, then outdoors to concrete hatchery raceways. Feeding rates average 2.5% body weight per day. A moist fish feed produced by BioMoist, Inc is fed from swim-up through release. Care is taken to avoid over-feeding, which can lead to a degraded rearing environment, which in turn can lead to bacterial gill disease. At all times, daily feeding rates are maintained below 0.10 pounds feed per gallon per minute pond inflow per day to minimize gill irritation, and to guard against bacterial gill disease out-breaks.

Hatchery rearing densities are those that yield the highest survival rates. Given that the actual identification of such densities is not likely, given current available data, the following conservative "standard" and "maximum" pond loading densities are applied in all proposed supplementation programs to promote the release of healthy, viable fish (S. Evans and T. Tynan, WDFW, pers. com. Feb. `98):

	Pounds fish/gpm inflow		**Pounds fish/ft3 rearing volume**	
Chum size	Standard	Max.	Standard	Max.
Swim-up	<1.0	1.5	0.5	0.75
1200-600/lb	1.0	2.5	1.0	2.0
600-400/lb	1.5	3.0	1.0	2.0

Accurate estimates of the biomass of the rearing population allow for the calculation of pond densities. Weight samples are taken bi-weekly to determine average fish size to be applied to inventoried numbers of fish in deriving biomass estimates.

5) Release methods, including number of fish and locations - Fish liberation strategies are designed to release fry of a size and condition, and at a time that will maximize freshwater exodus rates, maximize survival from the river to the estuary, maximize survival during estuarine migration, and maximize survival to adult return. Actively migrating summer chum smolts averaging 1.26 grams have been released at Quilcene NFH with high apparent adult return rates.

Releases from Quilcene NFH are forced, in the evening, and timed to coincide with a high tide. This release strategy is designed to allow the fish to reach the estuary at high tide under the cover of darkness, as a measure to minimize avian and fish predation on the migrating hatchery fish. The summer chum smolts are released at the Quilcene NFH from raceway discharge piping.
During the seven years of operation of the summer chum supplementation program (1993-99), release numbers have ranged from 25,000 to 613,000, and averaged 332,000.

6) Fish health protocols - Rearing ponds and screens are maintained in a manner that insures a hygienic environment for summer chum production. Mortalities are removed and enumerated at least daily to allow for monitoring of population size and fish health status. Rearing units are routinely cleaned to remove accumulated fish waste and uneaten feed. Troughs and tanks used for rearing are cleaned daily, and raceways are cleaned at least three times per week in a manner that does not re-suspend wastes into the water column where rearing fish may be adversely affected. The frequency of rearing unit cleaning is balanced to minimize disturbance to the fish.

All summer chum are reared under the guidance of certified fish health personnel and in accordance with the Co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times. Summer chum are examined by a fish pathologist within three weeks prior to release to determine fish health status.

e. *Monitoring and Evaluation and Research*

Monitoring and evaluation, and research, actions proposed in association with the summer chum salmon supplementation programs are designed to address the following SCSCI elements: 1) The estimated contribution of supplementation/reintroduction program-origin chum to the natural population during the recovery process; 2) Changes in the genetic, phenotypic, or ecological characteristics of target and non-target populations affected by the supplementation program; 3) The need and methods for improvement of supplementation activities in order to meet program objectives, or the need to discontinue a program because of failure to meet objectives; and 4) Determination of when supplementation has succeeded and is no longer necessary for recovery.

Monitoring and evaluation of summer chum supplementation actions in the Big Quilcene River have been underway since 1992. Studies have included juvenile marking (adipose clip with coded-wire tag, adipose clip only) for fisheries contribution and survival evaluations, stream surveys to enumerate spawners and evaluate straying, genetic stock identification work, and fishery interception monitoring. Broodstock collection and fish cultural practices have also been monitored and evaluated, including fish health monitoring and disease-status certification; monitoring of spawner age, sex ratio, fecundity, and length data; and egg, alevin, and fry mortality, size and growth monitoring. These studies and monitoring activities are expected to continue.

Specific measures proposed by USFWS to meet the above monitoring and evaluation objectives are as follows:

a) Element 1: Estimate the contribution of supplementation/reintroduction program-origin chum to the natural population during the recovery process.

1. All hatchery-origin summer chum fry are marked with an adipose fin clip to allow for distinction from natural-origin fish upon return as adults in fisheries, at the hatchery rack, and on the spawning grounds.
2. Spawning ground surveys are conducted throughout the summer chum return to count spawners, and to collect information regarding fish origin according to adipose fin clip observation, and age class composition through scale sampling.
3. The number of naturally spawning hatchery-origin summer chum that contribute to the supplemented population's annual escapement is estimated.
4. Escapements of nearby non-supplemented populations are monitored to determine the level of straying of supplementation program-origin fish to those drainages.
5. The total recruitment (fisheries contribution and escapement) of supplementation program origin chum is estimated. Survival rate estimates of hatchery fish are compared with estimates for natural-origin fish to measure the effectiveness of each program.

b) Element 2: Monitor and evaluate any changes in the genetic, phenotypic, or ecological characteristics of the populations presently affected by the supplementation program.

1. Genetic stock identification (GSI) allozyme collections of summer chum spawners will be continued for comparison with past collections to monitor changes in allelic characteristics, and with the intent to assess whether the supplementation program has negatively affected the genetic diversity of natural populations.
2. DNA samples are collected and archived for future analysis.
3. Natural spawner abundance and distribution of natural-origin and hatchery-origin fish are monitored. Spawner densities are determined and locations of preferred areas identified. Annual and long-term changes in spawning distribution of the populations are determined.
4. Spawning ground distribution, timing, and use by hatchery-origin fish are compared to traits exhibited by natural-origin spawners.

c) Element 3: Determine the need and methods for improvement of supplementation or reintroduction operations or, if warranted, the need to discontinue the program (as per criteria defined in Section 3.2.2.2 of the SCSCI).

1. All hatchery summer chum juveniles produced through the program are adipose fin clipped to allow for assessments of contribution and natural origin recruitment rates.
2. Fry survival for each program at various life stages is determined by:
    a. Monitoring growth and feed conversion for summer chum fry.
    b. Determining green egg to eyed egg, eyed egg to swim-up fry, and swim-up fry to released fry survival rates for summer chum.
    c. Maintaining and compiling records of cultural techniques used for each life stage, such as: collection and handling procedures, and trap holding durations, for chum broodstock; fish and egg condition at time of spawning; fertilization procedures, incubation methods/densities, temperature unit records by developmental stage, shocking methods, and fungus treatment methods for eggs; ponding methods, start feeding methods, rearing/pond loading densities, feeding schedules and rates for juveniles; and release methods for one gram fry.
    d. Summarizing results of tasks for presentation in annual reports.
    e. Identifying where the supplementation program is not meeting objectives, and make recommendations for improved fry production as needed.
3. A determination will be made of whether broodstock procurement methods are collecting the required number of adults that represent the demographics of the donor population with minimal injuries and stress to the fish by:
    a. Monitoring operation of adult trapping operations, ensuring compliance with established broodstock collection protocols .
    b. Monitoring timing, duration, composition, and magnitude of the run.
    c. Collecting biological information on collection-related mortalities and determine causes of mortality, and use carcasses for genetic stock profile sampling, if possible.
    d. Summarizing results for presentation in annual reports and providing recommendations on means to improve broodstock collection, and refining protocols if needed for application in subsequent seasons.

4. Fish health is monitored, specifically as related to cultural practices that can be adapted to prevent fish health problems. Professional fish health specialists of the USFWS will monitor fish health.
    a. Fish health monitoring is conducted by a fish health specialist. Significant fish mortalities to unknown causes are sampled for histopathological study.
    b. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998).
    c. Recommendations on fish cultural practices are provided on a monthly basis, based upon the fish health condition of chum fry.
    d. Fish health monitoring results are summarized in the annual report.

d) Element 4: Collect and evaluate information on adult returns. This element is addressed through consideration of the results of monitoring described in the above elements, and through the collection of information required under adaptive management criteria used as the basis for determining when to stop a supplementation or reintroduction program.

1. Age, sex, length, average egg size, and fecundity data are collected from a representative sample of broodstock for use as baseline data to document any phenotypic changes in the populations.
2. Commencing with the first year of returns of progeny from known naturally-spawned, hatchery-origin summer chum, results of spawning ground surveys and age class data collections are evaluated to:
    a. Estimate the abundance and trends in abundance of spawners;
    b. Estimate the proportion of the escapement comprised by chum of hatchery lineage, and of natural-origin lineage;
    c. Through mark sampling, estimate brood year contribution for hatchery lineage and natural-origin fish.

    The above information is used to determine whether the population has declined, remained stable, or has been recovered to sustainable levels.
3. Newly acquired electrophoretic analysis data reporting allele frequency variation of returning hatchery and natural-origin fish will be compared with baseline genetic data to determine if there is evidence of a loss in genetic variation (not expected from random drift) that may have resulted from the supplementation program.

Annual monitoring and evaluation reports will be reviewed and evaluated by the co-managers and USFWS to assess the effectiveness and effects of the supplementation and reintroduction programs. Adjustments that are needed, if any, will be discussed and implemented as determined to be necessary to meet the objectives of the SCSCI.

The USFWS also proposes to conduct research designed to increase scientific understanding of salmon population demographics and factors affecting summer chum salmon. This research includes the determination of run timing and presence of summer chum on spawning grounds to help gauge broodstock collection efforts for timing and scale, and installation and monitoring of

scour chains to measure degree of gravel movement in the Big Quilcene River. To conduct this research, streambanks along the Big Quilcene River are walked between mid-August and late September to determine presence and relative scale of summer chum escapement. Also, up to six stream transects with cable depth gauges are anchored prior to the summer chum spawning season in the river streambed. Regular measurements are made between early August and May to monitor gravel deposition and scour. These activities are expected to affect (through observation or harassment) less than 5% of the annual summer chum adult return on an annual basis.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The summer chum salmon supplementation program, and hatchery operational methods used to collect, rear and release summer chum at Quilcene NFH are consistent with the co-managers' SCSCI, the ESU-wide conservation proposed for recovering the listed population. The hatchery also operates within agreed fish production plans under the Hood Canal Salmon Management Plan, which is part of the Puget Sound Salmon Management Plan; a court ordered management framework resulting from *U.S. v. Washington* (PSSMP 1985).

1) Integration with fisheries management - The hatchery summer chum program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.5%, with an expected range of 3.3% to 15.3%. These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. No directed fisheries on summer chum salmon result from adult fish produced through the hatchery program.

2. Hamma Hamma Fish Hatchery

a. *Location, Operator, Goals, and Objectives*

The Hamma Hamma summer chum salmon supplementation project is located on John Creek, a right bank tributary to the Hamma Hamma River in Hood Canal. The project is managed through a partnership between two private and volunteer co-operative salmon enhancement groups: Long Live The Kings (LLTK) and the Hood Canal Salmon Enhancement Group (HCSEG); and WDFW. The project is staffed by LLTK and supported by HCSEG volunteers. Partial funding for the operation is provided by the Federal government, administered by the USFWS. A completed HGMP, and two supplemental documents describing broodstock collection, mating, egg incubation, and fish rearing procedures pertaining to the summer chum program were submitted to NMFS , including risk minimization measures applied to protect the listed population (LLTK 1999a; 1999b; 1999c). The summer chum recovery project is consistent with the co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000).

1) Intent of program - The goal of the Hamma Hamma project is to contribute to the restoration of a healthy, naturally self-sustaining population of Hamma Hamma River summer chum salmon

which maintains the genetic characteristics of the native stock. The objective is to lessen the current risk of extinction due to small population size by implementing an effective short-term recovery effort. This is accomplished by supplementing the indigenous summer chum population through artificial propagation and release of progeny secured from native broodstock for up to twelve years, speeding recovery of the population to abundances reflective of historic escapement levels

2) Performance objectives - The program is designed to produce adults that will return to successfully spawn in the natural environment. An additional desired result is to conserve the genetic and life history diversity of the target population. Monitoring and evaluation proposed for the program will determine the effects of the program on listed summer chum and the need for adjustment of supplementation methods, or, if warranted, the need to discontinue the program.

b) *Hatchery Facilities*

1) Water source, permitted amount - Water used for incubation and rearing is supplied by several groundwater springs that are right bank tributaries to John Creek. The springs exhibit a fairly constant flow, and a stable temperature, which will generally be warmer (daily and seasonally) than Hamma Hamma River water during the incubation and rearing periods. Thermograph data is collected to provide a precise overview of temperature differences between the springs and the river. A mass failure above the hatchery site in 1998 led to the loss of nearly all incubating summer chum in the program through severe sedimentation of spring water feeding the incubation container. Safeguards that have been installed to reduce the risk of loss from this factor are described below.

2) Broodstock collection, transportation, holding, and spawning - There are no permanent, physical structures associated with broodstock collection. Snorkelers in the Hamma Hamma River will either capture fish directly using a hook-and-line, or they will drive fish downstream into a block seine. Adults captured from the river are segregated by sex and held in capped, PVC tubes. The tubes are approximately 4’ long and 10” in diameter, and are perforated with 1" diameter holes throughout their length to allow for the free exchange of water. Tubes containing fish are secured by rope in quiescent areas within the river for holding until spawning. When the fish are mature, they are transported from the river by hand to a portable tent structure for spawning.

3) Incubation, rearing, and release - Hamma Hamma summer chum eggs are divided into at least three different remote streamside incubators (RSIs) for incubation. The eggs are incubated in 55 gallon RSIs. RSI’s this size have the capacity to incubate 100,000 eggs but in this project they will incubate between 2,500 and 20,000 eggs each, depending on the final egg take. These light loadings will minimize incubation stress and help safeguard the incubating eggs if any unforeseen catastrophic events dewater the barrels. Water flow into each RSI is regulated by an in-line valve between the water source and the barrel. Approximately 9 gallons of ground water per minute is supplied to each 55 gallon unit. Water will enter the bottom of each RSI via a water distribution pipe and up-well through a pea gravel pressure plate. The pea gravel insures

an even flow of water through the RSI. Artificial substrate (plastic bio-saddles or bio-rings) is placed immediately on top of the pea gravel. Approximately one-half of the RSI is filled with this resting substrate. Screened egg trays are placed immediately above the substrate. Water will exit each RSI through a pipe located close to the top of the barrel. Each RSI is also equipped with an opaque lid to prevent light from damaging the developing embryos and to protect the barrel from unwanted debris. Each RSI site will also have some form of head box or head trough, which will function as a silt trap. The head troughs will also be used when the fish are thermally marked. Buckets of ice are placed into each trough for prescribed periods of time to induce recognizable thermal patterns on the microstructure of the otoliths present in the incubating eggs and alevins.

As a additional safeguard against catastrophic loss (and in response to losses in 1998), upon reaching the eyed-egg stage, progeny of each summer chum family taken as broodstock are divided equally, with half of each family transferred in buckets by truck to Lilliwaup facility for propagation to the fry life stage. All summer chum fry produced from eggs transferred to Lilliwaup are returned via tank truck to earthen ponds at the Hamma Hamma Hatchery for additional rearing, acclimation, and release.

The outlet pipes for all the RSIs at the Hamma Hamma Hatchery will lead into 4'x4'x4' fiberglass tanks, or larger raceways, into which the emerging fry will volitionally enter. Fish are released directly from these rearing units into John Creek.

c. *Broodstock Collection Protocols, including Risk Minimization Methods*.
1) History and source, including viability status - The Hamma Hamma summer chum supplementation program was initiated in 1997 using indigenous broodstock procured from the river. The first hatchery-origin adult fish resulting from the program should return as three year olds in 2000. The source of broodstock used in the program will continue to be indigenous-origin summer chum adults returning to the Hamma Hamma River or John Creek. No other summer chum stocks have been transferred into the drainage, or are planned for use in future years, through the supplementation program. The annual broodstock collection goal for the program is based on criteria set forth in the SCSCI, which limits the number of fish taken for the program based on total run strength (WDFW and PNPTT 2000). The minimum number of fish to be collected each season is 25 pairs to help insure that the propagated population is representative of the founding population. Although the maximal broodstock collection level specified in the SCSCI (WDFW and PNPTT 2000) is 712, the actual, maximum number of fish to be collected each year at current run sizes is 50 pairs, to help insure that a significant proportion of the total population remains naturally spawning.

The Hamma Hamma summer chum stock was designated as "depressed" in status due to chronically low escapements, and at "moderate" risk of extinction by the co-managers (WDFW and PNPTT 2000). As a supplementation effort, use of natural broodstocks through the program will intentionally increase the numbers of summer chum returning to the Hamma Hamma Basin, resulting in recovery of the population.

2) Methods - Summer chum adults are collected from the Hamma Hamma River from mid-August through October 15, encompassing the identified adult summer chum spawning ground entry period in the river. Broodstock are collected at weekly levels proportional to average escapement timings for the returning population (LLTK 1999a). Two methods are used to secure adult summer chum for use as broodstock: a hook-and-line capture method, and a block seine capture method. Both methods employ two snorkelers, who swim the lower river downstream to a block seine held in place across the river at RM 1. The snorkelers either capture summer chum using hook-and-line (the preferred and primary method for collecting broodstock) or they drive fish downstream into the seine for capture (the secondary, back-up collection method). Regardless of the method used, care is taken to avoid capture and displacement of summer chum in the act of spawning to allow completion of redds.

The hook-and line method employs a large barbless fish hook attached to a metal cap and a high tensile strength line. The cap is attached to the shank of the hook with the opening facing toward the eye. A thin wooden stick is fitted into the cap, creating a gaff hook with a disengaging staff. The snorkeler holds the stick and the line, maintaining pressure on the hook, until a fish is engaged. Using the stick, the fish is hooked on the dorsal half of the caudal peduncle, anterior to or even with the adipose fin. The stick is then released, and the fish is retrieved with the line. The block seine is operated by at least three people trained in proper fish handling techniques. All non-target fish species are captured by hand from the seine and gently passed downstream. Any summer chum encountered are retained, up to the weekly broodstock collection goal. Care is taken to avoid walking on summer chum redds during operation of the seine. If large numbers of pink or fall chinook salmon are collecting in the seine, the seine lead line is lifted to allow the fish to escape downstream, rather than handling individual fish. Adults captured are segregated by sex and held in PVC tubes. The tubes are approximately 4' long and 10" in diameter, and have large holes drilled throughout their length to allow the free exchange of water. The tubes holding fish are placed in the river in backwater areas and secured to a fixed object on the bank with rope. Fish are held in the tubes until spawned. Females are checked for ripeness upon capture and twice per week thereafter, and will spawned as soon as possible. Males are live-spawned and returned to the tubes until they either spawn with three or more females or until they expire.

All hatchery-origin summer chum salmon released through the program have been otolith-marked, allowing for distinguishment of the hatchery fish from natural-origin fish beginning with the 2000 brood year return.
3) Fish Health Protocols - Fish health monitoring associated with adult fish used in the program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998).

d. *Hatchery Operational Protocols, Including Risk Minimization Measures Applied*.
1) Water withdrawal method and effluent discharge practices - Water used for incubation and rearing is gravity fed to RSIs and earthen ponds from springs emerging from the hill-side above

the hatchery location. The springs have generally provided a consistent, reliable flow of high quality water during the summer chum rearing period. As mentioned previously, a mass failure attributable to heavy rain-fall and forest practices led to a water supply failure, and fish loss, in 1998. Measures have been taken to reduce the risk of fish loss due to such events, including use of multiple spring sources, and avoidance of the hatchery area affected by the mass failure. These actions act to "spread the risk" during summer chum propagation, so that a similar land-slide event will not affect all fish maintained at the facility.

Due to its small size (less than 300 pounds of summer chum fry produced per year), the program is exempt from NPDES effluent discharge requirements. The program is not expected to impart any detrimental effects to water quality.

2) Annual target production goal (life stage, disposition of surplus) - Summer chum fed fry releases within the next few years are expected to range from 62,500 to125,000, at an average individual fish size of 1.0 gram. Consistent with the co-managers' SCSCI, when sufficient escapement and broodstock are available, up to 802,000 fed fry may be produced to help recover the population to average run size levels observed in the 1974-78 period (WDFW and PNPTT 2000). The production of surplus eggs or fish is avoided to the extent feasible by limiting the number of adult summer chum secured through broodstock collection operations. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Spawners are chosen randomly across the run at large. Female summer chum collected for the program are held in PVC tubes until ripe. Females are hand-checked for ripeness at least twice per week, and are spawned as soon as possible after ripeness is established. Males are used in the order captured, and are live- spawned until each male spawns with at least two and preferably three females. Back-up males are used to insure fertilization. Spawning is conducted using the 3x3 factorial method whenever possible, with back-up males used to insure fertilization. Under the 3x3 mating method, gametes from three females and three males are fertilized by partitioning eggs from each female into three aliquots (forming nine aliquots total from the three females). Each of the three aliquots from each female is then fertilized using a different male. The intent of this fertilization protocol is to buffer against the occurrence of non-fertile mates and to protect the effective population size from this happenstance. This fertilization method conforms with criteria set forth in the ESU-wide hatchery plan, which requires at least 1x1 spawning (WDFW and PNPTT 2000). Scales, otoliths, and GSI samples are removed from carcasses immediately after spawning, and all carcasses are returned to the Hamma Hamma River.

Green eggs are incubated in RSIs located on three separate spring-fed tributaries to Johns Creek. Each spring site will have three RSI's. As eggs are collected, they are sequentially loaded into different incubators, ensuring that the eggs in each incubator are approximately the same age and therefore in the same stage of development. At eyeing, the eggs are shocked and any dead eggs are removed and counted. As noted previously, one half of the eggs in each tray are transferred to Lilliwaup Hatchery and incubated there in an effort to minimize the risk of fish loss. While at

Lilliwaup Hatchery, the eggs and fry will receive a thermal mark that will indicate that they were incubated at Lilliwaup but reared in the Hamma Hamma basin. After the eggs destined for the Lilliwaup Hatchery have been removed, the remaining fish are thermally marked with a code indicating that these fish were incubated and reared entirely in the Hamma Hamma basin. The fry are allowed to volitionally exit the RSIs to enter a rearing container. At the completion of emergence, each RSI is inspected for dead eggs and alevins and malformed fry. These data are used, with gravimetric information collected for eggs at the eyed stage, to determine how many fry survived to emergence and entered their rearing containers

4) Rearing methods, including densities - Fish are reared in fiberglass tanks or raceways. Loading densities during rearing are maintained below levels recommended by the co-managers in the SCSCI. Each rearing vessel is covered with bird netting to prevent predation. As per the ESU-wide plan, these fry are fed for one to one and a half months for release as 1.0 gram smolts in early March. BioMoist, Inc. moist fish feed is introduced to the fry in the RSIs and then via the RSI outlet pipes into the rearing tanks. This technique is intended to minimize potential domestication effects. A careful accounting of any mortalities occurring during the rearing period is made so that an accurate estimate of the number of fish produced by this supplementation procedure is available. In addition, just prior to release, individual lengths and weights of 50 to 100 fingerlings from each rearing vessel are taken to form a record of mean lengths, weights, condition, and variation in each of these statistics.

5) Release methods, including number of fish and locations - From 62,500 to125,000 fed chum fry reared at the Hamma Hamma and Lilliwaup hatcheries are released from the rearing units en masse into John Creek in early March, at dusk, during a period of receding high tides. Feeding is discontinued for one day prior to release, and the outlet screen is removed from each tank to allow the fry to volitionally release. Fry remaining in the tanks the following day are force-released that following dusk.

6) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times. Summer chum are examined by a fish pathologist within three weeks prior to release to determine fish health status.

e. *Monitoring and Evaluation and Research.*

Monitoring and evaluation attached with the Hamma Hamma program are consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each supplementation program in the region are indicated (WDFW and PNPTT 2000). A primary objective of summer chum salmon monitoring and evaluation and research program is the collection of baseline biological information on summer chum salmon native to Hood Canal. Information collected will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. This baseline information is used in the future to determine the ecological and genetic effects of the

supplementation program on the propagated and natural-origin summer chum populations in the Hamma Hamma River. Biological samples collected from the summer chum will include tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples. Ten eggs are collected from each female for egg size determination. Scales are removed for age determination. Beginning in 2000, otoliths are sampled to determine origin of returning fish. Mortality data for the propagated population is collected during the incubation and rearing period. Length, weight, and condition factor data are collected from fry produced at release.

An additional objective is the determination of the need, and methods, for improvement of the supplementation program or, if warranted, the need to discontinue the program. This objective is pursued by otolith-marking all hatchery summer chum juveniles produced through the program to allow for assessment of contribution and natural origin recruit (NOR) production levels.

These monitoring and evaluation and research activities are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The supplementation program, and hatchery operational methods used to collect, rear and release summer chum, are consistent with the co-managers' SCSCI, which is the ESU-wide conservation proposed for recovering the listed population. The hatchery also operates within agreed fish production plans under the Hood Canal Salmon Management Plan, which is part of the Puget Sound Salmon Management Plan; a court-ordered plan under the *U.S. v. Washington* management framework.

1) Integration with fisheries management - The hatchery summer chum program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.5% (range 3.3% to 15.3%). These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. No directed fisheries on summer chum salmon result from adult fish produced through the hatchery program.

3. Lilliwaup Hatchery

a. *Location, Operator, Goals, and Objectives*

The Lilliwaup Hatchery summer chum salmon supplementation project is located at RM 0.5 on Lilliwaup Creek, a westside tributary to Hood Canal, Washington. WDFW initiated the program as a cooperative integrated recovery project in 1992 with the HCSEG to rebuild the indigenous summer chum salmon population in Lilliwaup Creek. This effort was conceived as part of a multi-agency initiative to increase the abundance of summer chum in response to declines in the

population observed in the 1980s, and the designation of west-side Hood Canal summer chum stock as critically depressed through the 1992 WDFW-Tribal Salmon and Steelhead Stock Inventory process (WDF et al. 1993). In 1994, LLTK assumed primary responsibility for this project. The project is now managed by LLTK through a contractual agreement with WDFW, and is partially funded through a contract administered by USFWS. LLTK consults with the HCSEG on the operation of the project.

WDFW and LLTK submitted a completed HGMP to NMFS describing the summer chum program, including risk minimization measures applied to protect the listed population (LLTK 1999d). Included with the HGMP was an addendum describing catastrophe response protocols that are applied. The project is consistent with the co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000). Lilliwaup Creek historically supported a large (several thousand adults) population of summer chum. Inadvertent over fishing and other factors drastically reduced this population so that in 1998 only 17 adult fish returned to the stream. Without intervention, the co-managers are concerned that this unique population of summer chum salmon will become extinct.

1) Intent of program - The goal of the project is to contribute to the restoration of a healthy, naturally self-sustaining population of summer chum salmon which maintains the genetic characteristics of the native stock in Lilliwaup Creek (LLTK 1999d). The project objective is to lessen the current risk of extinction due to small population size by implementing an effective short-term recovery effort. This is accomplished by supplementing the indigenous summer chum population through artificial propagation and release of progeny secured from native broodstock for up to twelve years, speeding recovery of the population to abundances reflective of historic escapement levels. The SCSCI presents the following objectives for the program: 1) develop and maintain, for 12 years (beginning in 1992), a population comprised of supplemented and naturally spawning fish using hatchery and natural-origin broodstock; 2) boost the numbers of naturally produced fish in the Lilliwaup using the indigenous population as the donor; 3) monitor, evaluate, and report on the effectiveness of the supplementation program, as measured by consistency with criteria set forth in the SCSCI.

2) Performance objectives - The program is designed to produce adults that will return to successfully spawn in the natural environment. An additional desired result is to conserve the genetic and life history diversity of the target population. Monitoring and evaluation proposed for the program will determine its success in increasing the summer chum run size, and the effects of the program on listed natural summer chum . The need for adjustment of supplementation methods, or, if warranted, the need to discontinue the program will also be indicated through the monitoring and evaluation program.

b) *Hatchery Facilities*

1) Water source, permitted amount - Water used for the Lilliwaup program originates from Beardslee Creek, a surface water tributary to Lilliwaup Creek. Beardslee Creek is generally several degrees warmer than Lilliwaup Creek, possibly due to its smaller size. In the event of water loss in the hatchery, a low-flow alarm is installed at Lilliwaup Hatchery,

and standby staff are available to respond to an alarm within five minutes. In the event of an expected freshet, hatchery personnel will remain overnight at the facility to safeguard the facility against flooding. The Lilliwaup facility has a backup water supply to be used in the event of emergency. There is also support from WDFW's Hoodsport and George Adams hatcheries, which can provide trash pumps to pump water from Lilliwaup Creek into fish holding tanks if necessary. Fish can also be transported off-station to either WDFW facility within 12 hours if necessary. The addendum document included with the LLTK HGMP further describes additional catastrophe management measures that are applied for the program.

2) Broodstock collection, transportation, holding and spawning - To collect broodstock, a temporary weir and adult fish trap are placed in Lilliwaup Creek at the furthest downstream point of observed spawning activity (approximately RM 0.25). The trap consists of a double "V" weir metal-framed box framed with 2"x2" wooden pickets spaced to contain upstream migrating adult fish. The weir blocking fish and directing them into the trap is constructed of fence posts and chicken-wire, anchored to the streambed with sand-bags. The trap is in place and operating from August 1 through October 15, which encompasses the summer chum salmon adult freshwater entry period in Lilliwaup Creek. The weir is checked for captured fish at least once per day. In the event of a freshet, hatchery personnel will remain on station and check the trap every two hours.

Chum salmon captured in the trap are transported from the creek in fish holding tubes to 8' or 20' diameter circular, fiberglass ponds at Lilliwaup Hatchery, where they are segregated by sex for holding through spawning. When ripe, the fish are spawned under cover in a permanent hatchery building on the premises. All carcasses are returned to Lilliwaup Creek after spawning.

3) Incubation, rearing and release - Newly fertilized eggs are loaded into 55 gallon RSIs housed within the hatchery building for incubation. Upon swim-up, fry volitionally migrate from the RSIs into 4' circular tanks for start-feeding. When the fish are actively feeding, they are moved to 20' circular fiberglass tanks for rearing through release. Summer chum fry are released from the 20' ponds directly into the hatchery outlet channel leading to Lilliwaup Creek.

c. *Broodstock Collection Protocols, including Risk Minimization Methods*.

1) History and source, including viability status - The Lilliwaup summer chum supplementation program was initiated in 1992 using indigenous broodstock captured from the creek. The co-managers developed the following requirements for Lilliwaup project broodstock collection activities at its inception to protect the natural population: 1) the program would continue for a maximum of three generations (12 years); (2) all brood stock would be captured in Lilliwaup Creek; (3) at least 50% of adults returning to river in any given year are allowed to spawn naturally; (4) egg takes are represented throughout the timing duration of the run, and the spawning ratio shall be one female to one male; (5) brood stock would be sampled for GSI, scales, other biological characters, and for disease assessment; and (6) a maximum of adult 25 pairs are used in this project, unless otherwise agreed by the co-managers.

For the first five years of the program, summer chum adults were captured by LLTK staff using seines and hook and line gear. Due to small Lilliwaup summer chum escapements (1992-96 range 40-105 fish), high flows in some years, the presence of pink salmon commingled with chum in odd numbered years, and the relative inefficiency of the collection methods applied, success in capturing sufficient broodstock for the supplementation program was low (10 to 23 % of the total return). WDFW technical staff expressed concern that the small number of summer chum broodstock collected and, as a result, the low number of progeny propagated in the Lilliwaup program may pose adverse within population genetic diversity effects to the natural population (Phelps 1996). The need to collect a larger number of broodstock to minimize the risk of within population diversity loss, and to effectively respond to the critical status of the natural population using hatchery intervention was highlighted. These concerns led to a decision by the co-managers to assist in the installation of a fish weir on the creek to improve summer chum adult collection efficiency. The program will also be allowed to collect up to 100% of the total return for the supplementation program as an emergency measure, and until the returning adult population increases to a level where the immediate risk of extirpation is not a factor (WDFW and PNPTT 2000).

The source of broodstock used in the program will continue to be indigenous-origin summer chum adults returning to the creek. No other summer chum stocks have been transferred into the drainage, or are planned for use in future years, through the supplementation program. The annual broodstock collection goal is based on criteria set forth in the SCSCI, which limits the number of fish taken for the program based on total run strength (WDFW and PNPTT). Since 1992, actual broodstock collection levels have ranged from 0 to 22 fish (1992 -98 data). At average run size levels, the collection goal for the program is 25 males and 25 females. Consistent with the ESU-wide plan, and, as mentioned above, due to the current, extremely depressed condition of the population, 100 % of the returning population may be captured for use in the hatchery program beginning in 1999 as an emergency measure. There are no external marks on hatchery summer chum produced through the program, so there is no means for differentiating natural and hatchery origin adults upon return. Beginning in 1998, all hatchery-origin fish have been otolith-marked, so proportions of hatchery and natural-origin fish can be ascertained post-spawning beginning in 2002 and in subsequent years.
The Lilliwaup summer chum stock was designated as “critical” in status based on chronically low escapements, and at “high” risk of extinction by the co-managers (WDFW and PNPTT 2000). Use of natural broodstock through the program will intentionally increase the number of returning summer chum, assisting in the recovery of the population.

2) Methods - Summer chum adults are collected from Lilliwaup Creek across the identified summer chum spawning migration period in Lilliwaup Creek (mid-August through October 15). Since 1996, a weir and adult fish trap have been operated at the most downstream point of observed spawning activity to collect broodstock. This location is well below the uppermost point of tidal influence, and spawning below the trap is not anticipated. Collection of the entire run as an emergency measure as described above will eliminate collection bias. The trap is checked at least daily for captured fish, and more frequently during freshets. If it is determined that there is a risk to fish life, the trap will be opened

to allow free passage of fish through the trap. The operation of the weir is supplemented with regular foot surveys of the creek to insure capture of all returning summer chum. Fish that avoid capture in the trap are collected using the hook and line capture method.

Summer chum captured are transported to the hatchery site for sorting by sex, holding in 8' outdoor tanks, and spawning within 12 hours of when ripeness is determined. Summer chum carcasses are returned to the creek after spawning to retain the nutrient value of the fish to the natural environment. Any chinook salmon collected incidentally in the summer chum broodstock trapping operation are released upstream on a daily basis. Any adipose-clipped (hatchery-origin) chinook are removed at the weir site. In a given year, up to 50 chinook may be encountered during trapping for summer chum in the Lilliwaup operation.

3) Fish Health Protocols - Fish health monitoring associated with adult fish used in the program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State (NWIFC and WDFW 1998).

d. *Hatchery Operational Protocols, Including Risk Minimization Measures Applied*.
1) Water withdrawal method and effluent discharge practices - Water used for incubation and rearing is gravity fed to RSIs and fiberglass rearing ponds from Beardslee Creek. A back-up water supply from Lilliwaup Creek and a domestic well are available in the event of water or power loss.

Due to its small size (less than 150 pounds of summer chum fry produced per year), the program is exempt from NPDES effluent discharge requirements. The program is not expected to impart any detrimental effects to water quality in habitat critical to summer chum salmon.

2) Annual target production goal (life stage, disposition of surplus) - Summer chum fed fry releases are expected to range from 25,000-50,000 for the next three years, at an average fish size of 1.0 - 1.5 grams. Actual fed fry release numbers have ranged from 0 to 20,000 over the seven years that the program has been in operation (1993-1999). Consistent with the co-managers' SCSCI, when sufficient escapement and broodstock are available, up to 376,000 fed fry may be produced to help recover the population to average run size levels observed in the 1974-78 period (WDFW and PNPTT 2000). The production of surplus eggs or fish is avoided to the extent feasible by limiting the number of adult summer chum secured through broodstock collection operations. Although not anticipated due to the poor status of the overall run, any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Female summer chum are held in the circular fiberglass tanks until ripe. Females are hand-checked for ripeness daily, and are spawned within 12 hours of ripeness being determined. Males are used in the order captured, and are live spawned until each male spawns at least two and preferably three females. Back-up males are used to insure

fertilization. Spawning is conducted using the 3x3 factorial method whenever possible, with back-up males used to insure fertilization.

Fertilized eggs are loaded into the Heath stack incubators at low densities (2,500 per Heath tray) for incubation in the hatchery building through the eyed stage. The eggs are shocked at eye-up, allowing for removal and enumeration of mortalities. Surviving eyed eggs are then loaded at low densities into 55 gallon RSIs (10,000 eggs total per RSI), also positioned in the hatchery building. Average green to eyed egg survival rates have exceeded 92% during incubation at Lilliwaup Hatchery. Since 1998, all eggs incubated in the hatchery have been otolith-marked to identify hatchery-origin fish on return and to assess contribution rates for the program.

4) Rearing methods, including densities - Fry are allowed to volitionally migrate upon swim-up from the RSIs inside hatchery building into 4' diameter circular tanks for start-feeding. Accumulated temperature units (TUs) range from 900 to 2,000 at swim-up, and swim-up dates ranged from January 14 to February 7. Mean weight at swim-up is approximately 0.33 grams. Rearing densities for swim-up fry are 2,500 fish per 4' circular tank. Fry are transported by bucket to 20' circular tanks outdoors on the hatchery grounds for completion of rearing. Loading densities are maintained at 25,000 fish per tank. Natural rearing methods are applied, when possible, to reduce the risk of domestication effects, including allowances for volitional migration, covering of rearing tanks to avoid human disturbance and provide shade, and introduction of feed to influent water to mimic natural feed access. Sampling of fry during rearing is minimized as a further measure to mimic natural conditions and avoid human disturbance during rearing.

5) Release methods, including number of fish and locations - Program goals call for release of fed fry at 1.0 gram average fish size (56 mm tl), 1-1.5 months after swim-up. Fry releases into Lilliwaup Creek adjacent to the hatchery site are planned for dusk on the first day with appropriate, high tides to help protect the fish from predators, between late February and mid-March. Releases are forced, in the evening, and timed to coincide with a receding high tide. As mentioned above, release numbers in recent years have ranged between 0 and 20,000 fed fry. Fry releases are expected to range from 25,000 to 50,000 for the next three years.

6) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times. Summer chum are examined by a fish pathologist within three weeks prior to release to determine fish health status. Green egg to fry release survival rates have been high for the program (>90 %), and well within levels expected for an effective hatchery program (see Fuss and Ashbrook 1995).

e. *Monitoring and Evaluation and Research.*
Monitoring and evaluation attached with the Lilliwaup program are consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each

supplementation program in the region are indicated (WDFW and PNPTT 2000). A primary objective of summer chum salmon monitoring and evaluation and research program is the collection of baseline biological information on summer chum salmon native to Hood Canal. Information collected will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. This baseline information will be used in the future to determine the ecological and genetic effects of the supplementation program on the propagated and natural-origin summer chum populations in Lilliwaup Creek. Biological samples collected from the summer chum will include tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples. Ten eggs are collected from each female for egg size determination. Scales are removed for age determination. Beginning in 2000, otoliths are sampled to determine origin of returning fish. Mortality data for the propagated population is collected during the incubation and rearing period. Length, weight, and condition factor data are collected from fry produced at release.

An additional objective is the determination of the need, and methods, for improvement of the supplementation program or, if warranted, the need to discontinue the program. This objective is pursued by otolith-marking all hatchery summer chum juveniles produced through the program to allow for assessment of contribution and natural origin recruit (NOR) production levels.

These monitoring and evaluation and research activities are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures. Listed chinook salmon are not likely to be affected by these programs.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The supplementation program, and hatchery operational methods used to collect, rear and release summer chum, are consistent with the co-managers' SCSCI, which is the ESU-wide conservation proposed for recovering the listed population. The hatchery also operates within agreed fish production plans under the Hood Canal Salmon Management Plan, which is part of the Puget Sound Salmon Management Plan; a court-ordered plan under the *U.S. v. Washington* fisheries management framework.

1) Integration with fisheries management - The hatchery summer chum program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.5% (3.3% to 15.3%). These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. No directed fisheries on summer chum salmon result from adult fish produced through the hatchery program.

4. Union River Supplementation/Tahuya River Reintroduction Program

a. *Location, Operator, Goals, and Objectives*

The proposed program involves supplementation of the Union River summer chum salmon population to boost adult returns to the watershed using the indigenous population as the donor. Increased adult summer chum returns resulting from the project, above identified Union River natural spawner and supplementation goals, will enable future use of Union stock for the reintroduction of summer chum into the Tahuya River, an adjacent Hood Canal tributary. The original summer chum salmon population in the Tahuya River was extirpated in the early 1990s.

The supplementation project on the Union River is a new project, initiated in 2000 (see Figure 1). The Union River program (and the future reintroduction effort for the Tahuya River using Union stock) is jointly operated by WDFW (as the lead agency) in cooperation with the Hood Canal Salmon Enhancement Group (HCSEG). WDFW will provide technical support, including assistance in fish trapping and spawning at a weir located at RM 0.3 on the Union River, egg fertilization, incubation, and otolith marking at George Adams Hatchery (located on Purdy Creek, a tributary to the Skokomish River), biological sampling, and fish health monitoring. The HCSEG, with funding provided through USFWS, will assist in fish trapping and spawning. The HCSEG is also responsible for on-site staffing of the Huson Spring facility at RM 1.5 on the Union River, where fry for the supplementation program are produced for release. PNPT Council and Skokomish Tribal staff will provide technical input for the program.

A completed HGMP describing the Union River summer chum supplementation program, including risk minimization measures applied to protect listed summer chum and chinook salmon, was submitted to NMFS on June 16, 2000 (WDFW 2000e). The HGMP is used as a reference in providing the following information regarding the proposed supplementation program using Union River stock. The program described in the HGMP is consistent with, and supported by, the co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000). A new or revised HGMP that provides further details regarding the proposed transfer of Union River stock for the Tahuya River reintroduction program will be provided by WDFW at a later date.

1) Intent of program - The proposed supplementation program is the initial step in an effort to reintroduce summer chum salmon to a Hood Canal watershed where annual adult returns once numbered in the thousands: the Tahuya River. In the SCSCI, the Tahuya River was identified as an extirpated stock and a candidate for reintroduction (WDFW and PNPTT 2000). The Initiative also identified the Union River summer chum salmon stock as a potential candidate for supplementation to allow for its use as a donor stock for reintroduction (WDFW and PNPTT 2000). The Union River summer chum stock is considered the most appropriate donor stock for reintroduction of summer chum to the Tahuya River, as it is the nearest summer chum stream geographically, and the stock shows genetic, life history pattern, and ecological similarities to the extirpated Tahuya population (WDFW 2000e).

Objectives defined in the SCSCI for supplementation on the Union River are as follows: 1) develop and maintain for up to12 years a population comprised of supplemented and naturally

spawning fish using hatchery and natural-origin broodstock from the Union River; 2) boost the numbers of naturally produced summer chum in the Union River using the indigenous population as the donor; 3) produce a maximum of 86,000 fed fry each year for release into the Union River; 4) monitor and evaluate the effectiveness of the supplementation program, as measured by consistency with criteria set forth in the SCSCI; and 5) reintroduce Union River stock summer chum salmon into the Tahuya River when returns to the Union River reach abundance levels that exceed natural spawner and supplementation program escapement objectives and provide for a minimum transfer of gametes from 25 summer chum pairs.

2) Performance objectives - The egg to smolt survival advantage imparted by artificial propagation is designed to boost annual adult return levels to the Union River above abundances that may be expected through natural production. Adult returns to the Union River during the period when supplementation occurs are monitored to evaluate hatchery fish contribution rates and the effects of the program on the naturally spawning donor population. Expected results from the program are an increase in adult summer chum returns to the Union River that will allow for the eventual transfer of surplus gametes to the Tahuya River. Details regarding further measures applied to monitor the results and effects of the supplementation program are presented in the HGMP submitted for the program, and in the SCSCI (WDFW 2000e; WDFW and PNPTT 2000).

b. *Hatchery Facilities.*

1) Water source, permitted amount - The Union River program relies on well or spring water sources at three separate sites. Adult fish procured for use as broodstock are trapped and held for spawning directly in the Union River, without the need to withdraw water. Eggs transferred to George Adams Hatchery are incubated using water provided by three wells, two of which are permitted for withdrawal of 500 gpm, with the third permitted for 1,200 gpm. The hatchery also has a back-up water supply, provided by gravity feed at 500 gpm. Eyed eggs and fry are incubated and reared at the Huson Spring facility on water supplied via gravity feed through an intake structure on adjacent springs at rates of 12 gpm and 60 gpm, respectively.
The wells at George Adams Hatchery provide water for egg incubation ranging in temperature from 43 to 50 degrees Fahrenheit. Huson Spring water is supplied at a constant temperature of 47 degrees Fahrenheit. Influent dissolved oxygen levels at both hatchery sites are at saturation.

2) Broodstock collection, transportation, holding, and spawning - Beginning with brood year 2000, broodstock are collected using a temporary weir and trap live box placed in the Union River at approximately RM 0.3. The trap is designed to withstand periodic high water events. A trailer on-site will provide shelter to allow HCSEG staff to be present continuously at the weir site during its operation to collect broodstock. Summer chum adults retained as broodstock are held through spawning in a holding pen, located near the trap location. The holding pen is designed and constructed to withstand high water events, and is secured to prevent predation and poaching. The pen will also be constructed to allow for segregation of fish by sex and capture date. Broodstock may also be held in PVC tubes either in the trap, near the trap site, or in the holding pen. Fish are spawned directly adjacent to the trap beneath a temporary awning to shield gametes from rain.

Gametes procured at the Union River site are transported by truck in oxygenated, chilled plastic bags to George Adams Hatchery. Moistened, eyed eggs are transferred to the Huson Spring site by truck in 5 gallon buckets cushioned by foam pads.

3) Incubation, rearing, and release - Summer chum eggs transferred into George Adams Hatchery from the Union River are incubated through the eyed stage in either vertical stack incubators or isolation buckets. Eyed eggs transferred to Huson Spring are incubated through fry swim-up in 55 gallon remote site incubators (RSIs) supplied with water at a rate of 4 to 12 gpm. Swim-up fry are reared at Huson Spring in 16' x 3' x 3' fiberglass raceways. Upon completion of rearing, summer chum fry reared at Huson Spring may be released on-site, or transferred by truck for release near the mouth of the Union River in an oxygenated 4' x 4' x 2.5' plastic fish tote, or in a WDFW fish transport tank truck. If the transport truck is used for release, the estimated time in transit to the release location is less than 60 minutes.

c. *Broodstock Collection Protocols, including Risk Minimization Measures.*
1) History and source, including viability status - The proposed program is new and scheduled for initiation beginning with the 2000 summer chum brood year return. The source of broodstock used to initiate the supplementation program is the indigenous summer chum stock in the Union River.

The Union River summer chum salmon population was designated as “healthy” in status, but at “moderate” risk of extinction by the co-managers in the SCSCI (WDFW and PNPTT 2000). A “moderate” extinction risk was applied to the stock based on a declining escapement trend in recent years. The Tahuya River summer chum population proposed for future reintroduction was extirpated by the early 1990s, and was therefore designated as “extinct” by the co-managers in the SCSCI (WDFW and PNPTT 2000).

2) Methods - The number of broodstock that are collected from the Union River is consistent with guidelines defined in the SCSCI (WDFW and PNPTT 2000). The allowable annual broodstock collection proportion is set at 50 % of the total female summer chum salmon return to limit effects of the removal of adult fish on abundance and diversity of the naturally spawning population. Up to 97 adult summer chum salmon (39 females and 58 males) are proposed to be collected to meet annual fed fry release objectives for the supplementation program. The program goal, assuming a 1:1 sex ratio, is 78 adults (39 females and 39 males).

Summer chum salmon adults are captured at the Union River weir within the August 1 through October 15 spawning migration period. Fish not retained as broodstock are released upstream of the trap to spawn naturally. The trap is checked several times daily for captured fish, and more frequently during freshets. The trap is opened to allow free fish passage if adverse water conditions appear to pose a risk to summer chum encountering the weir and trap.

Summer chum are collected as broodstock randomly as the fish arrive at the trap location, proportional to the timing, weekly abundance and duration of the total return to the river.

WDFW will prepare a sampling schedule to guide weekly broodstock collection numbers. The location of the weir and trap in the lower reaches of the Union River (RM 0.3), near the downstream point of observed natural spawning, will help insure that fish retained as broodstock are representative of the total run to the river.

Summer chum broodstock are removed from the trap and held through spawning in a holding pen located near the trap. Males and females are segregated, and maintained in separate sections of the pen by capture date. Fish are held in the holding pen up to a maximum of 10 days. As mentioned previously, the pen is secured and monitored by on-site staff to minimize the risk of poaching or predation of summer chum during holding.

3) Fish health protocols - Broodstock collected at the Union River weir are sampled by WDFW Fish Health Division staff and certified as free of regulated fish pathogens. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Eggs transferred to George Adams Hatchery are disinfected upon fertilization in an iodophore solution prior to loading into incubators to minimize the risk of fish pathogen transmission.

d. *Hatchery Operational Protocols including Risk Minimization Measures.*
1) Water withdrawal method, effluent discharge practices - Water used for incubation at George Adams Hatchery is supplied by three infiltration wells adjacent to the Skokomish River. This source of water is low in fines, and siltation is not expected to be a risk factor to incubating summer chum eggs. The WDFW hatchery is supplied with an alarm system and back-up generator in the event of power failure, and is staffed full-time to allow rapid response to other factors, such as flooding, that could harm incubating eggs. The Huson Spring facility is supplied by water that is gravity-fed from an adjacent spring. The level of fines in this water source is also low, and incubating eggs are unlikely to be adversely affected by siltation. Due to its reliance on a gravity feed water source, the Huson Spring operation will not be affected by power failures. The Huson Spring facility is equipped with a low flow alarm, which is monitored by several volunteer crew members who are able to respond within several minutes. A back-up water supply will also be available. The facility will not be staffed full time. The operation is checked at least once daily during operation and more frequently during high flows and/or severe cold weather events.

George Adams Hatchery operates under a NPDES permit that limits discharge effects on the environment, and requires monitoring of effluent for settleable and suspended solids. The Huson Spring facility will produce a relatively small amount of fish each year, and well under the 20,000 pounds per year criteria set by the Washington Department of Ecology (WDOE) as the limit for concern regarding hatchery effluent discharge effects and for the requirement for a NPDES permit.

2) Annual target production goal (life stage, disposition of surplus) - The annual target, on-station fish production level for the Union River supplementation program is a maximum of

86,000 fed fry of Union River stock at an average size of 1.0 gram (WDFW and PNPTT 2000). The production of surplus eggs or fish is avoided to the extent feasible by limiting the number of adult summer chum secured through broodstock collection operations. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Adult summer chum collected and held at the Union River weir are spawned adjacent to the weir site. After collection of biological data (length, weight, DNA and GSI tissue samples and otoliths), spawned carcasses are returned to the Union River for nutrient enhancement purposes. Eggs and milt collected from spawned fish are placed separately in dry, zip-locked bags, and stored on ice for transport by truck to George Adams Hatchery. Eggs are fertilized at George Adams Hatchery factorially, or using at least a 1:1 spawning ratio. After fertilization, the eggs are disinfected (in an iodophore solution) and placed in vertical tray (Heath stack) incubators or isolation buckets for incubation to the eyed egg stage. All eggs will receive an otolith thermal mark during incubation to provide a distinctive mark for Union stock summer chum. Incubating eggs are treated with a formalin solution and dead eggs are removed when the eggs reach the eyed stage to prevent mortality from fungus. The eyed eggs are enumerated and transferred to Huson Spring for incubation through hatch in 55 gallon RSIs. Eyed eggs transferred from George Adams Hatchery to the Huson Spring facility are disinfected upon arrival in an iodophore solution. The eyed eggs are incubated under protected conditions (maintained in darkness, without physical disturbance) and at low densities (less than 25,000 eggs per RSI) with each RSI supplied with an inflow of 4 to 12 gpm spring water at a stable temperature of 47 degrees Fahrenheit. The incubation units at Huson Spring are protected from loss of flow through a battery-operated cell phone/alarm system, allowing rapid response to any system failure.

4) Rearing methods, including densities - Swim-up fry are allowed to emigrate volitionally from RSIs at Huson Spring into 16' fiberglass raceways for rearing. Beginning one to three days after ponding, feed is introduced to the fry via hand casting (several times per day) and through the use of automatic feeders. The summer chum salmon fry are fed a commercial fish meal-based diet at a rate of 2.5 % per body weight of the population per day for the duration of rearing. Sample weights to identify fish size and appropriate feeding rates are taken every one to two weeks during the rearing period. Preferred and maximum pond loading and feeding parameters specified in the SCSCI (WDFW and PNPTT 2000) are applied during rearing. Egg and juvenile fish health at Huson Spring are periodically monitored by WDFW Fish Health Division personnel and continuously by HCSEG staff. Significant fish mortality to unknown causes is sampled for histopathological study.

5) Release methods, including number of fish and locations - After 30 to 60 days of rearing in the fiberglass raceways, and upon reaching an individual size of approximately 1.0 gram (range 0.9 to 1.5 gms), the summer chum are released en masse into the Union River. The target release date range is March-April. Releases may be made on-site at RM 1.5 on the Union River, or fish may be transported by tank truck of fish tote downstream for release at a location on the Union River close to the estuary (approximately RM 0.1). Fish releases on-site would be designed to

distribute returning spawners across available spawning habitat in the river. Liberations near the estuary would allow rapid exodus from freshwater, minimizing loss of chum fry to predation in the lower river. The fry are released in the evening, on a high tide, to minimize the incidence of avian and fish predation.

6) Fish health protocols - Union River-origin summer chum are incubated and reared under the guidance of certified fish health personnel from WDFW, and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred from the Union River for fertilization at George Adams Hatchery are water hardened in an iodophore. Fungus in incubators is controlled by formalin drip prior to eye-up. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times, as specified in the SCSCI (WDFW and PNPTT 2000). The summer chum fed fry population will be examined by a fish pathologist within three weeks prior to release to document fish health status.

e. *Monitoring and Evaluation and Research* -
Monitoring and evaluation proposed to be conducted for the Union River supplementation program is consistent with SCSCI monitoring and evaluation elements required for all regional supplementation programs (WDFW and PNPTT 2000). These elements, carried forth as "Performance Indicators" by WDFW in the HGMP submitted for the program, include the following: 1) estimate the contribution of supplementation program-origin chum to the natural population during the recovery process; 2) monitor and evaluate any changes in the genetic, phenotypic, or ecological characteristics of the populations presently affected by the supplementation program; 3) determine the need, and methods, for improvement of supplementation operations, or, if warranted, the need to discontinue the program; and 4) collect and evaluate information on adult returns. Specific monitoring and evaluation measures are proposed to be implemented in response to each of these elements (see WDFW 2000e).

Primary objectives of the summer chum salmon monitoring and evaluation program will include collection of baseline biological information on summer chum salmon native to the Union River, identification of the success of the program in producing adult returns, and monitoring of effects on the natural donor population. Baseline information collected from summer chum adults retained as broodstock will include fecundity, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. Fish scales will also be removed for age determination. An additional objective is the determination of the need, and methods, for improvement of the supplementation program or, if warranted, the need to discontinue the program. This objective is being pursued by otolith-marking all hatchery summer chum juveniles produced through the program to allow for assessment of contribution and natural origin recruit (NOR) production levels. Beginning in 2003, otoliths will be sampled to determine whether returning fish were of hatchery or natural origin. Mortality data for the propagated population is collected during the incubation and rearing period. Data on fish per pound is collected from fry produced at release.

Injury or mortality levels to summer chum salmon will not be elevated as a consequence of the monitoring and evaluation and research activities, because they are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The proposed Union River summer chum supplementation program, and hatchery operational methods proposed to collect, transfer, rear and release summer chum, are consistent with the co-managers' SCSCI, which is the ESU-wide conservation proposed for recovering the listed population (WDFW and PNPTT 2000). Monitoring and evaluation and research proposed for the program is also fully consistent with activities set forth within the co-managers' conservation initiative to improve scientific understanding of artificial propagation benefits and risks. The program also operates within agreed fish production planning processes included under the Puget Sound Salmon Management Plan; a court-ordered plan under the *U.S. v. Washington* fisheries management framework.

1) Integration with fisheries management - The summer chum supplementation program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the Initiative is 10.8% (3.3% to 15.3%). These target rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries, and are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. No directed fisheries on summer chum salmon will result from adult fish produced through the Union River program.

Non-Federally Funded Programs

5. Big Beef Creek Hatchery

a. *Location, Operator, Goals, and Objectives*

The summer chum salmon hatchery program on Big Beef Creek is a reintroduction effort, initiated to restore a summer chum salmon run in an eastside Hood Canal tributary historically supporting a self-sustaining population of the species. The reintroduction project is operated jointly by WDFW (as the lead agency), in cooperation with the University of Washington and the HCSEG. USFWS provides eyed eggs and technical support for the program, but does not fund incubation, rearing, and research at Big Beef Creek. The reintroduction project was initiated in 1996, when Quilcene stock eyed eggs were first transferred in for on-site incubation, rearing, and release. The program is now in its fourth year of operation. In addition to the artificial propagation and research activities associated with the program, a spawning channel existing at the site was renovated in 1999 to enhance spawning success for summer chum adults returning in 1999 and beyond. The major objective of this renovation project was to provide a refuge for naturally spawning summer chum, assisting in increasing the numbers of naturally spawned fish produced in the watershed until habitat conditions in lower Big Beef Creek that are detrimental to spawning success are remedied.

An additional, important objective of the Big Beef Creek summer chum program is the conduct of monitoring and evaluation and research directed at hatchery, spawning channel, and natural origin summer chum. These programs are of region-wide importance, improving scientific understanding regarding the effects of, and the success in using, artificial propagation to rebuild or restore summer chum populations in the action area. Limiting factors to the re-establishment of a self-sustaining summer chum population in Big Beef Creek will also be identified.

A completed HGMP describing the summer chum artificial propagation, spawning channel, and research programs, including risk minimization measures applied to protect the listed population, was submitted to NMFS on May 12, 2000 (WDFW 2000a). The HGMP is used as a reference in providing the following information. The programs described in the HGMP are also consistent with, and supported by, the co-managers' SCSCI, where the programs, and fish propagation measures applied, are further described (WDFW and PNPTT 2000).

1) Intent of program - Big Beef Creek was identified by the co-managers at the onset of long term conservation planning for Hood Canal summer chum in 1993 as a candidate for summer chum reintroduction, using progeny of broodstock from the Quilcene NFH program (WDFW and PNPTT 2000). One primary reason that this eastside Hood Canal drainage was selected for reintroduction was that it showed no summer chum escapement for ten consecutive years, and it was apparent that the indigenous population was extirpated. Additional rationale for the initiation of the reintroduction program are presented in the SCSCI (WDFW and PNPTT 2000). Objectives for the program set forth in the SCSCI are as follows: 1) release Quilcene River-origin fry into the historical habitat of the Big Beef Creek population. Monitor adult returns from the initial releases and evaluate the natural spawning success of these adults, where success is measured by return of naturally produced adult off-spring; 2) determine if a self-sustaining, viable population has been established through the reintroduction program from QNFH; 3) develop and maintain, for up to 12 years (beginning in 1996), a population comprised of supplemented and naturally spawning fish using hatchery and natural-origin broodstock; 4) implement a study to identify and compare natural-origin and hatchery-origin chum spawner productivity, and survival from out-migration to adult return. Monitor, evaluate, and report annually the effectiveness of the supplementation program, as measured by consistency with criteria set forth in the SCSCI.

2) Performance objectives - The release of Quilcene River-origin fry into the historical habitat of the Big Beef Creek population is designed to result in adult returns that will eventually become self-sustaining. Adult returns from initial releases are monitored to evaluate the natural spawning success, where success is measured by return of naturally produced adult off-spring. A determination will be made whether a self-sustaining, viable population has been established through the reintroduction program from Quilcene NFH. A population comprised of supplemented and naturally spawning fish using hatchery and natural-origin broodstock will be developed and maintained for up to 12 years. Studies are implemented to identify and compare natural-origin, spawning channel origin, and hatchery-origin chum spawner productivity, and survival from egression to adult return. Details regarding these studies and their objectives are

fully detailed in the HGMP submitted for this program, and in the SCSCI (WDFW 2000a; WDFW and PNPTT 2000).

b. *Hatchery Facilities.*

1) Water source, permitted amount - Water used for incubation and rearing is supplied by a well located approximately ½ mile upstream of the hatchery site. The well also supplies water for a hatchery operated by NMFS for the Redfish Lake sockeye salmon captive broodstock program, and a hatchery fall chinook salmon program operated by the HCSEG using non-indigenous stock. The chinook salmon program is authorized by the co-managers (the resource management entities) and conducted under a pay-for-use contract with the University of Washington (the land-owner). The existing well is permitted for the withdrawal of 1,200 gpm, but the actual yield from the well is significantly lower, leading to sporadic problems in supplying a sufficient volume of water for the summer chum, sockeye, and fall chinook programs. The summer chum fed fry program requires up to 180 gpm of inflow to sustain rearing fish at appropriate flow densities at the period near attainment of programmed release size and timing objectives. The NMFS Redfish Lake sockeye program pays the University of Washington for the withdrawal of 600 gpm from the well, and the HCSEG is allotted 300 gpm via payment to the University for the production of fall chinook. An additional factor of concern is that the well, and the water supply line leading to the hatchery pad downstream, have been endangered by flooding in recent years. A new well is now installed closer to the hatchery location, to augment, then replace the old upstream well. Flow in the Big Beef Creek spawning channel is supplied as needed, by this new well. The station does, however, have an artesian well that can provide up to 300 gpm of water to the channel. The renovated spawning channel will require three to seven cfs to operate efficiently. If drought conditions exist, it may be difficult to acquire enough surface water to run the channel under ideal flow conditions.

The existing well provides water at a seasonally constant temperature of 10 degrees C, which will generally be warmer (daily and seasonally) than Big Beef Creek water during the majority of the hatchery summer chum salmon incubation and rearing periods (November through March).

2) Broodstock collection, transportation, holding, and spawning - Broodstock may be collected at Big Beef Creek beginning with brood year 2000. Two permanent weirs are available for trapping upstream migrating salmonids in the lower Big Beef Creek Basin. A weir and trap operated by WDFW as part of a natural-origin coho salmon productivity study spans lower Big Beef Creek at approximately RM 0.1. A second weir is positioned at the front of a culvert just upstream of the confluence of the Big Beef Creek Hatchery and spawning channel out-fall with Big Beef Creek. In combination, these weirs have the capability of removing all migrating adult fish attempting to reach spawning areas within the Basin upstream of RM 0.1. Hatchery-origin and natural-origin fish that spawn in Big Beef Creek below RM 0.1 will not be affected by either weir. Both weirs are of picket panel design, with V-weired fish holding boxes used to contain fish for retention for spawning or upstream passage. In future years, summer chum encountered in the traps will either be released upstream above the Big Beef Creek

weir, transported upstream for release into the renovated spawning channel, or retained for spawning for the on-going reintroduction program. Spawning is conducted in an area on or near the hatchery pad where eggs and milt procured from spawners can be protected for fertilization.

3) Incubation, rearing, and release - Summer chum eggs transferred in from Quilcene NFH, or taken from returning spawners, for the reintroduction program are incubated through swim-up in 55 gallon RSIs designated for the summer chum program. Each RSI may be loaded with up to 75,000 eggs, and supplied with 8-12 gpm flow from the main hatchery water line. The hatchery is equipped with a low-flow alarm, allowing response by on-site hatchery staff to restore flows. Egressing fry are collected in fish totes at the base of the RSIs for enumeration and transfer by bucket to 6' diameter fiberglass rearing ponds. Upon completion of rearing, the chum are gathered from the tanks in seines for enumeration and transfer via tanker truck approximately 200 yards for release into Big Beef Creek at approximately RM 0.1, just downstream of the WDFW weir.

The spawning channel is proposed for use as an additional means to establish Quilcene summer chum through allowances for natural spawning and incubation in a protected area that mimics natural conditions. A side channel of Big Beef Creek was originally modified into a 183 m x 6 m (600 foot long by 20 foot) wide controlled-flow spawning channel in the late1960s. This facility was used to produce summer- and normal-time chum salmon for almost twenty years. During the past decade, Big Beef Creek has breached the side walls of the channel on several occasions and deposited large quantities of silt, mud, and sand into the spawning channel and narrowed its width to 4.3 meters (14 feet). The channel was renovated in 1999 by: 1) removing the upper 40 to 60 cm (18 to 24 inches) of gravel from the lower 143 m (470 feet) of the channel, 2) restoring it to its original 6 m width, 3) replacing the removed gravel with 0.7 to 5 cm (0.25 to 2.0 inch) in diameter washed river rock from a nearby quarry, 4) installing six concrete weirs in the channel at 30 m (100 foot) intervals, and 5) using the material excavated from the channel plus additional fill to repair an existing dike that protects the channel from incursions by Big Beef Creek. These repairs allowed the side channel to again become an important summer chum salmon production area in the Big Beef Creek basin.

c. *Broodstock Collection Protocols, including Risk Minimization Measures.*
1) History and source, including viability status - Through 1999, broodstock used to supply eyed eggs for the Big Beef Creek reintroduction program have originated from Quilcene stock summer chum under propagation through the Quilcene NFH supplementation program. Broodstock collection protocols for the Quilcene program were described in a previous section of this Biological Opinion. Quilcene stock summer chum eyed eggs have been supplied for the reintroduction program since 1996, with 1999 marking the fourth year of egg transfers from Quilcene NFH. Eyed eggs transferred to Big Beef are taken from the total Quilcene NFH population in proportion to weekly egg take magnitudes, and representative of the breadth of the Quilcene summer chum return. These measures are designed to help insure that the transferred population is representative of the spawning timing and diversity of the founding population.

The indigenous Big Beef Creek summer chum population was extirpated by the early 1980s, and was therefore designated as "extinct" by the co-managers in the SCSCI (WDFW and PNPTT 2000). The founding population for the Quilcene NFH program (Quilcene stock) was designated as "depressed" in status by the co-managers (WDFW and PNPTT 2000). Prior to initiation of the Quilcene NFH supplementation program, the Quilcene stock was rated as at high risk of extinction. However, based on an increasing escapement trend and recent large escapements attributable in large part to the success of the hatchery program, the current extinction risk for this stock is low (WDFW and PNPTT 2000).

2) Methods - Broodstock collection methods employed for summer chum adults presently used in the program have been previously described in the section describing the Quilcene NFH program.

As mentioned above, two permanent weirs are available for trapping summer chum adults returning to Big Beef Creek in future years. Eggs are procured from these adults, supplanting Quilcene-origin transfers, as a measure to promote local adaptation of the Big Beef Creek population. Egg take schedules are developed that allow for the take of summer chum adults for spawning proportionately, across the total return. Broodstock will also be collected in the traps for transfer to the renovated spawning channel, or release upstream into Big Beef Creek. A schedule will also be developed to meter the use of returning adults for these purposes across the total return.

3) Fish health protocols - Broodstock at Quilcene NFH, and eyed eggs transferred to Big Beef, are certified as free of regulated fish pathogens by USFWS fish pathologists. All eggs transferred to Big Beef are disinfected upon arrival in an iodophore solution prior to loading into the RSIs as a additional measure to prevent fish pathogen transmission. Fish health monitoring is conducted by a fish health specialist. Significant fish mortalities to unknown causes are for histopathological study. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998).

d. *Hatchery Operational Protocols, including Risk Minimization Measures.*
1) Water withdrawal method, effluent discharge practices - Water used for incubation and rearing is supplied by a well feeding the main Big Beef Creek Hatchery water line. The hatchery is equipped with a low flow alarm which allows hatchery personnel that are on-site to respond and restore flows. Due to the small size of the cumulative Big Beef Creek hatchery programs (under 20,000 pounds total fish production per year), effluent water passing through the hatcheries is not subject to NPDES permit limits. However, all hatchery effluent water is passed through three consecutive 1 acre settling ponds as a measure to remove solids. These components of the Big Beef Creek program relating to water withdrawal through a well and effluent discharge are not likely to adversely affect listed natural summer chum either directly or incidentally.

2) Annual target production goal (life stage, disposition of surplus) - Summer chum fed fry releases through the Big Beef Creek reintroduction program are expected to range from 40,000-100,000 for the next three years, at an average fish size of 1.0 - 1.5 grams. This estimated production figure is reduced from release levels over the last three years, and takes into account the anticipated, additional production of unfed fry through summer chum spawning in the renovated channel. This unfed fry production range is also consistent with the co-managers' SCSCI. Under the Initiative, up to 103,000 fed fry may be produced to help restore the Big Beef Creek population to average run size levels observed in the 1974-78 period (WDFW and PNPTT 2000). The number of additional unfed fry that are produced through use of the spawning channel is unknown, and dependent on adult return levels to the creek, proportions of the return allowed to spawn in the channel, and egg to fry survival rates in the channel. Based on a channel capacity of 120 female chum spawners, an average fecundity of 3,000, and an assumed egg-to-smolt survival rate of 50 %, approximately 200,000 unfed fry could be produced each year.

At the present time, the production of surplus eggs or fish is avoided by controlling the number of eyed eggs transferred to Big Beef from the Quilcene NFH program. In future years, surplus production will be avoided by limiting the number of adult summer chum secured through broodstock collection operations for spawning or placement into the spawning channel. Any surplus production that does occur will be treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Mating methods applied for Quilcene summer chum used for the program have been described in the previous section for the Quilcene NFH program. These mating protocols will also be applied for summer chum spawned at Big Beef Creek in future years.

After disinfection with an iodophore, eyed eggs transferred from Quilcene are loaded into one of three RSIs at the Big Beef Creek site, supplied with well water at the rate of 8-12 gpm. The RSIs are loaded at low densities (8,000 eggs per RSI screen, up to 75,000 eggs per RSI) for incubation through swim-up. Green eggs fertilized at Big Beef Creek and incubated in the RSIs are shocked at eye-up, allowing for removal and enumeration of mortalities. Surviving eyed eggs will then be loaded back into the RSIs at the aforementioned densities. Screens within each RSI are removed as the eggs hatch, allowing enumeration of mortalities. Post swim-up, the RSIs are completely emptied to enumerate any additional alevin mortalities and malformed fry. Fry are allowed to volitionally migrate upon swim-up from the RSIs. Egressing fry are collected in fish totes at the base of the RSIs for enumeration and transfer by bucket to rearing ponds in the NMFS Big Beef Creek hatchery compound.

Because the well water used for incubation and rearing at Big Beef Creek is warmer and less variable diurnally than ambient water temperatures in the natural incubation environment in the Big Quilcene River and Big Beef Creek, the development of the summer chum eggs at Big Beef Creek Hatchery is artificially advanced. The eggs at Big Beef Creek therefore hatch and swim-

up much earlier than their natural-origin counterparts, leading to the potential for diminished survival if the hatchery fish are released as unfed fry, when productivity in the Hood Canal estuarine environment would be low. The 1 to 1.5 month rearing period required to achieve a 1.0 gram average fish size at release planned for the reintroduction program acts to balance this differential in development rates, so that the hatchery fish are released into the environment during the natural summer chum fry emigration period in March.

4) Rearing methods, including densities - Summer chum fry transferred from the RSIs are evenly divided among ten 6' diameter rearing tanks. Rearing densities in the tanks are maintained at under 3.0 pounds of fish per gallon per minute inflow to minimize the risk of fish disease outbreaks, including bacterial gill disease. The chum are weight-sampled bi-weekly during rearing to determine fish size and appropriate feeding rates. The fish are reared in the tanks for 30 to 60 days, until an individual average fish size of 1.0-1.5 grams is reached. Summer chum fry originating from the spawning channel will not be reared.

5) Release methods, including number of fish and locations - Releases through the reintroduction program are scheduled for March, to coincide with the natural summer chum egression period in Hood Canal. Fish are gathered from the tanks for release using seines and dip nets. After enumeration, the chum are transported by tank truck or tote and bucket for release into Big Beef Creek at RM 0.1. Releases are timed for dusk, on an incoming high tide to reduce the risk of avian predation, and fish stranding on the gravel berm that has formed in the estuary at the mouth of Big Beef Creek. Fry migrating volitionally each night from the spawning channel are collected in a smolt trap at the base of the channel for enumeration and marking prior to release the following evening.

6) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel from USFWS and WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times, as specified in the SCSCI (WDFW and PNPTT 2000). Summer chum fed fry are examined by a fish pathologist within three weeks prior to release to determine fish health status.

e. *Monitoring and Evaluation and Research* -
Monitoring, evaluation, and research attached with the Big Beef Creek program are consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each supplementation program in the region are indicated (WDFW and PNPTT 2000). All summer chum produced in RSIs are thermally marked, with a separate mark applied for each incubator. Egg and fry mortality records are maintained so that the number of fish liberated from each group can be estimated. In addition, length and weight data are collected from the fry just prior to their release.

Upon return, summer chum adults are placed into the renovated channel, others are artificially spawned and reared, and another portion will be allowed to spawn in the main

stem of Big Beef Creek. Information planned for collection from adult fish will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. Biological samples collected from the summer chum will include tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples.

The number of fry produced by the fish used in each of the above strategies is determined by direct counts. Cultured fish are incubated and then reared for approximately one month prior to being released into the Big Beef Creek estuary. Fry produced from the channel are captured by modified fyke nets and gravimetrically counted. Fry produced from the fish spawning in Big Beef Creek are captured at a weir in fan traps and also gravimetrically counted. All fry produced from the channel will be passively marked with stable strontium via a simple immersion procedure, the artificially cultured fish are thermally marked, while the juveniles produced from the main stem of Big Beef Creek will remain unmarked. When these fish return to the stream as adults, otoliths (ear bones) from a random sub sample of spawners will be collected, and evaluated for marks. Using these methods, estimates of the survival and production of adult chum salmon from a variety of restoration strategies are provided. This evaluation effort will also help determine which of these methods might be used in other stream systems where summer chum need to be re-introduced or enhanced.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The summer chum reintroduction program, and hatchery operational methods used to collect, transfer, rear and release summer chum, are consistent with the co-managers' SCSCI, which is the ESU-wide conservation proposed for recovering the listed population. Monitoring and evaluation and research proposed for the program is also fully consistent with activities set forth within the co-managers' conservation initiative to improve scientific understanding of artificial propagation benefits and risks. The hatchery also operates within agreed fish production plans under the Hood Canal Salmon Management Plan, which is part of the Puget Sound Salmon Management Plan; a court-ordered plan under the *U.S. v. Washington* fisheries management framework.

1) Integration with fisheries management - The hatchery summer chum program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.8 % (3.3 % to 15.3 %). These rates reflect target incidental fishery harvest levels in Canadian and U.S. fisheries, and represent decreased levels of summer chum harvests from previous years. No directed fisheries on summer chum salmon result from adult fish produced through the reintroduction program.

6. Salmon Creek

a. *Location, Operator, Goals, and Objectives*

The Salmon Creek summer chum supplementation program is a cooperative effort between two private salmon enhancement groups, the North Olympic Salmon Coalition (NOSC) and Wild Olympic Salmon (WOS), and WDFW. No Federal funding is received for the program. The

hatchery program has four components: a trap for collecting broodstock located at RM 0.5 on the left bank of Salmon Creek (a tributary to Discovery Bay in Jefferson County, Washington); WDFW's Dungeness Hatchery as an initial egg incubation station; Salmon Creek Hatchery, located at RM 2.5 on Salmon Creek for incubation to hatch and initial rearing; and a net-pen facility in Discovery Bay (positioned one mile from the mouth of Salmon Creek) for final rearing to release size. A completed Hatchery and Genetics Management Plan (HGMP) was submitted to NMFS on February 28, 2000 describing the summer chum program, including risk minimization measures applied to protect the listed population (WDFW 2000b). The hatchery program is consistent with the co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000).

1) Intent of program - Initiated in 1992, the project goal is to create a donor stock for the reintroduction of summer chum into Chimacum Creek, after first attaining stable, healthy return levels to Salmon Creek. Chimacum Creek is a Port Townsend Bay, Jefferson County tributary where the indigenous summer chum population was extirpated. The goal therefore includes supplementation of the Salmon Creek population to create a healthy, natural, self-sustaining population of summer chum that will maintain the genetic characteristic of the native stock. To meet this latter goal, transfers of eyed eggs to Chimacum Creek in any given year are only allowed if the natural spawner escapement goal to Salmon Creek is projected to have been achieved. The specific objectives of the program are to rebuild the Salmon Creek summer chum run to 1974-78 average levels (859 naturally spawning adults), and to provide sufficient progeny of Salmon Creek stock summer chum to restore a summer chum population in Chimacum Creek to1974-78 average levels (estimated to be 700 naturally spawning adults) (WDFW and PNPTT 2000).

2) Performance objectives - The Salmon Creek program has been operated to comply with the following guidelines (taken from the SCSCI 2000): 1) recovery planning shall be consistent with other WDFW summer chum recovery plans; 2) recovery actions must fully address impacts to other salmonid stocks and not adversely affect their population status; 3) recovery strategies should put the summer chum stock at no greater risk than if no action was taken; 4) the hatchery program is part of a long-term recovery effort which will have both stock rehabilitation and habitat restoration components; 5) the supplementation program is intended to support natural production, and the program will be discontinued once natural production has been stabilized at healthy stock levels as defined in 1992 SASSI (WDF et al. 1993); 6) the program is limited to twelve years (three chum generations, commencing in 1992), in compliance with stock genetic integrity objectives; 7) at least 50 % of adults returning to Salmon Creek in any given year must spawn naturally; and 8) beginning in 1995, the brood number is initially limited to 10 % of the total number of chum returning to the watershed, with collections occurring over the entire run-timing of the stock. Following the successful implementation of all protocols required in 1995, the allowable broodstock collection number was adjusted upward to 20 % of the total number of female summer chum returning to the watershed beginning in 1996.

b. *Hatchery Facilities*.

1) Water source, permitted amount - Eggs taken from summer chum adults trapped in Salmon Creek are incubated to the eyed stage at WDFW' Dungeness Hatchery. Water rights at the Dungeness facility allow for the withdrawal of up to15 cfs of surface water from intakes in the Dungeness River. After eye-up, the eggs are transferred to an incubation and initial rearing facility located on a tributary to Salmon Creek at approximately (RM 2.5). The Salmon Creek Hatchery uses a small volume of gravity-fed water (9 gpm during incubation and 40 gpm during rearing), drawn through an intake structure positioned in a 1/4 acre pond supplied by Houck Creek, and above a natural barrier to fish migration. The water is returned directly to the tributary near the withdrawal point. The summer chum fry are transferred to net-pens in Discovery Bay for rearing to release size in estuarine waters near the mouth of Salmon Creek.

2) Broodstock collection, transportation, holding, and spawning - Broodstock are collected for the program using a weir and permanent trap positioned in Salmon Creek at approximately RM 0.2. During 1992-1999, the weir was constructed of metal grating near the trap box, and metal posts and fencing material on the right bank side of the trap box. The trap box consists of a concrete structure framed by 2"x 2" pickets on the upstream end, and metal grating on the downstream end. Fish are contained in the 6' x 10' trap area through a "V" weir. During summer, 2000, the weir and trap were removed as part of a habitat recovery project designed to enhance summer chum freshwater survival. The weir was replaced with a temporary weir of similar dimensions, constructed of wood slats and fencing materials. The trap is of similar dimensions to the old trap, with a natural gravel bottom. Captured fish are held in the box until their daily removal for spawning or passage upstream. Fish are spawned directly adjacent to the trap. Spawning is accomplished as needed beneath a temporary awning to protect the eggs and milt collected from the fish from rain. Eggs and milt are transported chilled in plastic bags and buckets by truck to Dungeness Hatchery for fertilization and loading into incubators.

3) Incubation, rearing, and release - Green and eyed eggs are incubated in Heath stack incubators at Dungeness Hatchery and the Salmon Creek facility. Swim-up fry at Salmon Creek are initially reared in 8' x 2' x 1' fiberglass raceways. The fry are later transferred via tank truck to Discovery bay, where the fish are transferred into one of two 10' x 20' floating net-pen structures supporting 8' deep, 1/8" stretch mesh containment nets. At the appropriate fish size and time, the summer chum are released directly into Discovery Bay by lowering and inverting the net-pen.

c. *Broodstock Collection Protocols, including Risk Minimization Levels.*
1) History and source, including viability status - Indigenous summer chum broodstock were first collected from Salmon Creek for the supplementation program at the current weir location in 1992. The project is now in its eighth year of operation, and the indigenous population, now of hatchery and natural lineage, continues to be used as broodstock.

The founding Salmon/Snow summer chum stock, which includes fish returning to Salmon Creek and Snow Creek, was designated as "depressed" in status by the co-managers (WDFW and PNPTT 2000). As a supplementation effort, the program is designed to increase the numbers of summer chum returning to Salmon Creek, resulting in recovery of the population. Prior to

initiation of the supplementation program, the stock was rated as at high risk of extinction. However, based on an increasing escapement trend and recent large escapements attributable in large part to the success of the hatchery program, the current extinction risk for this stock is low (WDFW and PNPTT 2000).

2) Methods - Summer chum adults are captured within the August 1 and October 31 adult migration period each year. Fish not retained for use as broodstock are released upstream, above the weir site, to spawn naturally. The trap is checked at least daily for captured fish, and more frequently during freshets. If it is determined that there is a risk to fish life, the trap is opened to allow free passage of fish through the trap. As mentioned previously, the allowable broodstock collection number was initially set at 10 % of the total female summer chum return, to limit the effects of the removal of adult fish on abundance and diversity of the naturally spawning population. This limit was adjusted upward to 20 % of the total number of female summer chum returning to the watershed beginning in 1996. Summer chum broodstock are collected randomly as the fish arrive at the trap location, proportional to the timing, weekly abundance, and duration of the total return to the creek. The weir and fish trap are located in the lower reaches of the watershed, near the most downstream point of observed natural spawning activity. Less than10 % of the total summer chum return has been observed to spawn downstream of the trap (WOS 1998). Nearly the entire annual summer chum return to the creek is therefore vulnerable to trapping, decreasing the risk that fish trapped through the program are not representative of the total run. The trap is located on private property, accessed through three gates maintained by the property owner. Human disturbance or poaching of summer chum held in the trap have not been experienced during the duration of operation. Chinook salmon are not indigenous to Salmon Creek, and takes of listed chinook are not anticipated through the broodstock collection program. Any straying chinook salmon encountered in the trap are passed by hand upstream daily, above the weir, with minimal delay.

3) Fish Health Protocols - Fish health monitoring associated with adult fish used in the program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the Co-managers of Washington Fish Health Policy (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from all fish spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes.

d. *Hatchery Operational Protocols including Risk Minimization Measures.*

1) Water withdrawal method, effluent discharge practices - Water used for incubation at Dungeness Hatchery is supplied by infiltration wells adjacent to the Dungeness River. The hatchery is supplied with an alarm system and back-up generator in the event of power failure, and is staffed full-time to allow rapid response to other factors, such as flooding, that could harm incubating eggs. The hatchery at Salmon Creek is supplied by water that is gravity-fed from an adjacent pond. Incubating and rearing eggs and fry will therefore not be affected by power failures. The Salmon Creek hatchery is operated with a low flow alarm and back-up water supply triggered simultaneous to the alarm signal, allowing response of hatchery staff to water

supply failures. The facility is not staffed full time, but the operation is checked at least once daily during operation and more frequently during high flows and/or severe cold weather events. Net-pens used to finish rearing are supplied with water through tidal flow. The Dungeness Hatchery operates under a standing NPDES permit that limits discharge effects on the environment, and requires monitoring of effluent for settleable and suspended solids. The Salmon Creek Hatchery and net-pens produce a relatively small amount of fish each year, and well under the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects and for the requirement for an NPDES permit. The above components of the Salmon Creek program relating to water withdrawal and effluent discharge are not likely to adversely affect listed natural summer chum either directly or incidentally.

2) Annual target production goal (life stage, disposition of surplus) - The annual target fish production level for the Salmon Creek program is a maximum of 123,000 fed fry of Salmon Creek stock (209,000 if Snow Creek component is included) at an average size of 1.0 gram released on-station (WDFW and PNPTT 2000). In addition, a maximum of 86,000 fed fry equivalents are produced for transfer as eyed eggs to Chimacum Creek. The production of surplus eggs or fish is avoided to the extent feasible by limiting the number of adult summer chum secured through broodstock collection operations. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Summer chum adults collected at the Salmon Creek weir are spawned adjacent to the weir site. Eggs and milt collected from spawned fish are placed separately in dry, zip-locked bags, and stored on ice for transport by truck to Dungeness Hatchery (WOS 1998). Eggs are fertilized at Dungeness Hatchery factorially, or using at least a 1:1 spawning ratio. After fertilization, the eggs are placed in vertical tray (Heath stack) incubation units for incubation to the eyed egg stage. All eggs receive an otolith thermal mark at Dungeness during incubation. The eggs are shocked at eye-up, enumerated and transferred to Salmon Creek for incubation through hatch in Heath stack incubators. The eyed eggs are incubated at a density of 5,000-9,000 per tray, with each Heath stack supplied with flow at a rate of 3 gpm. The incubation units at Salmon Creek are protected from loss of flow through a battery-operated phone/alarm system, and an emergency reservoir and battery-powered pump.

4) Rearing methods, including densities - Fry from each egg take remain in incubators until 75% of fry are fully buttoned up. Fry are removed from incubators and ponded into raceways at Salmon Creek Hatchery upon absorption of the yolk sac. Lots are segregated during rearing by egg take date. One to three days after ponding, feed is introduced to the fry via hand casting and 12-hour automatic spring driven belt feeders. BioMoist #3 feed at the rate of 2.5% per body weight per day (% BW/day) is used during the fresh water phase. Within 1 to 2 weeks of ponding, after the fish have established feeding behavior, they are transferred to the saltwater net-pens in Discovery Bay at a size of about 1000 fpp. After transfer to saltwater, the feeding rate is increased to 5% BW/day. Hand casting of feed over the net-pens water surface is done at least once a day to insure all fish have exposure to feed. Sample weights to identify fish size and appropriate feeding rates are taken every one to two weeks during the net-pen rearing period. The rearing program may be adjusted beginning in 2001 to forgo the saltwater net-pen rearing

portion of the program, rearing the summer chum in freshwater only. WOS and the co-managers are discussing alternative avenues for rearing summer chum in the Salmon Creek watershed to an adequate release size.

5) Release methods, including number of fish and locations - Under the current program, after 30 to 60 days of rearing in the marine net-pens, and upon reaching an individual size of 1.0 - 1.5 gms, the summer chum are released into Discovery Bay. The marine area release location is approximately 1/3 of a mile from the tidal channel of Salmon Creek, and 1 mile from the mouth of the creek. The fry are released in the evening, on a high tide, to minimize the incidence of avian and fish predation. Since 1992, releases have ranged from 2,000 to 71,800 fry. As mentioned above, WOS and the co-managers may adjust the program to rear the summer chum in freshwater only, for direct release into Salmon Creek.

6) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred from Salmon Creek for fertilization at Dungeness Hatchery are water hardened in an iodophore. Fungus in incubators is controlled by formalin drip prior to eye-up. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters are adhered to at all times, as specified in the SCSCI (WDFW and PNPTT 2000). Fish reared in the salt water net-pens have experienced mortalities due to vibriosis and affected fish have been released after confirmation of disease by fish health personnel. Fish have been treated prophylactically by feeding medicated feed, and net-pen management strategies, including reduction in feeding levels, and reduction of fish densities through early fish releases. As of the 1998 brood year, all fry are to be inoculated with a vibrio vaccine dip prior to transfer to saltwater. Each year summer chum fry in the net-pens are examined by a fish pathologist within three weeks prior to release to determine fish health status.

e. *Monitoring and Evaluation and Research* -
Monitoring and evaluation, and research, conducted through the Salmon Creek program is consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each supplementation program in the region are indicated (WDFW and PNPTT 2000). A primary objective of summer chum salmon monitoring and evaluation and research program is the collection of baseline biological information on summer chum salmon native to Salmon Creek. Information collected will include fecundity, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. This baseline information will be used in the future to determine the ecological and genetic effects of the supplementation program on the propagated and natural-origin summer chum populations in the eastern Strait of Juan de Fuca. Biological samples collected from summer chum adults retained as broodstock includes tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples. Scales are also removed for age determination. Beginning in 1997, otoliths were sampled to determine returning fish were of hatchery or natural origin (Johnson 1998). Mortality data for the propagated

population is collected during the incubation and rearing period. Fish size data (number of fish per pound) is collected from fry at the time of release.

An additional objective is the determination of the need, and methods, for improvement of the supplementation program or, if warranted, the need to discontinue the program. This objective is being pursued by otolith-marking all hatchery summer chum juveniles produced through the program to allow for assessment of contribution and natural origin recruit (NOR) production levels. Initial results of otolith sampling of returning adults indicate that the contribution of supplementation program origin fish to the total Salmon Creek escapement is significant, with over half of the total three year old cohort in 1998 of hatchery-origin (Grimm 1999).

Injury or mortality levels to summer chum salmon will not be elevated as a consequence of the monitoring and evaluation and research activities, because they are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures. Listed chinook salmon are not likely to be affected by these programs.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The Salmon Creek summer chum salmon supplementation program, and hatchery operational methods used to collect, transfer, rear and release summer chum, are consistent with the co-managers' SCSCI, which is the ESU-wide conservation proposed for recovering the listed population (WDFW and PNPTT 2000). Monitoring and evaluation and research proposed for the program is also fully consistent with activities set forth within the co-managers' conservation initiative to improve scientific understanding of artificial propagation benefits and risks. The program also operates within agreed fish production planning processes included under the Puget Sound Salmon Management Plan; a court-ordered plan under the *U.S. v. Washington* fisheries management framework (PSSMP 1985).

1) Integration with fisheries management - The summer chum supplementation program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.8% (3.3% to 15.3%). These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. Actual harvest rates on summer chum produced in eastern Strait of Juan de Fuca watersheds should be lower, due to the lack of terminal area commercial fisheries directed at other species where summer chum may be incidentally taken. No directed fisheries on summer chum salmon result from adult fish produced through the Salmon Creek program.

7. Chimacum Creek

a. *Location, Operator, Goals, and Objectives*

The hatchery program on Chimacum Creek is a summer chum salmon reintroduction effort, initiated to restore a summer chum salmon run in a Port Townsend Bay, Washington tributary that historically supported a self-sustaining population of the species. The reintroduction project is conducted jointly by WOS and NOSC, with technical assistance provided by WDFW, the resource co-management agency with the tribes. No Federal funding is received for the program. The project was initiated in 1996, when Snow/Salmon stock eyed eggs from the Salmon Creek supplementation program were first transferred for on-site incubation and rearing at a hatchery on Chimacum Creek. The hatchery site was relocated in 1997 in the Naylor's Creek watershed, a left bank tributary to Chimacum Creek at RM 4.5. Chum produced at Naylor's Creek may also be transferred to net-pens for seawater acclimation, and continued rearing prior to release. The net pen site is located 1,500 feet northwest of Coon Spit (Kala Point) and less than 1.5 miles north of the mouth of Chimacum Creek in Port Townsend Bay. The net pens are attached to an existing dock within the Kala Point Community. WOS, NOSC, and WDFW are jointly conducting a monitoring and evaluation program to determine the effects of the program in re-establishing summer chum into the Chimacum Basin. The program is now in its fourth year of operation.

A completed HGMP describing the summer chum artificial propagation and monitoring and evaluation programs, including risk minimization measures applied to protect the reintroduced, listed population, was submitted to NMFS on February 28, 2000 (WDFW 2000c). Supplemental information pertaining to the net-pen rearing portion of the Chimacum program was also provided (WDFW 2001). The program described in the HGMP is consistent with, and supported by, the co-managers' SCSCI, where the programs and fish propagation measures applied are further described (WDFW and PNPTT 2000). The HGMP and the SCSCI are used as references in providing the following information.

1) Intent of program - The reintroduction of summer chum into Chimacum Creek was the primary reason for the initiation of the Salmon Creek supplementation program described above. WOS and NOSC, with support from WDFW, started the Salmon Creek supplementation program in 1992 to boost the Salmon Creek summer chum return to an abundance level that would allow transfer of "surplus" eggs to Chimacum Creek without adversely affecting the donor population. Chimacum Creek was reaffirmed by the co-managers as an appropriate location for summer chum reintroduction, using progeny of broodstock from the Salmon Creek program, in the SCSCI (WDFW and PNPTT 2000). The reintroduction program was initiated in 1996, and is now in its fourth year of operation. The first three and four year old adult returns to Chimacum Creek resulting from the reintroduction program were observed in 1999 and 2000, respectively.

2) Performance objectives - The program is designed to produce adults that will return to successfully spawn, creating a self-sustaining population in the natural environment. Monitoring and evaluation will determine its success in restoring a self-sustaining summer chum run, and identify the effects of the program on listed natural summer chum . The need for adjustment of supplementation methods, or, if warranted, the need to discontinue the program will also be indicated through the monitoring and evaluation program. The following are objectives for the

re-establishment of a summer chum population in Chimacum Creek, as set forth in the SCSCI: 1) release a maximum of 86,000 Salmon Creek-origin fry reared on Chimacum Creek into the lower watershed or the immediate estuary, and monitor adult returns from the initial releases and evaluate the natural spawning success of these adults, where success is measured by return of the naturally produced adult offspring; 2) develop and maintain, for up to 12 years, a population comprised of supplemented and naturally spawning fish using hatchery and natural-origin broodstock; and 3) monitor, evaluate and annually report the effectiveness of the reintroduction program, as measured by consistency with criteria set forth in SCSCI (WDFW and PNPTT 2000).

b) *Hatchery Facilities*

1) Water source, permitted amount - Incubation of Salmon Creek program progeny destined for Chimacum Creek from green to eyed egg stage is conducted at Dungeness Hatchery using water drawn from infiltration wells adjacent to the Dungeness River. Water required for the remainder of rearing is supplied by gravity flow from a spring-fed lake located on a tributary to Naylor's Creek. The lake is approximately 3 acres in size, with depths up to 10 feet. A slotted aluminum screened intake box in the lake is used to withdraw water for use in the hatchery via gravity feed through a buried 2" diameter line at a maximum rate of approximately 60 gpm. A parallel line of 2" ABS flexible tubing siphons water above ground and joins the primary line at the hatchery, functioning as an ongoing and backup system supplying more than 30gpm. In addition, the facility is armed with a low flow triggered alarm system; a battery driven audible alarm alerts hatchery staff in the event of water supply failure. If this occurs, a conventional and 12 volt battery array is in place to supply power to a sump pump; it requires manual activation. The remoteness of the location provides additional security from potential vandalism of the water supply (WOS 1998). The Port Townsend Bay net-pen site relies on tidal flow to sustain rearing fish. Water is supplied passively, and its use is non-consumptive at the net-pen site.

2) Broodstock collection, transportation, holding, and spawning - Summer chum propagated for this program are progeny of broodstock collected from Salmon Creek. Broodstock protocols for the Salmon Creek program are described above. No broodstock are proposed to be collected from Chimacum Creek for spawning at the present time. However, there is a potential that a collection strategy will be proposed in future years, pending the duration of the donor Salmon Creek program, and the success in establishing a self-sustaining return of summer chum in Chimacum Creek over the next few years.

3) Incubation, rearing, and release - Eyed eggs are transferred moist, in buckets, by truck for incubation at the Naylor's Creek facility. The eggs are incubated in a vertical stack incubation unit, supplied with 2.5 - 3.5 gpm inflow drawn from a 50 gallon settling tank, where water from the spring fed lake is treated to remove any sediments. The remaining flow from the lake is supplied to an 8' x 40' x 2.5' concrete raceway used for short term rearing. Three mesh-fabric net-pens each measuring 6' x 8' x 1.5' are suspended in the raceway to allow for division of different egg take groups. The net-pens are covered with netting to avert avian predation. At the appropriate release date, and upon reaching the desired fish release size, chum designated for freshwater release are bucketed into a 4' x 4' x 2.5' plastic tote filled with freshwater. The fish

are then trucked to a location in lower Chimacum Creek, transferred into buckets and hand-carried for release above the estuarine area near the creek mouth (WOS 1998). A portion or all summer chum fry may also be transferred to the marine net-pens near Kala Point for continued rearing. The fry are transferred into one of two 8'x8' floating net-pen structures supporting 6.5'deep, 1/8" stretch mesh containment nets. Rearing in the pens is short-term (less than 2 months per year).

c. *Broodstock Collection Protocols, including Risk Minimization Measures.*
1) History and source, including viability status - Broodstock used for the present reintroduction effort are collected at Salmon Creek, and adults now returning to Chimacum Creek are allowed to spawn naturally. It is the intention of the operators to collect adult returns to Chimacum Creek in future years, consistent with the SCSCI objective of using localized broodstock, when established and available to complete reintroduction efforts. Eggs collected from adults returning to Chimacum Creek would therefore supplant or complement Salmon Creek egg transfers in the coming years.

The indigenous Chimacum Creek summer chum population was extirpated by the early 1980s, and was therefore designated as "extinct" by the co-managers in the SCSCI (WDFW and PNPTT 2000). The history, source, and viability status of Salmon Creek broodstock presently used in the Chimacum program are indicated in the previous section describing the Salmon Creek supplementation effort.

2) Methods - Methods employed to collect broodstock used to produce progeny for the Chimacum program are presented in the previous section describing the Salmon Creek supplementation effort. Broodstock collection methods proposed for application at Chimacum Creek in future years will be described in an amended HGMP for the program.

3) Fish Health Protocols - Fish health monitoring associated with adult fish collected for use in the Chimacum reintroduction program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in summer chum broodstock collected at either Salmon Creek or Chimacum Creek is determined by sampling fish at spawning in accordance with procedures set forth in the Co-managers of Washington Fish Health Policy (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from all fish spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes.

d. *Hatchery Operational Protocols including Risk Minimization Measures.*
1) Water withdrawal method, effluent discharge practices - Water required for rearing at Naylor's Creek is supplied by gravity flow through a slotted aluminum screened box in a spring-fed lake at a rate of approximately 60 gpm and a parallel line joins the primary line at the hatchery, functioning as an ongoing and backup system supplying more than 30gpm. No listed salmonids are present in the lake that could potentially be affected by the withdrawal method. The small volume of water used for the program does not affect flows available to listed salmonids, if any, that may be present in downstream areas. As mentioned above, listed summer chum reared in the project are protected by a back-up water supply and audible alarm system

used to alert hatchery staff in the event of water supply failure. The remoteness of the location provides additional security from potential vandalism of the water supply (WOS 1998).

The volume of effluent discharged from raceways where fish are reared is minimal, and usually under 90 gpm. Total, annual fish production through the project is very low (<190 pounds), and water quality effects over the 30 to 45 day total rearing period are likely minimal. Effluent water is piped back to the Naylor's Creek tributary, just downstream of the point of withdrawal. No natural listed fish are likely to be adversely affected by water discharged after use for fish rearing by the hatchery program. Marine net-pens used to rear summer chum fry near Kala Point will rely on tidal flow. Fish production in the net-pens is low, and below annual poundage levels that are of concern, requiring a NPDES permit.

2) Annual target production goal (life stage, disposition of surplus) - The annual target fish production level for the program is a maximum of 86,000 fed fry at an average size of 1.0 gram (WDFW and PNPTT 2000). The production of surplus fish is avoided to the extent feasible by limiting the number of adult summer chum secured through the broodstock collection operation at Salmon Creek. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Mating methods for summer chum adults supplying progeny for the program are indicated in the previous section describing the Salmon Creek supplementation program. Eggs and fry are incubated in vertical stack incubators at Dungeness Hatchery (to the eyed egg stage) and Naylor's Creek (to swim-up). Beginning with the 1999 brood year, summer chum eggs destined for the Chimacum program have been marked through otolith banding while at Dungeness Hatchery. Eyed eggs are incubated and hatched in the incubator trays at a density of 2,000 - 10,000 per tray. The flow rate to the incubator is maintained at 2.5 - 3.5 gpm throughout the incubation period, which extends through late March.

4) Rearing methods, including densities - Fry from each egg take remain in incubators until 75% of fry are fully buttoned up. Fry are removed from the incubator between late February and late March and ponded to the rearing raceway upon observed absorption of the yolk sac. One to three days after ponding, feed is introduced to the fry via hand casting and 12-hour automatic spring driven belt feeders. Commercial feed at the rate of 2.5% per body weight per day is used. Freshwater rearing net-pens are loaded up to a maximum of 20,000 fish each and flows are maintained at approximately 10 gpm. Fish weights are sampled weekly to monitor fish growth and to adjust feeding rates. Fish behavior and mortality is recorded daily to monitor the population for fish disease outbreaks. Fry mortality has been low at 3 % to 7% from swim-up to release. At a different hatchery site, bacterial gill disease problems in 1997 led to elevated mortality levels for 1996 brood summer chum; that site was not used again. Low dissolved oxygen levels of effluent water (recorded at 49 % of saturation or approximately 5.0 ppm) has been of concern to the operators. Dissolved oxygen concentrations have been increased, however, through improvements in the amount of water and the header design used to introduce water to the raceway holding the net-pens. In addition, a more powerful electronic aerator has been installed in the clarifier/settling barrel which now delivers 100% saturated water to the

incubator. Rearing at the Kala Point net-pens will follow protocols developed and successfully implemented for marine net-pen rearing used for the Salmon Creek summer chum salmon supplementation program. Fry are reared in the marine net-pens for 30 to 60 days to the desired release size.

5) Release methods, including number of fish and locations - When the fish reach the target release size beginning in late March, the fish are bucketed from the rearing raceway into a 4' x 4' x 2.5' plastic tote filled with freshwater for transport to lower Chimacum Creek or transport to the Kala Point net-pens. Fish designated for freshwater release are transferred into buckets and hand-carried down a pathway for release into Chimacum Creek above the estuarine area near the creek mouth at approximately RM 0.1. The fish are released in the evening hours, at or near high tide, to reduce the likelihood for avian and fish predation. Fry transported for seawater rearing are released from the pens into Port Townsend Bay in late April or May by removing the containment net. Between 1997 and 1999, actual release numbers for the Chimacum program have ranged from 29,000 to 70,050 fed fry. The program has a target annual fry production of up to 86,000 fry, as specified in the SCSCI (WDFW and PNPTT 2000).

6) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred from Salmon Creek for fertilization at Dungeness Hatchery are water hardened in an iodophore. Prior to eye-up, fungus in incubators is controlled by a formalin drip. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Each year, summer chum fry are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. *Monitoring and Evaluation and Research* -
Monitoring and evaluation conducted for the Chimacum program is consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each summer chum program in the region are indicated (WDFW and PNPTT 2000). WOS and NOSC volunteers are surveying lower Chimacum Creek to enumerate returning spawners and to identify redd locations and to monitor intragravel dissolved oxygen. This information is being used to evaluate and remedy the effects of degraded stream habitat in the Chimacum watershed that has been identified as the major factor for extirpation of summer chum in the basin.

Injury or mortality levels to summer chum salmon will not be elevated as a consequence of the monitoring and evaluation and research activities, because they are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures. Listed chinook salmon are not present in the Chimacum watershed, and are therefore not likely to be affected by the above programs.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The Chimacum Creek summer chum reintroduction program, including hatchery operational methods used to transfer, rear and release summer chum, are consistent with the co-managers' SCSCI (WDFW and PNPTT 2000). Monitoring and evaluation proposed for the program is also fully consistent with activities set forth within the co-managers' conservation initiative. The program also operates within agreed fish production planning processes included under the Puget Sound Salmon Management Plan (PSSMP 1985).

1) Integration with fisheries management - The summer chum supplementation program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.8% (3.3% to 15.3%). These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in these interceptory fisheries from previous levels. Actual harvest rates on summer chum produced in eastern Strait of Juan de Fuca watersheds should be lower, due to the lack of terminal area commercial fisheries directed at other species where summer chum may be incidentally taken. No directed fisheries on summer chum salmon result from adult fish produced through the program.

8. Jimmycomelately Creek

a. *Location, Operator, Goals, and Objectives*.

The Jimmycomelately Creek summer chum salmon supplementation project is located on Jimmycomelately (JCL) Creek, a west-shore tributary to Sequim Bay, near Blyn, Washington. WDFW, with approval from the Point No Point Treaty Council tribes, initiated the program in 1999 as a cooperative project with NOSC and WOS to recover the indigenous, critically depressed summer chum salmon population in JCL Creek. A supplementation program was implemented that year as an immediate response to a precipitous decline in the abundance of the summer chum adult spawning population observed the previous four years. No Federal funding is received for operating or managing the program.

A completed HGMP describing the summer chum program, including risk minimization measures applied to protect the listed population, was submitted to NMFS by WDFW on February 28, 2000 (WDFW 2000d). The hatchery program is consistent with the co-managers' SCSCI, where the program, and fish propagation measures applied, are further described (WDFW and PNPTT 2000). JCL Creek supported up to one thousand spawners in the 1980s (run reconstruction data from the SCSCI). The population has declined since that time, and in 1999 only 7 adult fish returned to the stream. Without intervention, the co-managers are concerned that this population of summer chum salmon will become extinct in the very near future.

1) Intent of program - The goal of the project is to contribute to the restoration of a healthy, naturally self-sustaining population of summer chum salmon which maintains the genetic characteristics of the native stock in JCL Creek (WDFW 2000d). The project objective is to

lessen the current risk of extinction due to small population size by implementing an effective short-term recovery effort. This is accomplished by supplementing the indigenous summer chum population through artificial propagation and release of progeny secured from native broodstock for up to twelve years, speeding recovery of the population to abundances reflective of historic escapement levels. The specific objective of the program is to rebuild the JCL summer chum run to 1974-78 average levels (estimated to be 700 naturally spawning adults (WDFW and PNPTT 2000).

2) Performance objectives - The SCSCI presents the following objectives for use in evaluating the effects of the program: 1) initiate a supplementation program using the indigenous JCL summer chum broodstock, thus retaining future options for recovery of the JCL population; 2) boost the numbers of naturally produced fish in JCL Creek using the indigenous population as the donor - develop and maintain, for 12 years, a population comprised of supplemented and naturally spawning fish using hatchery and natural-origin broodstock; and 3) monitor and evaluate, and annually report the effectiveness of the supplementation program, as measured by consistency with criteria set forth in the SCSCI (WDFW and PNPTT 2000). As an emergency measure, and as specified for extremely small populations that are identified as at immediate risk of extinction in the SCSCI, the supplementation program is allowed to collect 100 % of the returning population for artificial propagation. This emergency measure will be continued until the population rebounds to annual return levels greater than 100 spawners (WDFW and PNPTT 2000). Chinook salmon are not present in JCL Creek, and listed chinook are not likely to be affected by the proposed supplementation program.

b. *Hatchery Facilities.*

1) Water source, permitted amount - Summer chum adults are trapped and held in JCL Creek for spawning, and no water is removed from the creek for broodstock collection and holding purposes. Unfertilized gametes are transferred to WDFW's Hurd Creek Hatchery for fertilization, incubation and rearing through the fry stage. The hatchery, located 4 miles north of Sequim, Washington, is supplied with well water and water withdrawn from Hurd Creek, a tributary to the Dungeness River. The hatchery is permitted for the withdrawal of 6.4 cfs of water from these sources. Fed fry are returned to circular rearing tanks that are gravity fed by springs tributary to JCL Creek at approximately RM 1.0 for continued rearing and acclimation. Water used for rearing at Hurd Creek and JCL Creek is returned to the creeks near the point of withdrawal.

2) Broodstock collection, transportation, holding, and spawning - Broodstock are collected for the program using a temporary weir and trap box positioned in Jimmycomelately Creek at approximately RM 0.1. The weir is constructed of metal posts and wood slat panels. Fish are directed into the 6' by 10' tubular steel trap box and trap area through a "V" weir; the trap area has a natural gravel bottom. Captured fish are held in fish tubes constructed of perforated PVC pipe within the trap box until their daily removal for spawning or passage upstream. Fish are spawned directly adjacent to the trap. Spawning is accomplished as needed beneath a temporary awning to protect the eggs and milt collected from the fish from rain. Eggs and milt are transported chilled in plastic bags and ice chests by truck to Hurd Creek Hatchery for

fertilization and loading into iso-bucket incubators. Fertilization is accomplished in a designated location at the hatchery where the JCL Creek-origin fish can be isolated, to reduce the risk of fish disease transfer.

3) Incubation, rearing, and release - Green eggs are incubated in iso-buckets and eyed eggs are incubated in Heath stack incubators at Hurd Creek Hatchery. Upon swim-up, the fish are started on feed in 4' diameter circular tanks supplied with 5 gpm inflow. The fish are transferred in aerated buckets or tote by truck for final rearing and acclimation in 4' fiberglass circular tanks supplied with 5 gpm inflow at the JCL Creek location. In preparation for release, the fry are netted and bucketed into an aerated tote filled with creek water or aerated buckets for transport by truck to the mouth of JCL Creek. The fry are again netted and placed in plastic buckets for release by hand into the Sequim Bay estuary. All eyed eggs currently remain at Hurd Creek Hatchery, but as the return of summer chum adults increases to JCL Creek, remote site incubators (RSIs) will be used on JCL Creek. Each 55 gallon RSI will be loaded at low densities (8,000 eggs per RSI screen, up to 50,000 eggs per RSI) and supplied with 5-12 gpm inflow for incubation through swim-up.

c. *Broodstock Collection Protocols, including Risk Minimization Measures.*
1) History and source, including viability status - The program commenced in 1999 using indigenous broodstock collected from JCL Creek at RM 0.1. The source of broodstock used in the supplementation program will continue to be the indigenous stock. No transfers of summer chum populations from other watersheds are planned, as a measure to maintain the genetic and ecological characteristics of the indigenous population. The JCL summer chum population was designated as critically depressed through the 1992 WDFW-Tribal Salmon and Steelhead Stock Inventory process (WDF et al. 1993). More recently, the JCL summer chum stock was determined to be “critical” in status based on chronically low escapements, and at “high” risk of extinction by the co-managers (WDFW and PNPTT 2000). As a supplementation effort, use of the natural broodstock through the program will intentionally increase the number of returning summer chum, assisting in the recovery of the population.

2) Methods - Summer chum broodstock are collected at RM 0.1 in JCL Creek between August 15 and October 15, which represents the entire period when natural spawning occurs. A temporary weir and trap box are used to capture and hold adult fish for spawning. The lower river location of the trapping operation allows for access to virtually the entire summer chum return, helping to insure that broodstock collected represent the total returning natural population. The retention of 100% of the summer chum trapped for use as broodstock reduces the likelihood of adverse genetic effects to the population that may result from non-random selection (either intentional or unintentional) of fish for artificial propagation. The weir and trap are checked at least daily by NOSC, WOS, or WDFW staff during operation, to insure that the trap is operating properly and that any fish captured are held in safe condition. Monitoring of the trap is increased during freshets. In the event flooding, the weir panels are removed, allowing fish to pass safely. This measure prevents injury or mortality to summer chum if the trap were allowed to continue to operate during a flood event. Summer chum held in the locked trap box are further safeguarded from poaching or predation by being held in PVC tubes and by the

presence of a landowner residence immediately adjacent to the trap. To further reduce risk to summer chum adults, the co-managers are investigating transfer to, and holding of, adults at WDFW's Hurd Creek Hatchery prior to spawning. Any such transfer would be consistent with fish health protocols developed by the co-managers. Chinook salmon are not indigenous to JCL Creek, and the capture of listed chinook are not anticipated through the broodstock collection program.

3) Fish Health Protocols - Fish health monitoring associated with adult fish used in the program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in summer chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the Co-managers of Washington Fish Health Policy (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from all fish spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes.

d. *Hatchery Operational Protocols including Risk Minimization Measures.*
1) Water withdrawal method, effluent discharge practices - No water is removed for the JCL Creek broodstock trapping operation. Fish are trapped and held directly in the creek. Water used for incubation and rearing at Hurd Creek Hatchery is supplied by a well, and through water withdrawn from Hurd Creek, at a combined, permitted amount of 6.4 cfs (Fuss and Ashbrook 1995). The head-box structure used to withdraw water from Hurd Creek is screened in compliance with NMFS screening criteria, and adverse effects on any listed fish species present in the creek are minimal. The hatchery is staffed full-time to allow for rapid response to catastrophic events including flooding or power failure. A low flow alarm system and back-up generator also allow for appropriate response to water or power failures to safeguard rearing fish. Water required for rearing at the remote salmon rearing site at JCL Creek is supplied by gravity flow from a spring-fed stream. Incubating and rearing eggs and fry will therefore not be affected by power failures. Combined intake systems can supply as much as 60gpm, although the operation requires less than 20gpm. Parallel intakes function as back-up water supply for this operation. A 2-inch PVC pipe enters each intake box carrying the water 40 to 60 feet to one 55 gallon clarifier/regulator barrel where water flow from both lines is collected and distributed to the incubation units and/or rearing vessels. The only valves operative in the system are on the outflow from the 55 gallon clarifier/regulator barrel controlling flow to the incubation units and/or rearing vessels. Excess flow is managed by 2-inch diameter line exiting the top of the barrel above the outflow lines to the incubation/rearing vessels. Due to their small size, no listed fish use the springs for spawning and rearing. Water removed from the springs for fish rearing is returned to JCL Creek near the point of withdrawal. Hurd Creek Hatchery has been issued an NPDES permit authorizing the release of effluent from the hatchery, in compliance with permit limits. No effluent discharge permits are required for the JCL summer chum rearing program due to its small size (presently less than 50 pounds of fish production per year). No adverse effects to listed fish populations are expected as a result of effluent discharge from the Hurd Creek and JCL Creek operations. The JCL Creek site is not staffed full time, but is checked at least twice daily during operation and more often during high flows and severe cold weather events. The remoteness of the location provides additional security from potential vandalism of the water supply.

2) Annual target production goal (life stage, disposition of surplus) - The annual target fish production level for the program is a maximum of 86,000 fed fry at an average size of 1.0 grams (WDFW and PNPTT 2000). This maximum level of production was derived to rebuild the population to and average adult abundance experienced in the 1970s, when the population appeared to be at healthy, self-sustaining levels. The production of surplus fish is avoided to the extent feasible by limiting the number of adult summer chum secured through the broodstock collection operation. Any surplus production is treated in accordance with protocols set forth in the SCSCI (WDFW and PNPTT 2000).

3) Mating and incubation methods - Adult fish are spawned adjacent to the weir on JCL Creek, or possibly on-site at Hurd Creek Hatchery if adults are held there. Biological information, including fish age, size, fecundity, egg size, gamete viability, occurrence of pathogens, DNA samples, and GSI samples are collected from all summer chum spawned. All carcasses are returned to JCL Creek post-spawning to retain natural nutrient enrichment processes. After transport from JCL Creek, eggs are fertilized at Hurd Creek Hatchery factorially, or using at least a 1:1 spawning ratio. After fertilization, the eggs are water hardened in an iodophore solution as per co-manager Fish Health Policy guidelines (NWIFC and WDFW 1998), then placed in iso-bucket incubators for incubation through the eyed stage. The iso-bucket incubators will each be loaded with the eggs from one female and supplied with 0.5 gpm inflow. Upon eye-up, the eggs are shocked to allow for the removal of dead and unfertilized eggs, then placed in vertical stack incubators for incubation through hatch. All fish are thermally marked at this stage by regulating water temperatures to apply otolith bands. Fungus in the incubators is controlled by formalin drip prior to the eyed stage, consistent with Co-manager Fish Health Policy guidelines. In the first year of operation, survival rates for JCL summer chum during incubation were 66% from green egg to eye-up and 97% from eye-up to the swim-up stage. Most mortality was likely due to low viability of milt or eggs from the earliest returning adults; this has also occasionally been observed with the earliest egg takes from summer chum in the Salmon Creek supplementation program. Fish are held as long as possible to fully ripen in future years to address this potential problem.

Because the well water used for incubation at Hurd Creek is warmer and less variable diurnally than ambient water temperatures in the natural incubation environment in JCL Creek, the development of the summer chum eggs at Hurd Creek Hatchery would be artificially advanced. The eggs at Hurd Creek will therefore hatch and swim-up much earlier than their natural-origin counterparts, leading to the potential for diminished survival if the hatchery fish were released as unfed fry, when productivity in the marine environment would be low. To address this potential risk, eyed eggs are placed in vertical stack incubators and chilled to slow cumulation of temperature units and minimize this potential difference in advanced development. In addition, the 1 to 1.5 month rearing period required to achieve a 1.0 gram average fish size at release planned for the JCL program will act to balance this differential in development rates, so that the hatchery fish are released into the environment during the natural summer chum emigration period in March and April.

4) Rearing methods, including densities - Fry are removed from incubators and ponded into 4' diameter circular tanks at Hurd Creek Hatchery upon absorption of the yolk sac. At Hurd Creek Hatchery, feed is presented to the fry six times per day until fry are feeding actively; and then at 2% to 3.5% per body weight per day until transfer to JCL Creek. At JCL Creek, feed is presented to the fry via hand casting and 12-hour automatic spring driven belt feeders. Commercial feed at the rate of 2-3% per body weight per day is used. Freshwater rearing tanks are loaded up to a maximum of 4,000 fish each and flows are maintained at approximately 5-8 gpm, well below 3.0 pounds fish per gpm inflow to minimize the risk of disease outbreaks in the population. At the Hurd Creek and JCL Creek locations, sample weights to identify fish size and appropriate feeding rates are taken every one to two weeks during the fresh water rearing period. Fish behavior and mortality is recorded daily to monitor the population for fish disease outbreaks.

Fry are transported by truck in aerated buckets or tote to the JCL Creek rearing site in February or March for continued rearing in 4' diameter fiberglass tanks. The fish are reared for an additional month to adequately acclimate the fish to JCL Creek, applying the same methods and densities as described above for Hurd Creek.

5) Release methods, including number of fish and locations - All summer chum fry produced through the program are released into lower JCL Creek in the inter-tidal area during March or early April at an average fish size of 1.0 gram (55 mm fork length (FL)). The fish are released during darkness, on an out-going high tide to minimize the risk of avian and fish predation. Up to 86,000 summer chum fry may be released through the program. The projected release number for 2000, the initial year of the program, is 3,900 fed fry.

6)) Fish health protocols - All summer chum are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred from JCL Creek for fertilization at Hurd Creek Hatchery are water hardened in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. The summer chum fry are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. *Monitoring and Evaluation and Research* -
Monitoring and evaluation, and research, proposed for the program is consistent with requirements set forth in the SCSCI, where monitoring and evaluation elements required for each supplementation program in the region are indicated (WDFW and PNPTT 2000). A primary objective of summer chum salmon monitoring and evaluation and research program is the collection of baseline biological information on summer chum salmon native to JCL Creek. Information collected will include fecundity, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, and the occurrence of malformed fry in off-spring. This baseline information will be used in the future to determine the ecological and genetic effects of the supplementation program on the propagated and natural-origin summer chum populations in the eastern Strait of Juan de Fuca. Biological samples collected from summer chum adults

retained as broodstock includes tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples. Scales are also removed for age determination.

An additional objective is the determination of the need, and methods, for improvement of the supplementation program or, if warranted, the need to discontinue the program. This objective is being pursued by otolith-marking all hatchery summer chum juveniles produced through the program to allow for assessment of contribution and natural origin recruit (NOR) production levels. Beginning in 2002, otoliths will be sampled to determine if returning fish are of hatchery or natural origin. Mortality data for the propagated population is collected during the incubation and rearing period. Average fish size data is collected from the fry at the time of release.

Injury or mortality levels to summer chum salmon will not be elevated as a consequence of the monitoring and evaluation and research activities, because they are a part of, and directly linked to, the standard hatchery procedures proposed for the program. Expected summer chum salmon injury or mortality levels resulting from these activities are included in the above sections describing broodstock collection and fish rearing procedures. Listed chinook salmon are not likely to be affected by these programs.

f. *Consistency with Court Mandates and including Compliance with ESU-wide Conservation Plans.*

The proposed JCL summer chum supplementation program, and hatchery operational methods used to collect, transfer, rear and release summer chum, are consistent with the co-managers' SCSCI, the ESU-wide conservation proposed for recovering the listed population (WDFW and PNPTT 2000). Monitoring and evaluation and research proposed for the program is also fully consistent with activities set forth within the co-managers' conservation initiative to improve scientific understanding of artificial propagation benefits and risks. The program also operates within agreed fish production planning processes included under the Puget Sound Salmon Management Plan (PSSMP 1985).

1) Integration with fisheries management - The summer chum supplementation program is integrated with fisheries management measures as defined in the SCSCI (WDFW and PNPTT 2000). The "base conservation" fishery total harvest rate proposed under the SCSCI is 10.8% (3.3% to 15.3%). These rates reflect incidental fishery harvest levels in Canadian and U.S. fisheries. These rates are designed to decrease harvest impacts to listed summer chum in interceptory fisheries from previous levels. Actual harvest rates on summer chum produced in eastern Strait of Juan de Fuca watersheds should be lower, due to the lack of terminal area commercial fisheries directed at other species where summer chum may be incidentally taken. No directed fisheries on summer chum salmon result from adult fish produced through the JCL Creek program.

B. <u>Artificial Propagation Programs Producing Other Salmonid Species</u>

Federally funded and non-Federally funded (WDFW funded, or WDFW administered and privately funded) hatchery programs producing salmonid species other than summer chum salmon in the action area that may adversely affect listed summer chum salmon are described in this section. Key resources used for information regarding each hatchery program, including fish production levels by species and age class, facility descriptions, and hatchery operational and management practices are the co-managers' SCSCI (WDFW and PNPTT 2000), HGMPs submitted for the Federal-nexus programs, and WDFW's *Hatchery Operations and Performance Summary* document (Fuss and Ashbrook 1995). Annual salmonid production information for the programs described in this section is summarized in Table 11, taken from the SCSCI (WDFW and PNPTT 2000).

Hatcheries within the Hood Canal and Strait of Juan de Fuca region annually release fall chinook, coho, fall chum, winter steelhead and, in odd-numbered years, pink salmon juveniles to increase run sizes, and augment Pacific Northwest treaty Indian and non-Indian fisheries. Hood Canal- region hatcheries presently produce approximately 30.0 million fall-run chum salmon, 6.0 million fall chinook salmon, 1.0 million coho salmon, 0.1 million winter steelhead, and (in odd-numbered years) 1.0 million pink salmon each year. Fall chum salmon hatchery production in Hood Canal is the largest in the state, with fry releases from WDFW hatcheries producing adult returns to the Canal averaging 416,000 fish in recent years (1987-94 WDFW run reconstruction data, June 27, 1995). Hatchery programs in the Strait of Juan de Fuca region annually produce 3.6 million juvenile fall-run chinook, 2.1 million spring-run chinook, 0.4 million coho salmon, and 11,000 winter steelhead.

Federally Funded Programs

1. U.S. Fish and Wildlife Service Programs

HGMPs submitted by USFWS for coho salmon and fall chum salmon artificial propagation programs at Quilcene NFH (USFWS 1999b; 1999c), and the SCSCI (WDFW and PNPTT 2000) provide the following information for the USFWS hatchery producing other salmonid species within the Hood canal summer chum ESU. Private cooperative group programs that receive Federal funding through the USFWS for fall chinook salmon and winter steelhead production in the action area are included in the section below describing hatchery programs administered under the authority of WDFW.

Quilcene National Fish Hatchery

a. Stock History - Quilcene NFH collects, rears, and releases unlisted coho and fall chum salmon into the Big Quilcene River, a tributary to Hood Canal, Washington. The program produces yearling coho salmon smolts for on-station release and transfer to local marine net-pens, and fed fall chum fry for on-station release. Eyed coho salmon eggs are also transferred to WDFW's George Adams Hatchery to produce coho smolts for cooperative marine net-pen projects within Hood Canal operated by the Skokomish and Port Gamble S'Klallam tribes. Coho salmon propagated at the hatchery are mainly of indigenous stock, but transfers of coho from other watersheds have occurred sporadically in past years, prior to 1968 (USFWS 1999b). The coho program at Quilcene NFH has been self-sustaining since that time. The propagation of coho at Quilcene NFH began with on-station releases in 1912. Transfers of Quilcene stock coho

smolts to the Quilcene Bay net-pens began in 1994. The Port Gamble net-pens received Quilcene stock coho beginning in 1993. Fall chum salmon are of local stock, originating from transfers of fall chum adults collected at Wolcott Slough into the hatchery (through the early 1980s), and inter-mixing of that stock with native Big Quilcene River fall chum (USFWS 1999c). Fall chum salmon have been propagated for on-station release at Quilcene NFH since 1912.

The Big Quilcene River has an indigenous population of summer chum salmon that is being supplemented with fed fry releases by the hatchery for recovery purposes. Based on an increasing escapement trend and recent large escapements attributable in large part to the success of this supplementation program, the current extinction risk for the summer chum stock is low (WDFW and PNPTT 2000)

b. Purpose and Location - The hatchery is located on the left bank of Big Quilcene River, a tributary to Hood Canal, at RM 2.8. The hatchery began operation in 1912. The purpose of the Quilcene NFH coho and fall chum salmon hatchery programs is to increase production of salmon in Hood Canal for harvest as adult fish in tribal and non-Indian commercial fisheries, and in Puget Sound recreational fisheries.

c. Facilities - A detailed description of broodstock capture, spawning, incubation, rearing, and release facilities at Quilcene NFH is provided in the previous section describing the summer chum salmon supplementation program. Facilities used for the propagation of coho salmon and fall chum salmon for on-station release or transfer to other facilities are the same as those used for the summer chum program. A maximum water withdrawal from the Big Quilcene River and Penny Creek for use in the hatchery of 65 cfs is permitted and regulated by the Washington State Department of Ecology under surface water rights certificates. Waste water discharge is monitored and controlled for settleable solids and suspended solids, as specified under NPDES discharge permit # WA-187-2.

d. Disease Protocols - Fish health monitoring of adult coho and fall chum collected at Quilcene NFH is conducted by USFWS. The incidence of viral pathogens in coho and fall chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the “Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State” (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by USFWS staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from USFWS and in accordance with the co-managers’ fish health policy (NWIFC and WDFW 1998). All eggs taken on-station, or transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior, and monitoring of daily mortality trends. All coho and fall chum salmon populations reared at the facility are examined by a USFWS fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Adult coho and fall chum migrating up the Big Quilcene River are collected through a permanent, electrified, concrete splash dam spanning the river at RM 2.8. Fish encountering the dam are diverted into a fish ladder leading to the discharge points for adult holding ponds at the hatchery. Twice weekly during the coho and fall chum migration period, fish collecting at the top of the ladder are captured with nets, enumerated by sex, and either passed to holding ponds for eventual spawning or sacrificed as surplus to hatchery needs. Quilcene coho salmon are an early-migrating stock, returning as adults to the hatchery from early September through early November each year. Quilcene NFH fall chum return to the river between mid-November and mid-January, which is the same escapement timing exhibited by "native" fall chum salmon populations in the region. Annual broodstock collection goals for the operation are based on egg take goals of 1.3 million for coho and 2.6 million for fall chum. Assuming average fecundity of 2,000 and 2,800 respectively, for these species, and a one to one spawning ratio, 1,300 coho adults and 2,100 fall chum adults are required each year as broodstock. Hatchery-origin adult fish that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Hood Canal and Puget Sound. In particular, surplus coho salmon returns to Quilcene Bay are important for Skokomish and Port Gamble S'Klallam tribal net fisheries and for state-managed recreational fisheries during August and September. Surplus coho and fall chum that escape fisheries and reach the hatchery are provided to Washington Treaty Tribes for ceremonial and subsistence purposes and to the U.S. Justice Department for use in the Federal prison system. Prior to 1994, USFWS released up to 800 adult coho surplus to hatchery needs upstream of the hatchery weir (Zajac 2000). After 1994, coho salmon fry were released above the hatchery instead of adult fish. The fry release program has been discontinued, and USFWS now proposes to resume upstream planting of up to 230 surplus coho salmon adults to use upstream habitat for natural production (Zajac 2000).

f. Releases and Identification - Annual coho and fall chum salmon production goals for Quilcene NFH are presented below (from USFWSb; USFWSc). Actual, projected release or transfer numbers for 2000 are close to the programmed levels below.

Species	Annual goal	Age Class	Size (fl mm)	Release or Transfer Timing
Coho				
Quilcene NFH	450,000	Smolt	154 mm	early to mid-May
Quilcene Net-pens 1/	200,000	Smolt	131-167 mm	January - February
Port Gamble Pens 1/	500,000	Eyed egg	1400/lb	December - January
Fall chum	2,200,000	Fed fry	47 mm	late April - early June

1/ Transfers to tribal cooperative programs for eventual release as smolts into Hood Canal marine waters.

All coho salmon smolts released on-station, and a portion (45 %) of the coho transferred to the Quilcene net-pens are marked to support mass marking programs. A proportion of the coho salmon smolts released from Quilcene NFH and the Quilcene Net-pens also receive a coded wire tag to identify contribution rates of the programs to fisheries and escapement. Fall chum fry

produced at the hatchery are not marked to identify their origin, or to differentiate them from natural-origin fish at the present time.

In 1999, WDFW began implementing measures at state-managed hatcheries in Hood Canal to minimize the risk of adverse effects posed by the release of unfed and fed fall chum fry through food resource and habitat competition on emigrating summer chum fry in marine waters. These proposed measures included delaying the release of all fall chum fry until after April 1 to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. Fall chum propagated through the Quilcene NFH program are native, late-timed stock, that have historically been released into Hood Canal during the month of May and well after the summer chum emigration period. The USFWS fall chum program has therefore already been in compliance with measures taken to reduce risks to summer chum salmon.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, USFWS takes the following actions: 1) monitor release-to-adult percent survival rates; 2) monitor size at release and population uniformity relative to fish release size objectives; 3) acclimate all fish to the release location; 4) collect adults from throughout the run; 5) maintain a spawning population for each species under propagation above 500 fish; maintain a male:female spawning ratio greater than or equal to 1.0; 6) adhere to the co-managers' fish health policy (NWIFC and WDFW 1998); and 7) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

2. Point No Point Treaty Tribal Programs

The SCSCI (WDFW and PNPTT 2000) and personal communications with PNPTC technical staff were used as references to provide the following information for BIA-funded Point No Point Treaty tribal hatchery programs.

Enetai Hatchery

a. Stock History - The Skokomish Tribe's Enetai Hatchery collects, rears, and releases unlisted fall chum, and until recently, fall chinook salmon into Hood Canal, Washington. Fall chum propagated in the program are of Walcott Slough/Big Quilcene NFH lineage. This stock is now localized through the Enetai program, and transfers to sustain the program are not generally needed. The fall chinook program had been sustained year-to-year through egg transfers from George Adams or Hoodsport hatcheries. As of 1999, fall chinook are no longer released from Enetai Hatchery, and only the fall chum program is discussed in the following text. The propagation of fall chum of Walcott/Quilcene lineage began when the hatchery first commenced production in the late 1970s, and has continued to the present date. Fall chum of the same run-timing as the localized hatchery stock are indigenous to Enetai Creek. Enetai Creek is not recognized as a summer chum production stream, and has no indigenous summer chum population (WDFW and PNPTT 2000).

b. Purpose and Location - The hatchery is located on Enetai Creek, a minor, southern tributary of Hood Canal, east of the the town of Potlatch, Washington. The hatchery began operation in 1977 with the release of brood year 1976 fall chum salmon. Chinook salmon production began in 1981 (brood year 1980). Enetai Hatchery was built to increase production of fall chum and fall chinook salmon in the Hood Canal region for harvest as returning adults in Hood Canal commercial net fisheries. For a brief period (brood years 1984 - 87), winter steelhead were reared at Enetai Hatchery and released as fingerlings in the Skokomish River in an effort to enhance steelhead adult returns.

c. Facilities - Enetai Hatchery uses seven 24' diameter circular fiberglass rearing ponds and an adult trap and holding facility for the fall chum rearing and trapping programs. Release capacity for the facility is 1.5 million fed fall chum fry. An additional one million unfed fry are also released each year. Netarts Bay-style shallow matrix incubators are used for the incubation through swim-up of up to 2.5 million fry. Water for the program is supplied by gravity flow from Enetai Creek. Approximately 2 cfs is used by the hatchery to produce chum salmon. Fish production each year at the hatchery is quite low (approximately 4,000 pounds) and well below the 20,000 pound annual production level used as the standard to require compliance with the effluent discharge and monitoring requirements of a NPDES permit.

d. Disease Protocols - Fish health monitoring associated with adult fish collected at the facility is conducted through the Northwest Indian Fisheries Commission (NWIFC) Fish Health Division. The incidence of viral pathogens in fall chum salmon broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the “Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State” (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by NWIFC Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from the NWIFC, and in accordance with the co-managers’ fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior, and monitoring of daily mortality trends. All salmon reared at the facility are examined by a NWIFC fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Returning fall chum are collected for use as broodstock through a weir and fish trap positioned in intertidal waters at the mouth of Enetai Creek. Fish collected in the trap are generally mature, and spawned directly at that location. Fall chum return to Enetai from early December through January, with peak returns in the first week in December. The Enetai Hatchery trap is typically operated from late November through early January to collect returning broodstock. The trap is checked at least daily when operating. Captured fish are removed from the trap and spawned daily. The annual fall chum broodstock collection goal is 1,500 adults. Adult fish that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Hood Canal. Surplus fish that escape fisheries and reach the hatchery are also sold as spawned and unspawned carcasses directly from

the hatchery pond to fish buyers under contract with the Skokomish Tribe. Fall chum are also used for ceremonial and subsistence purposes by the Tribe.

f. Releases and Identification - Annual Enetai Hatchery juvenile fall chum salmon release goals are presented below (from WDFW and PNPTT 2000). Approximately 1,250,000 fed fry were released in 2000, representing the lowest production in years due to a low adult return to the hatchery in 1999. The 2000 release total includes fry resulting from transfer of approximately 466,000 eggs from Quilcene National Fish Hatchery (the original brood stock source) to help offset low on-station adult return and egg take levels in 1999.

Species	Annual Goal	Age Class	Size (fl mm)	Timing
Fall chum	**1,000,000**	Unfed fry	38-40 mm	March - April
	1,500,000	Fed fry	43-56 mm	April - May

WDFW has delayed the release of all fall chum fry until after April 1 at its southwest Hood Canal hatcheries to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. Release of unfed fry at Enetai Hatchery will be terminated if it is not possible to release the fry after April 1. Fall chum propagated at Enetai Hatchery are of Walcott/Quilcene lineage, which is an indigenous, late-spawn timed stock.

g. Monitoring and Evaluation - Monitoring and evaluation associated with the Enetai program is designed to insure that the hatchery is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the fall chum stock, and maximizes survival of eggs and fish under propagation. The Skokomish Tribe takes the following actions to meet these objectives: 1) monitor the number of adults collected at the hatchery weir; 2) monitor and estimate release-to-adult percent survival rates; 3) collect adults from throughout the run; 4) maintain a spawning population above 500 fish for propagation; 5) maintain a male:female spawning ratio above 0.33; and 6) comply with the co-managers' fish health policy (NWIFC and WDFW 1998).

Quilcene Net-pens

a. Stock History - The Skokomish Tribe's Quilcene Bay Net-pen program is sustained through transfers of coho salmon smolts propagated at Quilcene NFH. The coho are reared through the late spring in the net-pens for release at the net-pen site into Hood Canal, Washington. The propagation of coho salmon at the site began in 1986, and has continued to the present date. Coho stocks reared in past years at the net-pens have included Dungeness and George Adams Hatchery coho. Only Quilcene stock coho are now released from the site. Because the net-pen coho originate from broodstock collected at Quilcene NFH, the net-pen coho salmon are of the same run-timing as the source hatchery stock indigenous to the Big Quilcene River. Tributaries adjacent to the marine area release site (the Big and Little Quilcene rivers) support a listed summer chum population, which is being supplemented through a recovery program at Quilcene NFH. Based on an increasing escapement trend and recent large escapements attributable in

large part to the success of this supplementation program, the current extinction risk for the summer chum stock is low (WDFW and PNPTT 2000).

b. Purpose and Location - The net-pens are located in marine waters, adjacent to the eastern shoreline of Quilcene Bay in northern Hood Canal, approximately three miles southeast of the town of Quilcene, Washington. The net-pens began operation in 1986, however Quilcene stock coho have been under propagation at the site since 1994. The purpose of the net-pen program is to increase production of coho salmon in the Hood Canal region for harvest as returning adults in Hood Canal and Quilcene Bay tribal and non-Indian commercial net fisheries, and in WDFW-managed recreational fisheries.

c. Facilities - The net-pen facility consists of a single net pen supported at its periphery by steel walkways on foam-filled plastic floats. The net pen is 50' square and 40 feet deep. The pen system is anchored to bedlands to maintain the pens in position. Railings on the walkways are used to support the ½" stretch mesh net-pen in which the coho are contained for rearing. Tidal flow maintains adequate temperature and dissolved oxygen levels in the pens during rearing. Fish production during the course of rearing at the net-pens is approximately 9,000 pounds (for 200,000 fish release assuming rearing of 25 fish/lb coho to a 12 fish/lb average release size), which is below the 20,000 pound annual production level used as the standard to require compliance with the effluent discharge and monitoring requirements of a NPDES permit.

d. Disease Protocols - Fish health monitoring by USFWS staff, and through the Northwest Indian Fisheries Commission (NWIFC) Fish Health Division. The incidence of viral pathogens in coho salmon broodstock used to sustain the program is determined by sampling fish at spawning at Quilcene NFH in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of the Quilcene coho population spawned for evaluation by USFWS fish health staff for disease certification purposes. Coho salmon at the net-pens are reared under the guidance of certified fish health personnel from the NWIFC, and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. All salmon reared at the facility are examined by a NWIFC fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - No broodstock are collected at the net-pen site. The program is sustained through collection of adult fish at Quilcene NFH. Broodstock collection methods employed at Quilcene NFH have been described in a previous section. Adult fish resulting from the net-pen program home to a great extent to the Quilcene NFH, their place of origin, during September and October. Returning net-pen origin coho that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Hood Canal and in Quilcene Bay, near the mouth of the Big Quilcene River. Surplus adult coho and fall chum salmon that escape fisheries and reach the hatchery are provided to Washington Treaty

Tribes for ceremonial and subsistence purposes and to the U.S. Justice Department for use as food in the Federal prison system.

f. Releases and Identification - Annual Quilcene Bay Net-pen coho salmon smolt release goals are presented below (from WDFW and PNPTT 2000). Actual release numbers in 2000 were approximately 200,000 smolts. Historically, the release goals have varied depending on the source and availability of smolts for transfer to the pens. The current goal reflects the production capacity at Quilcene National Fish Hatchery given its other production objectives.

Species	Annual Goal	Age Class	Size (fl mm)	Timing
Coho	**200,000**	Smolt	131 - 167 mm	late April - June

g. Monitoring and Evaluation - Monitoring and evaluation associated with the net-pen program is designed to insure that the program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the fall chum stock, and maximizes survival of eggs and fish under propagation. Most of these objectives are met through monitoring and evaluation applied by USFWS during broodstock collection and fish rearing programs at Quilcene NFH. The Skokomish Tribe insures that the rearing program is monitored in compliance with the co-managers' fish health policy (NWIFC and WDFW 1998).

Little Boston Hatchery

a. Stock History - The Port Gamble S'Klallam Tribe's Little Boston Hatchery rears and releases unlisted fall chum into Port Gamble Bay, Hood Canal, Washington. Fall chum propagated in the program are of Finch Creek stock, originally obtained each year as eyed eggs from WDFW's southwest Hood Canal hatcheries, but now sustained by adult brood stock returning to the hatchery. Salmon propagation at the location began in 1977 (brood year 1976), and continues to the present date. Walcott Slough stock fall chum were originally used to meet production needs, but by 1980 (brood year 1979) hatchery production had switched to Finch Creek stock. In past years, there were experiments in production of chinook, coho and pink salmon at Little Boston Hatchery but all of these programs were terminated. Little Boston Creek, the water course on which the hatchery is located, receives naturally spawning fall chum each year at modest levels, surplus to hatchery brood stock needs. The creek is not recognized as a summer chum production stream, and has no indigenous summer chum population (WDFW and PNPTT 2000).

b. Purpose and Location - The hatchery is located on Little Boston Creek, a minor tributary at the terminus of Port Gamble Bay, near the the town of Port Gamble, Washington. The hatchery began operation in 1977. Little Boston Hatchery was built to increase production of fall chum in the Hood Canal region for harvest as returning adults in Hood Canal commercial net fisheries.

c. Facilities - Little Boston Hatchery uses three 13' diameter circular fiberglass rearing ponds for the fish propagation program. Release capacity for the facility is 1.0 million fed fall chum

fry. Netarts Bay-style shallow matrix incubators are used for fry incubation through swim-up. Water for the program is supplied by gravity flow from Little Boston Creek. Up to 1 cfs is used by the hatchery to produce juvenile salmon. Fish production at the hatchery is quite low (approximately 3,000 pounds) and well below the 20,000 pound annual production level used as the standard to require compliance with NPDES effluent discharge and monitoring requirements.

d. Disease Protocols - Fish health monitoring associated with adult fish collected at the facility is conducted through the Northwest Indian Fisheries Commission (NWIFC) Fish Health Division. The incidence of viral pathogens in fall chum salmon broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by NWIFC Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from the NWIFC, and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. All salmon reared at the facility are examined by a NWIFC fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Hatchery production is sustained through adults returning to the hatchery. The adults are collected during the month of November. Fish are collected and spawned once or twice each week, with the collection of spawners spread proportionately throughout the run. Adult fish returning to Port Gamble Bay are harvested in tribal commercial and non-Indian recreational fisheries in Hood Canal during the August through December period. Surplus fish that escape fisheries and reach the hatchery are allowed to spawn naturally, or are sold as unspawned carcasses directly from the hatchery pond to fish buyers under contract with the Port Gamble S'Klallam Tribe. Surplus hatchery fall chum adults are also used for ceremonial and subsistence purposes by the Tribe.

f. Releases and Identification - Annual Little Boston Hatchery juvenile salmon release goals are presented below (from WDFW and PNPTT 2000). Fall chum release numbers for 2000 were approximately 520,000 fed fry. The 2000 release total is lower than the hatchery goal because of low adult returns for use as broodstock in 1999.

Species	Annual Goal	Age Class	Size (fl mm)	Timing
Fall chum	**1,000,000**	**Fed Fry**	**41-66 mm**	**April**

Beginning in 1999, WDFW delayed the release of all fall chum fry until after April 1 at its southwest Hood Canal hatcheries to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. Little Boston fall chum are also released after the predominate (March) summer chum emigration period.

g. Monitoring and Evaluation - Monitoring and evaluation associated with the Little Boston program is designed to insure that the hatchery is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the fall chum stock, and maximizes survival of eggs and fish under propagation. The Port Gamble S'Klallam Tribe takes the following actions to meet these objectives: 1) monitor the number of adults harvested in Port Gamble Bay fisheries and escaping to Little Boston Creek; 2) monitor and estimate release-to-adult percent survival rates; and 3) comply with the co-managers' fish health policy (NWIFC and WDFW 1998).

Port Gamble Bay Net-pens

a. Stock History - The Port Gamble S'Klallam Tribe's Port Gamble Bay Net-pen program is sustained through transfers of Quilcene stock coho salmon smolts produced at WDFW's George Adams Hatchery. The coho are reared through the late spring in the net-pens for release at the net-pen site into northern Hood Canal, Washington. The propagation of coho salmon at the site began in the early 1980s, and has continued to the present date. Coho stocks reared in past years at the net-pens have included Dungeness and George Adams Hatchery coho. Only Quilcene stock coho are now released from the net-pens, in compliance with co-manager stock transfer and fish health policy requirements which limit inter-basin hatchery fish transfers. Because the net-pen coho originate from broodstock collected at Quilcene NFH, the net-pen coho salmon are of the same early run-timing as the source hatchery stock indigenous to the Big Quilcene River. If not harvested in net fisheries targeting returning adults at the release site, these net-pen-origin coho salmon may stray into tributaries south of the release site that have been identified as summer chum streams (NRC 1997).

b. Purpose and Location - The net-pens are located in marine waters adjacent to the southern shoreline of Port Gamble Bay in northern Hood Canal, approximately one mile west of the town of Port Gamble, Washington. The net-pens began operation in 1981 (brood year 1979), but the use of Quilcene stock coho only began in1993 (the first of a five year transition to use of Quilcene stock only at the site that was completed in 1997). A primary purpose of the net-pen program is to increase production of coho salmon in the Hood Canal region for harvest as returning adults in Hood Canal and Port Gamble Bay tribal commercial net fisheries, and in WDFW-managed recreational fisheries.

c. Facilities - The facility consists of two net pens supported at their peripheries by steel walkways on foam-filled plastic floats. Each net pen is 50' square and 25 feet deep. The array is anchored to bedlands to maintain the pens in position. Railings on the walkways are used to support the ½" stretch mesh net-pens in which the coho are contained for rearing. Tidal flow maintains adequate temperature and dissolved oxygen levels in the pens during rearing. Fish production during the course of rearing at the net-pens is approximately 17,000 pounds (assuming rearing of 25 fish/lb coho to a 12 fish/lb average release size), which is below the 20,000 pound annual production level used as the standard to require compliance with NPDES effluent discharge and monitoring requirements.

d. Disease Protocols - Fish health monitoring by USFWS staff, and through the Northwest Indian Fisheries Commission (NWIFC) Fish Health Division. The incidence of viral pathogens

in coho salmon broodstock used to sustain the program is determined by sampling fish at spawning at Quilcene NFH in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of the Quilcene coho population spawned for evaluation by USFWS fish health staff for disease certification purposes. Coho salmon at the net-pens are reared under the guidance of certified fish health personnel from the NWIFC, and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior, and monitoring of daily mortality trends. All salmon reared at the facility are examined by a NWIFC fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - No broodstock are collected at the net-pen site. The program is sustained through collection of adult fish at Quilcene NFH, and transfer of eyed eggs to George Adams Hatchery for rearing to smolt size. Broodstock collection methods employed at Quilcene NFH have been described in a previous section. Adult fish resulting from the net-pen program home to a great extent to the release site in Port Gamble Bay, where the fish are harvested in tribal gill net fisheries. Coho adults that escape fisheries may stray to Hood Canal tributaries to spawn (NRC 1997).

f. Releases and Identification - Annual Port Gamble Bay Net-pen coho salmon smolt release goals are presented below (from WDFW and PNPTT 2000). Coho release numbers in 2000 were approximately 380,000 smolts.

Species	Annual Goal	Age Class	Size (fl mm)	Timing
Coho	400,000	Smolt	131 - 167 mm	late April - late May

g. Monitoring and Evaluation - Monitoring and evaluation associated with the net-pen program is designed to insure that the program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the fall chum stock, and maximizes survival of eggs and fish under propagation. Most of these objectives are met through monitoring and evaluation applied by USFWS and WDFW during broodstock collection and fish rearing programs at Quilcene NFH and George Adams Hatchery. The Port Gamble S'Klallam Tribe insures that the rearing program is monitored in compliance with the co-managers' fish health policy (NWIFC and WDFW 1998).

3. Washington Department of Fish and Wildlife-Non-governmental Cooperative Programs
This section describes Federally funded, WDFW-non-governmental cooperative salmonid hatchery programs producing unlisted salmonids that may adversely affect listed summer chum salmon in the action area. Federal funding for these programs is distributed through USFWS. These programs are administered by WDFW, and are generally managed, operated, and partially funded by non-governmental (private and volunteer) enhancement groups, with some WDFW involvement.

References used to provide the following information for these WDFW cooperative non-governmental enhancement group programs are the SCSCI (WDFW and PNPTT 2000), two HGMPs submitted by LLTK for hatchery programs on the Hamma Hamma River (LLTK 2000a; 2000b), two documents describing LLTK and HCSEG programs (LLTK 1999e; HCSEG 1999), and a WDFW document describing the Hamma Hamma winter steelhead program.

a. Stock History - The WDFW-non-governmental cooperative programs rear and release unlisted fall chinook and winter steelhead into the Skokomish and Hamma Hamma rivers in the Hood Canal region. As described in the previous section, the non-governmental groups involved in these programs are also active in three programs that collect, rear, and release listed indigenous-origin summer chum salmon for stock recovery purposes.

Fall chinook salmon presently propagated in these cooperative programs are of localized, Green River, Puget Sound lineage, and have generally been obtained as eyed eggs or smolts from WDFW's Hoodsport or George Adams hatcheries. Steelhead produced for LLTK/HCSEG stock recovery program on the Hamma Hamma River are of indigenous origin. Discussions among the co-managers are underway to transition broodstocks used for on-going fall chinook programs on the west-side of Hood Canal from WDFW hatchery returns, to adult fish recruiting to the west-side rivers . The Hamma Hamma steelhead project will continue to work with the native stock over the course of its operation (LLTK 2000a).

b. Purpose and Location - LLTK, in cooperation with HCSEG, operates hatchery programs producing unlisted salmonids on John Creek, a right bank tributary to the Hamma Hamma River at RM 1.4, and on Lilliwaup Creek at RM 0.5. Both of these watersheds are west-side tributaries of Hood Canal. Partial funding for the two programs is provided through Federal sources, and administered by USFWS. All fall chinook salmon incubated and reared at Lilliwaup Hatchery are transferred as eyed eggs to the John Creek conservancy location, or as yearlings for release from a rearing pond on a small right bank tributary near the mouth of the Skokomish River (Endicott or Old Hatchery Inn Hatchery). No chinook salmon are released on-station into Lilliwaup Creek through the program. Fall chinook are propagated by the groups to enhance the number of fish returning to spawn naturally in the region, and for harvest as returning adults in Northeast Pacific and Puget Sound commercial and recreational fisheries. An additional purpose of the fall chinook programs could include stock recovery using indigenous stocks, pending the success in obtaining natural-origin broodstock from tributaries of Hood Canal. The Lilliwaup and Hamma Hamma hatcheries are also operated to increase production of indigenous stock Hamma Hamma winter steelhead for stock recovery purposes.

Of the watersheds affected by the programs, the Hamma Hamma and Lilliwaup watersheds harbor listed summer chum populations, and the Skokomish River population is considered extinct. The co-managers have designated Hamma Hamma summer chum population as depressed , and the Lilliwaup population as critical in status (WDFW and PNPTT 2000).

c. Facilities - Facilities used by LLTK to incubate and rear steelhead and fall chinook at the Lilliwaup and Hamma Hamma hatcheries are the same as those used to produce summer chum at those facilities. The facilities have been previously described in the section of this Opinion addressing summer chum-directed programs. The use of NATURES rearing methods is an important component of the Hamma Hamma chinook salmon and steelhead programs. Facilities used to rear fish at that location, including earthen ponds that mimic the character of natural rearing environs, carry forth this production strategy (LLTK 2000a). One-half of the steelhead for this program are reared at LLTK Lilliwaup Hatchery and returned to the Hamma Hamma River for release as two-year-old smolts. The other half of annual production is reared and released on-station. The Old Hatchery Inn acclimation site near the mouth of the Skokomish River used for yearling fall chinook production consists of an earthen rearing pond supplied with water by gravity flow from an unnamed creek. After transfer from Lilliwaup Hatchery and acclimation at the Old Hatchery Inn (Endicott) site, fall chinook are released as yearlings into the Skokomish River. The LLTK hatchery projects are small in size, producing salmon and steelhead at levels below which a NPDES permit, and attendant effluent monitoring conditions, would be required.

d. Disease Protocols - Fish health monitoring of adult fish collected to supply eggs or smolts for the private and volunteer group programs is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in fall chinook and fall chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. Salmonids at the LLTK facilities are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred by WDFW for incubation through the programs are water hardened (at fertilization) or disinfected in an iodophore at transfer as eyed eggs as safeguards against fish disease transfer. Fish are monitored daily during rearing by the operators for signs of disease, through observations of feeding behavior and monitoring of mortality trends. Salmon and steelhead reared after swim-up at the projects are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Fall chinook salmon broodstock providing eggs for the programs have been collected when available as surplus at WDFW's Hoodsport, George Adams, or McKernan hatcheries. Broodstock collection methods applied at those facilities, and surplus adult disposition practices, are described in previous sections. In 2000, the Hamma Hamma program was partially sustained through the collection and spawning of male broodstock collected from the Hamma Hamma River. Male fish will be crossed with female chinook collected for the program at the WDFW hatcheries. The Hamma Hamma program is expected by NMFS to transition to the use of localized adult returns only as broodstock commencing in 2001 (D. Poon, NMFS, pers. comm.).

Steelhead propagated through the Hamma Hamma steelhead recovery program are collected by hydraulic sampling naturally spawned steelhead redds in the upper Hamma Hamma River between April and June, to extract eyed eggs for incubation and rearing to the smolt or two year old age class (LLTK 2000a). Attempts are made to extract eggs from all identified redds to help insure that the propagated population is representative of the genetic diversity of the founding natural population.

f. Releases and Identification - Projected annual hatchery salmonid release numbers for these cooperative programs by species, age class, and timing are presented below (updated for 2000 from WDFW and PNPTT (2000) by T. Johnson, WDFW, pers. comm.).

All fall chinook salmon eyed eggs used for the Skokomish River and Hamma Hamma River projects are otolith-marked to allow for their differentiation at spawning from natural fish. In addition, WDFW proposes to mark all sub-yearling and yearling chinook salmon produced in WDFW-administered Hood Canal hatchery programs (including these programs) with an adipose fin clip in future years, pending agreement with the Point No Point Treaty Tribes. Steelhead produced for the Hamma Hamma recovery program are marked with an adipose clip to allow for visual differentiation at spawning from natural Hamma Hamma fish.

Species	Annual goal 1/ (on-station)	Age Class	Size (fl mm)	Release Timing (avg)
Fall chinook				
Skokomish River	190,000	Yearling	195 mm	April, June
Hamma Hamma R.	70,000	Fingerling	80 mm	May
Winter steelhead				
Hamma Hamma 2/	150	Adults	620 mm	March-April
Hamma Hamma	4,500 **3/**	2+ Yearling	180 mm	April 15

1/ Goal from WDFW Future Brood Document - February 2, 2000.
2/ Projected release date 2002.
3/ Released 1,400 fish at 100 fpp in January 1999, 300 fish at 25 fpp in January 2000, and 1,500 fish at 8 fpp in May 2000.

g. Monitoring and Evaluation - Monitoring and evaluation at these hatcheries is designed to insure that they are operated in a manner that maximizes survival of all life stages under propagation, and comply with WDFW production and release reporting requirements. The following actions are required to meet these objectives: 1) monitor the number of adults passed upstream of any fish weirs operated; 2) monitor and report the weekly number of adults or progeny collected for use as broodstock; 3) monitor egg-to-release survival rates; 4) report the number of fish of each species and age class released each year from each project; and 5) comply with the co-managers' fish health policy (NWIFC and WDFW 1998) during all phases of the hatchery programs.

Non-Federally Funded Programs

4. Washington Department of Fish and Wildlife Hatchery Programs

Hatchery programs managed and funded by WDFW that may adversely affect listed summer chum salmon in the action area are described in this section. The WDFW *Hatchery Operations and Performance Summary* document (Fuss and Ashbrook 1995) and the SCSCI (WDFW and PNPTT 2000) provide the following information for these hatchery programs.

Hoodsport Hatchery

a. Stock History - Hoodsport Hatchery collects, rears, and releases unlisted fall chinook, fall chum, and pink salmon into Hood Canal, Washington. Fall chinook salmon propagated in the program are of localized, Green River, Puget Sound lineage. Fall chinook returns to Hood Canal Hatchery were founded beginning in 1953 through direct imports of eggs from WDFW's Green River Hatchery, and through transfers of Green River-lineage eggs from Dungeness Hatchery (WDF 1957; K. Kloempken, WDFW, pers. comm., July, 1998). Although the fall chinook program is now sustained by adult returns to the hatchery, for the first forty years of operation (through the early 1990s), the program relied on Green River lineage egg transfers mainly from south Puget Sound hatcheries to meet production needs. Fall chum produced at the hatchery are derived from the indigenous population in Finch Creek, and broodstock have been secured from adults returning to the hatchery each year. The hatchery pink salmon population returning to Hoodsport is non-indigenous in origin, derived from Dungeness River and Dosewallips River stocks. The propagation of these species and lineages began when the hatchery first commenced production in the 1950s, and has continued to the present date. Only fall chum are indigenous to Finch Creek. A native run of summer chum on Finch Creek was extirpated by the 1960s (WDFW and PNPTT 2000).

b. Purpose and Location - The hatchery is located on Finch Creek, a west-side tributary of Hood Canal, in the town of Hoodsport. The hatchery began operation in February, 1953. Hoodsport Hatchery was built to increase production of fall chinook, fall chum, and pink salmon in the Hood Canal region for harvest as returning adults in Northeast Pacific and Puget Sound commercial and recreational fisheries (Fuss and Ashbrook 1995).

c. Facilities - Hoodsport Hatchery includes a fish weir deployed seasonally in Finch Creek at RM 0, and a water intake dam with an adequate fishway spanning Finch Creek at RM 0.1, thirteen standard rearing ponds, one large rearing pond, and a combination rearing and adult holding pond. Release capacity for the facility is 15 to 17 million fish, the majority of which are fall chum fry. Vertical stack incubators are used for the incubation of up to 11 million fry. Flow for rearing can be supplied from either freshwater or seawater sources. Freshwater is supplied by gravity flow through withdrawal at the Finch Creek intake dam. The intake dam is equipped with a fishway, but hatchery disease control policies, until recently, have not allowed upstream fish passage (Barber et al. 1997). Coho salmon and steelhead can jump the dam, and fall chum salmon can escape upstream of the intake during flood events only. When used for rearing, seawater is supplied by pumps with intakes in Hood Canal, directly offshore from the hatchery. The hatchery has permitted water rights for 17.4 cfs from Finch Creek and 8.8 cfs through the seawater intake. The hatchery is operated in compliance with the effluent discharge and monitoring requirements of a National Pollutant Discharge Elimination System (NPDES) permit

issued and administered by Washington Department of Ecology. Total suspended solids, settleable solids, and upstream and downstream temperatures and dissolved oxygen levels are monitored in hatchery influent and effluent to meet NPDES permit requirements.

d. Disease Protocols - Fish health monitoring associated with adult fish collected at the facility is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in fall chinook, fall chum, and pink salmon broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs taken on-station, or transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. All salmon reared at the facility are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

As mentioned above, it has been a practice at the hatchery to prevent escapement of returning salmonids upstream of the hatchery intake at Finch Creek. This practice was applied to limit the risk of the horizontal transmission of fish diseases to fish under propagation in the hatchery. Beginning in 1998, WDFW relaxed this disease control measure, allowing passage upstream of any summer chum salmon adults encountered through the hatchery trapping operation. This conservation measure is applied annually during the August through September summer chum freshwater entry period.

e. Broodstock Collection and Disposition of Surplus Adults - Returning fall chinook, fall chum, and pink salmon are collected for broodstock through a weir spanning Finch Creek at its mouth in intertidal waters. Fish encountering the weir are directed into an adult holding pond, and no adult fish can access areas upstream of the weir without handling in the hatchery. Pink salmon return in odd-numbered years only between July and September, with a peak return to the hatchery in late September. Fall chinook return to the hatchery from August to October, with peak returns in October. Fall chum return from October through December, with peak returns in mid-to-late November. The Hoodsport Hatchery weir is typically in-place and operated from July (odd-numbered years) or August (even-numbered years) through December each year, and fish are removed and checked for maturity at least twice weekly during this period. Annual broodstock collection goals have been approximately 1,000 fall chinook, 27,000 fall chum, and 2,000-4,000 pink salmon (Brood year average from 1989-93 data). Hatchery-origin adult fish that are surplus to hatchery broodstock collection needs are available for harvest in commercial and recreational fisheries in Hood Canal and Puget Sound. In particular, surplus fall chum and fall chinook returns to marine waters directly adjacent to the hatchery are important for Skokomish tribal net fisheries and for WDFW-managed commercial and recreational fisheries between August and December. Surplus fish that escape fisheries and reach the hatchery are

sold as spawned and unspawned carcasses directly from the hatchery pond to fish buyers under contract with WDFW. Surplus fish are also provided to the Skokomish Tribe for ceremonial and subsistence purposes.

f. Releases and Identification - Annual Hoodsport Hatchery juvenile salmon release goals by species, age class, and timing are presented below (from WDFW and PNPTT 2000). Actual, projected release numbers for 2000 are 3.0 million sub-yearling and 0.25 million yearling fall chinook, 6.6 million fall chum salmon, and 1.4 million pink salmon (WDFW Hatcheries Program data, February 2000).

Species	Annual goal	Age Class	Size (fl mm)	Timing
Fall chinook	3,000,000 250,000	Sub-yearling Yearling	80-86 mm 195 mm	June 1 - 22 May 2
Fall chum	15,000,000	Fed Fry	48-52 mm	March 24 - April
Pink	1,000,000	Fed fry	50 mm	March 15

In previous years, a proportion of the total number of fall chinook produced at Hoodsport (approximately 5 % of annual production) were marked with an adipose clip-coded wire tag combination to identify fisheries contribution and survival. No adipose clip-coded wire tagged fall chinook juveniles are currently being released at Hoodsport Hatchery. WDFW proposes to mark all chinook salmon produced at the hatchery in future years, pending agreement with the Point No Point Treaty Council tribes.

Beginning in 1999, WDFW implemented measures to minimize adverse effects that may be posed by the release of unfed and fed fall chum fry through food resource and habitat competition on emigrating summer chum fry in marine waters. These measures included delaying the release of all fall chum fry until after April 1 to minimize their duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. The same release delay practice is proposed for pink salmon fry produced at Hoodsport in 2000. WDFW's release delay actions follow risk aversion recommendations made by WDFW technical representatives involved in drafting the SCSCI. Due to space and flow concerns at programmed fall chum production levels, WDFW was unable to meet this post-April 1 release recommendation during 1999 at Hoodsport Hatchery. Fall chum salmon fry were released during the month of March for fish health maintenance reasons. During 2000, all fall chum were released on or after April 1.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, WDFW takes the following actions: 1) monitor the number of adults passed upstream of the weir; 2)monitor release-to-adult percent survival rates; 3) monitor size at release and population uniformity relative to fish

release size objectives; 4) acclimate all fish to the release location; 5) collect adults from throughout the run; 6) maintain a spawning population for each species under propagation above 500 fish; 7) maintain a male:female spawning ratio above 0.33; 8) adhere to the co-managers' fish health policy (NWIFC and WDFW 1998); and 9) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

George Adams Hatchery

a. Stock History - George Adams Hatchery collects, rears, and releases unlisted fall chinook, coho, and fall chum salmon into southern Hood Canal, Washington. Fall chinook salmon propagated in the program are of localized, Green River, Puget Sound lineage. Although the fall chinook program is now sustained by adult returns to the hatchery, until the early 1990s, the

program relied on egg transfers from WDFW hatcheries in south Puget Sound to meet production needs. Coho salmon are of uncertain ancestral lineage, with components including Dungeness, Soos Creek, and Hood Canal natural-origin stocks. The hatchery has relied on "adapted" Purdy Creek broodstock returning to the hatchery since initial operation, however. Fall chum produced at the hatchery are from localized returns of Finch Creek-lineage fish, and from direct transfers of eggs taken at Hoodsport Hatchery. The propagation of these species and lineages began when the hatchery first commenced production in the early 1960s, and has continued to the present date. Only fall chum are indigenous to Purdy Creek, but this stock has been mixed with Finch Creek lineage fish over the duration of the George Adams operation.

b. Purpose and Location - The hatchery is located on Purdy Creek, a tributary of the Skokomish River, eight miles north of the city of Shelton. The hatchery began operation in 1963. George Adams Hatchery was built to increase production of fall chinook, fall chum, and pink salmon in the Hood Canal region for harvest as returning adults in Northeast Pacific and Puget Sound commercial and recreational fisheries.

c. Facilities - George Adams Hatchery has a fish weir spanning Purdy Creek, six standard rearing ponds, two large rearing and release ponds, and a combination adult holding and rearing pond. The adult holding pond is an instream pond on Purdy Creek. The fish weir at the base of the pond blocks passage of adult salmon (Barber et al. 1997). Eight channel raceways and two 10'x100' raceways are also available for rearing. Release capacity for the facility is 13 million fish of various species. Vertical stack incubators are used for the incubation of up to 90 million eggs. Water is supplied by gravity flow from Ellis Creek and by pump from Purdy Creek. Both sources are properly screened to prevent harm to natural-origin fish in the watersheds. The hatchery has permitted water rights for 21.3 cfs from Purdy Creek and 2.5 cfs from Ellis Creek. The hatchery is operated in compliance with the effluent discharge and monitoring requirements of a NPDES permit issued and administered by Washington Department of Ecology. Total suspended solids, settleable solids, and upstream and downstream temperatures and dissolved oxygen levels are monitored in hatchery influent and effluent to meet NPDES permit requirements.

d. Disease Protocols - Fish health monitoring associated with adult fish collected at the facility is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in fall chinook, coho, and fall chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs taken on-station, or transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of

daily mortality trends. All salmon reared at the facility are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Returning fall chinook, coho, and fall chum are collected for broodstock through a permanent weir spanning Purdy Creek adjacent to the hatchery. Fish encountering the weir are directed into an adult holding pond, where they can be enumerated and either held for spawning or passed upstream. Fall chinook return to the hatchery from August to October, with peak returns in October. Coho salmon are trapped at the hatchery from September through January, with peak spawning in November. Fall chum return from October through December, with peak returns in mid-to-late November. The George Adams weir is typically in-place and operated from August through December each year, and fish are removed and checked for maturity at least twice weekly during this period. Annual broodstock collection goals have been approximately 2,500 fall chinook, 1,400 coho, and 5,400 fall chum (1989-93 brood year data). Hatchery-origin adult fish that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Hood Canal and Puget Sound. In particular, surplus fall chum, coho, and fall chinook returns to lower Hood Canal marine waters and to the Skokomish River are important for Skokomish tribal net fisheries and for state-managed commercial and recreational fisheries between August and December. Surplus fish that escape fisheries and reach the hatchery are also sold as spawned and unspawned carcasses directly from the hatchery pond to fish buyers under contract with WDFW.

f. Releases and Identification - Annual George Adams Hatchery juvenile salmon release goals by species, age class, and timing are presented below (from WDFW et al. 2000). Actual, projected release numbers for 2000 are 3.7 million fall chinook, 0.495 million coho, and 5.0 million fall chum (WDFW Hatcheries Program data, February 2000).

Species	Annual goal (on-station)	Age Class	Size (fl mm)	Timing
Fall chinook	4,370,000	Sub-yearling	80-86 mm	June 1 - 22
Coho	422,000	Yearling	131-156 mm	June 11-July 16
Fall chum	5,000,000	Fed fry	48-52 mm	April-May

All coho salmon are marked with an adipose fin clip, and a proportion of the total number of fall chinook produced at George Adams are marked with an adipose clip-coded wire tag combination to identify fisheries contribution and survival. WDFW proposes to mark the entire chinook salmon population in future years, pending agreement with the Point No Point Treaty Council tribes.

Beginning in 1999, WDFW implemented measures to minimize the potential adverse effects that may be posed by the release of unfed and fed fall chum fry through food resource and habitat competition on emigrating summer chum fry in marine waters. These measures included delaying the release of all fall chum fry until after April 1 to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. WDFW's actions in this

regard were following recommendations made by WDFW technical representatives involved in drafting the SCSCI. The fall chum salmon release delay was designed to minimize the risk of adverse effects on the listed summer chum salmon population.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, WDFW takes the following actions: 1) monitor the number of adults passed upstream of the weir; 2) monitor release-to-adult percent survival rates; 3) monitor size at release and population uniformity relative to fish release size objectives; 4) acclimate all fish to the release location; 5) collect adults from throughout the run; 6) maintain a spawning population for each species under propagation above 500 fish; 7) maintain a male:female spawning ratio above 0.33; 8) adhere to the co-managers' fish health policy (NWIFC and WDFW 1998); and 9) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

McKernan Hatchery

a. Stock History - McKernan Hatchery collects, rears, and releases unlisted fall chum salmon into Weaver Creek, Hood Canal, Washington. Fall chum produced at the hatchery are from localized returns of Finch Creek-lineage fish, and from direct transfers of eggs taken at Hoodsport Hatchery. The propagation of fall chum of Finch Creek origin began when the hatchery first commenced production in the late 1970s, and has continued to the present date. Fall chum are indigenous to the Skokomish River. However, the localized McKernan stock was initiated using Finch Creek lineage fish over the duration of its operation, and the hatchery still relies on egg infusions from Hoodsport to maintain production objectives.

b. Purpose and Location - The hatchery is located on Weaver Creek, a tributary of the Skokomish River, two miles west of George Adams Hatchery. The hatchery began operation in 1977. McKernan Hatchery was built to increase production of adult fall chum in Hood Canal and the Skokomish River for harvest in tribal and non-Indian commercial fisheries.

c. Facilities - McKernan Hatchery has three standard rearing ponds (two 17'x140'x3' and one 22'x140'x3'). Release capacity for the facility is 11 million chum fry. Vertical stack incubators are used for incubation to hatch of up to 12 million eggs. Water is supplied by gravity flow from Weaver Creek and by pumps on Weaver Creek. Two wells are used to supplement the creek water. Water intakes on Weaver Creek are properly screened to prevent harm to natural-origin fish. The hatchery has permitted water rights for 12 cfs from Weaver Creek and 6.9 cfs from wells at the hatchery. The hatchery is operated in compliance with the effluent discharge and monitoring requirements of a NPDES permit issued and administered by Washington Department of Ecology. Total suspended solids, settleable solids, and upstream and downstream temperatures and dissolved oxygen levels are monitored in hatchery influent and effluent to meet NPDES permit requirements.

d. Disease Protocols - Fish health monitoring of adult fish collected at the facility, or at other southwest Hood Canal hatcheries supplying eggs for the program, is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in fall chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs taken on-station, or transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. All salmon reared at the facility are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Returning fall chum are collected for broodstock through a permanent weir spanning Weaver Creek adjacent to the hatchery. Fish encountering the weir are directed into an adult holding pond, where they can be enumerated and held for spawning on an at least twice weekly basis. Fall chum return from October through December, with peak returns in mid-to-late November. The weir in Weaver Creek is typically in-place and operated from October through December each year to trap fall chm adults. The annual broodstock collection goals for the operation have been approximately 10,500 adults (1989-93 brood year data). Hatchery-origin adult fish that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Hood Canal and Puget Sound. In particular, surplus fall chum returns to lower Hood Canal marine waters and to the Skokomish River are important for Skokomish tribal net fisheries and for state-managed commercial fisheries between August and December. Surplus fish that escape fisheries and reach the hatchery are also sold as spawned and unspawned carcasses directly from the hatchery pond to fish buyers under contract with WDFW.

f. Releases and Identification - The annual fall chum fed fry release goals for McKernan are presented below (from WDFW et al. 2000). Actual, projected release numbers for 2000 are 9.9 million fall chum fed fry (WDFW Hatcheries Program data, February 2000).

Species	Annual goal (on-station)	Age Class	Size (fl mm)	Timing
Fall chum	10,000,000	Fed fry	48-52 mm	March-April

Fall chum salmon fry produced at McKernan Hatchery are not marked to identify their origin, or to differentiate then from natural-origin fish at the present time.

Beginning in 1999, WDFW implemented measures to minimize the potential effects that may be posed by the release of unfed and fed fall chum fry as a result of food resource and habitat competition with emigrating summer chum fry in marine waters. These proposed measures included delaying the release of all fall chum fry until after April 1 to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. This release delay practice followed recommendations made by WDFW technical representatives involved in drafting the SCSCI. The release delay until after April 1 was designed to minimize the risk of adverse effects on juvenile summer chum salmon. Due to space and flow limitations on programmed fall chum production levels, WDFW was unable to meet the post-April 1 release recommendation during 1999 at McKernan Hatchery, and fall chum salmon were released during the month of March. During 2000, all fall chum were released on or after April 1.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, WDFW takes the following actions: 1) monitor release-to-adult percent survival rates; 2) monitor size at release and population uniformity relative to fish release size objectives; 3) acclimate all fish to the release location; 4) collect adults from throughout the run; 5) maintain a spawning population for each species under propagation above 500 fish; 6) maintain a male:female spawning ratio above 0.33; 7) adhere to the co-managers' fish health policy (NWIFC and WDFW 1998); and 8) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

Dungeness and Hurd Creek Hatcheries

a. Stock History - Dungeness Hatchery collects, rears, and releases ESA-listed chinook, and unlisted coho and pink salmon into the Dungeness River, Washington. Hurd Creek Hatchery is used as a satellite facility to rear listed Dungeness chinook for a captive broodstock program, and to incubate and early rear coho salmon originating from natural-origin fish collected in Snow Creek, a tributary to Discovery Bay in Jefferson County. A small steelhead yearling acclimation program is also sustained at Dungeness Hatchery through transfers of non-indigenous stock smolts from WDFW's Bogachiel or Eels Springs hatcheries. Chinook salmon propagated in the programs are of indigenous Dungeness River lineage, and have been designated by NMFS as essential for the recovery of the listed Puget Sound chinook ESU. Coho and pink salmon are of also of native Dungeness River origin, the latter species being the focus of a stock rebuilding program. The Dungeness River has been designated as critical habitat for summer chum salmon by NMFS (65 FR 7764). The co-managers have assigned an "unknown" status to the summer chum population in the river, but consider any fish present as of "native" origin (WDFW and PNPTT 2000). More information is needed regarding the summer chum population before any recovery activities are contemplated for the stock. Snow Creek has an indigenous summer chum population that is considered to be of the same stock as the population in Salmon Creek. The Snow /Salmon summer chum population is "depressed" in status, but at low risk of extinction (WDFW and PNPTT 2000).

b. Purpose and Location - The Dungeness Hatchery is located on the Dungeness River, six miles southwest of Sequim, Washington. The hatchery was built in 1902, and is operated in its present form to increase production of adult coho salmon in the Strait of Juan de Fuca region for Northeast Pacific and Puget sound fisheries, and to help restore native chinook and pink salmon in the Dungeness River. Hurd Creek Hatchery is located approximately four miles north of Sequim. Hurd Creek was built in 1960, and is presently operated to incubate fall chinook eggs for transfer back to the Elwha River. Hurd Creek is also used to rear Dungeness chinook to adult size for spawning as part of a stock restoration program. The Dungeness complex is also used for incubation and early rearing support for the Snow Creek coho salmon recovery program. Steelhead smolts trucked in and acclimated at Dungeness Hatchery are produced to enhance tribal and recreational fisheries in the Dungeness River.

c. Facilities - Dungeness Hatchery has ten 10' x 100' raceways for fish rearing, one ½ acre rearing and release pond, and an adult holding pond. Release capacity for the station is approximately 2 million fish. Incubation facilities include 17 shallow and 10 deep trough incubators and a few vertical stack incubators, providing a total hatching capacity of 5 million fry., two large rearing and release ponds, and a combination adult holding and rearing pond. Hurd Creek hatchery has four large raceways and one large creek pond for rearing of up to 2.6 million fish for release. Incubation is done in deep troughs which have a capacity of approximately 12 million eggs to the eyed stage, and 2 million eggs to hatch. Water to the Dungeness Hatchery is supplied by gravity flow from Canyon Creek and the Dungeness River. The hatchery has permitted water rights for 15 cfs from the Dungeness River and 8.7 cfs from Canyon Creek. Hurd Creek has a permitted water right for 6.4 cfs from the creek and a well in combination. All water sources are properly screened to prevent harm to natural-origin fish in the watersheds. Both hatcheries are operated in compliance with the effluent discharge and monitoring requirements of NPDES permits issued and administered by Washington Department of Ecology. Total suspended solids, settleable solids, and upstream and downstream temperatures and dissolved oxygen levels are monitored in hatchery influent and effluent to meet NPDES permit requirements.

d. Disease Protocols - Fish health monitoring associated with adult fish collected at the facility is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in chinook, coho, and pink broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the “Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State” (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. All salmon are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers’ fish health policy (NWIFC and WDFW 1998). All eggs taken on-station, or transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of

daily mortality trends. All salmon reared at the facility are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Coho broodstock are collected at Dungeness Hatchery through volunteer recruitment to a fish ladder and holding pond. There is no weir on the river adjacent to the hatchery, and fish can by-pass the hatchery. Chinook used for the restoration program have been obtained by collecting progeny via hydraulic redd sampling, or by seining the river to collect fry or fingerlings. More recently, captive broodstock have been successfully spawned to provide sufficient numbers of chinook to meet program production needs. No adult chinook are collected from the river. Pink salmon broodstock are collected by installing a temporary weir near the mouth of the river. High flows in recent years have made the task of installing and operating a weir for pink collection problematic. Dungeness Hatchery is typically operated to collect coho broodstock from October to November. Pink salmon may be collected in the lower river during August and September. Annual broodstock collection goals have been 500 to 1,500 coho (1989-93 brood year data). Hatchery-origin coho that are surplus to hatchery needs are harvested in commercial and recreational fisheries in Dungeness Bay and in the river during October and November. Surplus fish that escape fisheries and reach the hatchery are also sold as spawned and unspawned carcasses directly from the hatchery pond to fish buyers under contract with WDFW.

Snow Creek coho salmon are collected upon return as adults at a weir and trap located in the upper watershed of Snow Creek. Coho are trapped at this location between October and December during the natural-origin coho migration period in the creek. Adults surplus to program needs are passed above the weir to spawn naturally.

f. Releases and Identification - Annual Dungeness Hatchery juvenile salmon release goals by species, age class, and timing are presented below (from WDFW and PNPTT 2000). No fish reared at Hurd Creek are released on-station. Actual, projected release numbers for Dungeness Hatchery in 2000 are 1.5 million chinook fry/fingerlings, 450,000 coho yearlings, 32,000 coho fry (Snow Creek), and 22,000 winter steelhead (WDFW Hatcheries Program data, February 2000).

Species	Annual goal	Age Class	Size (fl mm)	Timing
Chinook	1,700,000	Fry, fingerlings, and sub-yearlings	47->57 mm	June 15 - July 15
Coho				
Dungeness	450,000	Yearling	131 mm	May 30
Snow Ck.	16,000	Fingerling	70-100 mm	November, March
Snow Ck.	16,000	Unfed fry	35-38 mm	March - April
Pink	few	Fed fry	48-52 mm	March - April
Steelhead	22,000	Yearling	>180 mm	April 24 - May14

All chinook salmon released for the stock restoration program, and all coho salmon and steelhead, are marked with an adipose clip to allow for their differentiation from natural-origin fish. A proportion of the total number of chinook and coho salmon produced at Dungeness Hatchery are marked with an adipose clip-coded wire tag combination, to identify fisheries contribution and survival.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, WDFW takes the following actions: 1) monitor the number of adults passed upstream of the hatchery or pink salmon weir; 2) monitor release-to-adult percent survival rates; 3) monitor size at release and population uniformity relative to fish release size objectives; 4) acclimate all fish to the release location; 5) collect adults from throughout the run, or that are representative of the diversity of existing natural spawners (chinook and pink salmon); 6) maintain a spawning population for each species under propagation above 500 fish; 7) maintain a male:female spawning ratio above 0.33 for coho, and above 1.0 for chinook and pink salmon; 8) adhere to the co-managers' fish health policy (NWIFC and WDFW 1998); and 9) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

Eells Spring Hatchery Off-station Winter Steelhead Smolt Release Program

a. Stock History - Eells Spring rears unlisted winter steelhead for off-station releases into the Skokomish, Duckabush, and Dosewallips rivers. Steelhead produced at the hatchery are of non-indigenous origin, and are transferred in as eggs from WDFW's Bogachiel or Chambers Creek hatcheries. The steelhead are of Chambers Creek (south Puget Sound) lineage. The propagation of winter steelhead at the hatchery began in the mid-1940s, and has continued to the present date. Winter steelhead are indigenous to the all of the rivers where Eells Spring steelhead are released, but the distinct characteristics of any native populations may have been affected by long-term out-planting of non-indigenous stock into the rivers. The Skokomish, Duckabush, and Dosewallips rivers where winter steelhead are out-planted are all summer chum and fall chinook streams, and are considered critical habitat for these listed species. The co-managers have designated the three summer chum populations as extinct, depressed, and depressed, respectively. The latter two populations are considered to be at low risk of extinction (WDFW and PNPTT 2000).

b. Purpose and Location - The hatchery is located on Hunter Creek, a tributary of the Skokomish River, approximately four miles upstream of George Adams Hatchery. The hatchery

began operation in 1946. Eells Spring Hatchery was built to rear and out-plant winter steelhead smolts in various local rivers and streams for fisheries augmentation purposes.

c. Facilities - Eells Spring Hatchery has eight concrete raceways (10'x85'), 12 circular concrete rearing ponds (40' diameter), and two earthen rearing ponds (1.25 and 1.75 acres in size). The hatchery has a capacity to rear 220,000 steelhead smolts. The hatchery has 112 shallow trough incubators with a capacity of 2 million eggs to the eyed developmental stage. Water is supplied by pumps from four springs with a combined flow of 22 cfs. The hatchery is operated in compliance with the effluent discharge and monitoring requirements of a NPDES permit. Total suspended solids, settleable solids, and upstream and downstream temperatures and dissolved oxygen levels are monitored in hatchery influent and effluent to meet NPDES permit requirements.

d. Disease Protocols - Fish health monitoring of adult fish that provide progeny for the hatchery program is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in winter steelhead broodstock is determined by sampling fish at spawning at the hatchery of origin in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. All steelhead are reared under the guidance of certified fish health personnel from WDFW and in accordance with the co-managers' fish health policy (NWIFC and WDFW 1998). All eggs transferred to and from the hatchery for fertilization or incubation are water hardened or disinfected in an iodophore as a safeguard against fish disease transfer. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. All steelhead reared at the facility are examined by a WDFW fish health specialist within three weeks prior to out-planting to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - No adult winter steelhead are trapped for use as broodstock at the hatchery. The program relies on transfers of eggs from WDFW Chambers Creek or Bogachiel hatcheries to sustain production. All hatchery-origin adult fish produced through the program are designated for harvest in tribal and recreational fisheries in the three Hood Canal rivers where Eells Spring steelhead are planted. These fisheries occur between December through February, when adult winter steelhead return to the rivers. Surplus fish that escape fisheries may spawn naturally in the rivers.

f. Releases and Identification - The annual winter steelhead out-planting goals for Eells Spring Hatchery are presented below (from WDFW et al. 2000). Actual, projected release numbers for 2000 are near annual goal levels listed in the table.

Species	Annual goal (on-station)	Age Class	Size (fl mm)	Timing
Winter steelhead				
Skokomish R.	50,000	Yearling	180-230 mm	April 15-May 15
Duckabush R.	10,000	Yearling	180-230 mm	April 15-May 15

Species	Annual goal (on-station)	Age Class	Size (fl mm)	Timing
Dosewallips R.	12,500	Yearling	180-230 mm	April 15-May 15

All winter steelhead smolts planted into Hood Canal stream are marked with an adipose clip to allow for their differentiation from natural-origin steelhead for stock assessment and fisheries selectivity purposes. Fish are not acclimated to the river out-planting location prior to release.

g. Monitoring and Evaluation - Monitoring and evaluation at the hatchery is designed to insure that the hatchery program is operated in a manner that minimizes interactions with other fish populations, maintains stock integrity and genetic diversity of the hatchery stocks, maximizes survival of all life stages under propagation, and that insures compliance with state and Federal water quality standards. In order to accomplish these objectives, WDFW takes the following actions: 1) monitor release-to-adult percent survival rates; 2) monitor size at release and population uniformity relative to fish release size objectives; 3) collect adults from throughout the run at the hatchery of origin; 4) maintain a male:female spawning ratio above 1.0 at the hatchery of origin; 5) comply with fish health monitoring procedures in the co-managers' fish health policy (NWIFC and WDFW 1998); and 6) conduct environmental monitoring, including effluent settleable solids, suspended solids, and water temperature, to insure compliance with water quality standards.

5. Washington Department of Fish and Wildlife-Non-governmental Cooperative Programs
This section describes non-Federally funded WDFW cooperative salmonid hatchery programs producing unlisted salmonids that may adversely affect listed summer chum salmon in the action area. These programs are administered by WDFW, and are generally funded, managed and operated by non-governmental (private and volunteer) enhancement groups, with some WDFW involvement.

References used to provide the following information for these WDFW cooperative non-governmental enhancement group programs are the SCSCI (WDFW and PNPTT 2000), an HGMP submitted for the hatchery program on the Duckabush River (LLTK 2000c), and two documents describing LLTK and HCSEG programs (LLTK 1999e; HCSEG 1999).

a. Stock History - The WDFW-non-governmental cooperative programs rear and release unlisted fall chinook and fall chum salmon into various streams and rivers in the Hood Canal region. One project also collects fall chinook broodstock from returns resulting from hatchery fish releases into Big Beef Creek, an eastside tributary to Hood Canal.

Fall chinook salmon propagated in the private and volunteer group programs are of localized, Green River, Puget Sound lineage, and have generally been obtained as eyed eggs or smolts from WDFW's Hoodsport or George Adams hatcheries. The fall chinook return established at Big Beef Creek is of the same origin. Fall chum salmon produced through the programs are of Finch Creek-lineage, provided through direct transfers of surplus eggs taken from one of the three

major WDFW fall chum hatcheries in southwest Hood Canal. Co-operative fish propagation projects have been operated by WDFW and the non-governmental groups in the Hood Canal region since the mid-1980s. The fall chinook and fall chum stocks used in the projects have remained the same for these programs through the present date. Discussions among the co-managers are underway to transition broodstocks used for on-going fall chinook programs on the west-side of Hood Canal (including the Duckabush program) from WDFW hatchery returns, to adult fish recruiting to the west-side rivers .

b. Purpose and Location - Under the current program, fall chinook salmon incubated and reared at Lilliwaup Hatchery are transferred as eyed eggs to the Duckabush River site for rearing and release. Fall chinook are released from the Duckabush site to enhance the number of fish returning to spawn naturally in the region, and for harvest as returning adults in Northeast Pacific and Puget Sound commercial and recreational fisheries. An additional purpose of the fall chinook program could include stock recovery using the indigenous stock, pending the success in obtaining natural-origin broodstock from tributaries of Hood Canal.

The Duckabush River harbors a listed summer chum populations. The co-managers have designated the Duckabush population as healthy (WDFW and PNPTT 2000).

The non-governmental groups administered by WDFW also operate artificial propagation programs in a number of small Hood Canal tributaries, as well as in several major east-side and west-side Hood Canal watersheds. The groups have operated projects on the Union, Tahuya, Dewatto, Big Beef, Duckabush, and Skokomish watersheds to produce non-indigenous fall chinook and fall chum salmon for educational, research, natural-origin stock enhancement, and fisheries enhancement purposes. All of these watersheds presently harbor, or at one time sustained, indigenous summer chum populations. The status of summer chum populations in the watersheds ranges from extinct (Big Beef, Dewatto, Tahuya, and Skokomish), to depressed (Duckabush), to healthy (Union) (WDFW and PNPTT 2000). Big Beef Creek is presently the subject of a restoration program to reintroduce a self-sustaining summer chum population. Unlisted fall chinook and fall chum salmon enhancement projects on the Union, Tahuya, and Dewatto rivers have been terminated by the co-managers, following conservation decisions included in the SCSCI designed to reduce adverse effects to listed summer chum salmon (WDFW and PNPTT 2000).

Other cooperative fall chinook and fall chum hatchery projects have been operated for stock enhancement, educational, and fisheries augmentation purposes on small Hood Canal tributaries that have not been identified as sustaining summer chum populations, either in past years or at the present time. These streams have included Mills Creek, Little Mission Creek, Sweetwater Creek, Skull Creek, and several unnamed tributaries to Hood Canal. These fall chinook and fall chum salmon programs have been evaluated by the co-managers for consistency with the SCSCI (WDFW and PNPTT 2000). Marine net-pen projects have been operated by the volunteer groups cooperatively along the western shore of Hood Canal at Glen Ayr Marina (approximately two miles north of the town of Hoodsport, Washington), Hoodsport Marina (adjacent to the town of Hoodsport, and Pleasant Harbor Marina (south of Brinnon, Washington). The purpose of

these net-pen projects was to produce yearling fall chinook for harvest in Northeast Pacific and Puget Sound commercial and recreational fisheries. All of these small net-pen projects were recently terminated by the co-managers and the co-operative groups.

c. Facilities - The co-operative hatchery sites are generally small, and comprised of one to several RSIs for incubation, and in several instances, natural, earthen rearing ponds or raceways (e.g., the Johnson Creek site on the Duckabush (LLTK 2000c)) for the production of fall chinook or fall chum fed fry, or sub-yearling fall chinook. Water for these operations is generally drawn from springs identified as providing a stable flow of high quality water. Maintenance of natural rearing conditions, and low levels of human intervention into the salmon life cycle, are stressed for facilities assembled for these projects. Water from springs used for egg incubation and fish rearing is generally provided to incubation and rearing vessels by gravity flow through 2" diameter PVC pipes.

The fall chinook salmon program at Big Beef Creek Hatchery uses four 24' circular fiberglass tanks for rearing approximately 200,000 fall chinook fry to sub-yearling release size each year. A 4' diameter tank is used to start fry on feed. Vertical stack incubators housed in a hatchery building are used for the incubation of eggs. Water is presently supplied by siphon flow from a well located adjacent to Big Beef Creek ½ mile upstream from the hatchery. An additional well is has been installed immediately adjacent to the hatchery that will require water to be pumped for use in the hatchery. A back-up generator and a low flow alarm system provide the ability to respond to flow loss to the hatchery. The well used to supply the fall chinook program has a permitted water right for the withdrawal of 1,2000 gpm. All of the cooperative hatchery projects are small in size, producing salmon at levels below which a NPDES permit, and attendant effluent monitoring requirements, would be required. However, Big Beef Creek Hatchery has three settling ponds that are used to treat hatchery effluent prior to its release into the estuary.

d. Disease Protocols - Fish health monitoring of adult fish collected to supply eggs or smolts for the WDFW-non-governmental cooperative programs is conducted through the WDFW Fish Health Division. The incidence of viral pathogens in fall chinook and fall chum broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of each fish population spawned for evaluation by WDFW Fish Health Division staff for disease certification purposes. WDFW Fish Health Division coverage at the smaller facilities has been sporadic, and the level of compliance with the co-managers' fish health policy is uncertain. All eggs transferred by WDFW to the private and volunteer group projects for incubation are water hardened (at fertilization) or disinfected in an iodophore at transfer as eyed eggs as safeguards against fish disease transfer. Fish are monitored daily during rearing by the operators for signs of disease, through observations of feeding behavior and monitoring of mortality trends. Salmon reared after swim-up at most projects are examined by a WDFW fish health specialist within three weeks prior to release to determine health status.

e. Broodstock Collection and Disposition of Surplus Adults - Fall chinook and fall chum salmon broodstock providing eggs for the majority of the programs have been collected when available as surplus at WDFW's Hoodsport, George Adams, or McKernan hatcheries. Broodstock collection methods applied at those facilities, and surplus adult disposition practices, are described in previous sections. Fall chinook returning to Big Beef Creek between August and November are collected at either of two fish weirs spanning the creek and the hatchery and spawning channel outfall at approximately RM 0.2. Fish are spawned upon capture, or are held until mature in an earthen pond used for settling hatchery effluent water immediately below the Big Beef Creek Hatchery. Because fall chinook are not native to Big Beef Creek, and as a measure to minimize the risk of redd superimposition and spawning ground competition with summer chum in the process of being re-introduced to the watershed, no hatchery fall chinook are supposed to be allowed upstream of the fish trapping weirs to spawn naturally. Broodstock trapped in the creek surplus to annual production needs at Big Beef Creek are removed unspawned for sale to a private contractor or for on-site burial.

f. Releases and Identification - Annual salmon release numbers for these cooperative hatchery programs by species, age class, and timing are presented below (updated from WDFW and PNPTT 2000 by T. Johnson, WDFW, pers. comm.).

Species	Annual goal 1/ (on-station)	Age Class	Size (fl mm)	Release Timing (avg)
Fall chinook				
Big Beef Ck.	200,000	Sub-yearling	80-86 mm	June 1
Duckabush River	30,000	Sub-yearling	80-86 mm	May
Fall chum				
Misc. Hood Canal	200,000	Unfed/fed fry	38 mm	February-March

1/ Goal from WDFW Future Brood Document - February 2, 2000.

All fall chinook salmon eyed eggs used for the Duckabush River program (and in past years, for the now-terminated Dewatto River, Union River, and Tahuya River programs) have been otolith-marked to allow for their differentiation at spawning from natural fish. In addition, WDFW proposes to mark all chinook salmon sub-yearlings produced in WDFW-administered Hood Canal hatchery programs with an adipose clip in future years, pending agreement with the Point No Point Treaty Tribes. Fall chum fry and fingerlings produced through the co-operative projects are not marked at the present time.

Beginning in 1999, WDFW implemented measures to minimize the potential adverse effects that may be posed by the release of unfed and fed fall chum fry through food resource and habitat competition on emigrating summer chum fry in marine waters. These measures included delaying the release of all fall chum fry from WDFW hatcheries until after April 1 to minimize the duration of interaction with March-emigrating summer chum fry in the Hood Canal estuary. WDFW's actions in this regard were following recommendations made by WDFW, PNPT tribal, and USFWS technical representatives involved in drafting the SCSCI that were designed to minimize the risk of adverse effects on the listed population. These measures are proposed to be applied to the cooperative and HCSEG fall chum salmon programs (WDFW and PNPTT 2000).

g. Monitoring and Evaluation - Monitoring and evaluation at these hatcheries insures that they are operated in a manner that maximizes survival of all life stages under propagation, and comply with WDFW production and release reporting requirements. The operators are required by WDFW to take the following actions to meet these objectives: 1) monitor the number of adults passed upstream of any fish weirs operated; 2) monitor and report the weekly number of adults or progeny collected for use as broodstock; 3) monitor egg-to-release survival rates; 4) report the number of fish of each species and age class released each year from each project; and 5) comply with the co-managers' fish health policy (NWIFC and WDFW 1998) during all phases of the hatchery programs.

II. Species Status and Critical Habitat

A. Stock Status, Population Trends, and Life History

1. Hood Canal Summer Chum Salmon

The Hood Canal summer chum salmon ESU was formally listed as "threatened" under the ESA on March 25, 1999 (64 FRN 14508). Of the sixteen populations of summer chum identified in this ESU, seven are considered to be "functionally extinct" (Skokomish, Finch Creek, Anderson Creek, Dewatto, Tahuya, Big Beef Creek, and Chimacum). The remaining nine populations are well distributed throughout the ESU, except for the eastern side of Hood Canal. The ESU has two geographically distinct regions: the Strait of Juan de Fuca (SJF) and Hood Canal (HC). Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts, and display varying survival patterns and stock status trends (WDFW and PNPTT 2000).

In the Hood Canal region, summer chum are still found in the Dosewallips, Duckabush, Hamma Hamma, Big and Little Quilcene, and Union rivers and Lilliwaup Creek. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum populations declined rapidly beginning in 1979, and has remained at depressed levels. The terminal run size for the Hood Canal summer chum stocks averaged 28,971 during the 1974-1978 period, declining to an average of 4,132 during 1979-1993 (WDFW and PNPTT 2000). Abundance during the 1995-1998 period improved, averaging 10,844. However, much of the increase in abundance can be attributed to a supplementation program for the Big/Little Quilcene River summer chum stock begun in 1992. Summer chum adult escapements into the Union River have been stable or increasing in relation to historical levels. Escapements to the Dosewallips and Duckabush rivers have been generally above threshold levels of concern, but are highly variable. Recent year escapements in the Hamma Hamma River, and particularly in Lilliwaup Creek, have often been below threshold escapement levels that represent an increased risk to the population (WDFW and PNPTT 2000).

In the Strait of Juan de Fuca, summer chum stocks are found in Snow, Salmon, and Jimmycomelately Creeks and the Dungeness River. The Snow and Salmon creek populations are treated as a single stock complex (WDFW and PNPTT 2000). The terminal area (nearshore

marine and freshwater) abundance of returning adult summer chum in the Strait of Juan de Fuca region began to decline in 1989, a decade after the decline observed for summer chum in Hood Canal. Adult summer chum abundance declined from an average of 1,923 for the 1974-1988 period to a average of 477 during 1989-1994 period (WDFW and PNPTT 2000). During the most recent period (1995-1998), the average for the region has increased to 1,039. However, much of the increase may be due to the summer chum supplementation program in the Snow/Salmon system initiated in 1992. Escapements in Jimmycomelately have continued to be poor, averaging less than 100 spawners in the last three years. There are no systematic surveys to determine summer chum salmon abundance in the Dungeness River. Although their presence is routinely noted in surveys for other species, the status of the summer chum population in the Dungeness River is unknown (WDFW and PNPTT 2000).

The observed reductions in the numbers of summer chum salmon in the region are the result of the combined impacts of a number of factors (Johnson et al. 1997; summary below from WDFW and PNPTT 2000). Habitat degradation and loss from a variety of sources, including forest practices, road building, residential construction, stream flow alteration, diking, and channelization, have had major negative effects on summer chum streams throughout the ESU. Climatic factors, including a shift since 1977 to warmer, dryer conditions during the September summer chum spawning period, and higher flows during the October through March incubation period, are thought to have had moderate to major negative effects on summer chum productivity. Competition or predation impacts posed by other salmonid species have had moderate, negative effects on summer chum. Finally, over-harvest in Canadian per-terminal and U.S. terminal area commercial fisheries directed at other species have had moderate to major negative effects on listed summer chum abundance and production.

Stock status ratings presented in Table 2 are based on SASSI definitions (WDF et al. 1993). The extinction risk ratings were developed by the co-managers to prioritize and guide stock recovery responses, including determinations of when supplementation is appropriate. The methods used to derive these ratings were provided by Allendorf et al. (1997). Criteria from Allendorf et al. (1997) used to assess the level of extinction risk included: the extinction risk probability using population viability analysis; effective population size per generation; total population size per generation; population decline; and incidence of catastrophic population decline rate and effect (WDFW and PNPTT 2000).

Table 2. The status of the Hood Canal summer chum salmon ESU as indicated by spawner abundance, stock status and extinction risk determinations for remaining stocks (taken from WDFW and PNPTT 2000).

Stock	Abundance *	Stock Status	Extinction Risk Rating
Union	269	Healthy	Moderate
Lilliwaup	47	Critical	High
Hamma Hamma	73	Depressed	Moderate

Table 2. The status of the Hood Canal summer chum salmon ESU as indicated by spawner abundance, stock status and extinction risk determinations for remaining stocks (taken from WDFW and PNPTT 2000).

Stock	Abundance *	Stock Status	Extinction Risk Rating
Dosewallips	207	Depressed	Low
Duckabush	185	Depressed	Low
Quilcene	100	Depressed	High **
Snow/Salmon	296	Depressed	High **
Jimmycomelately	85***	Critical	High***
Dungeness	Unknown	Unknown	Special Concern

* Five year (1988-93) pre-supplementation program average annual spawner escapement levels.
** Extinction risk rating is based on population status prior to implementation of a supplementation program.
*** Abundance and extinction risk ratings are based on current (1994-98) average escapements.

The above stock status and extinction risk ratings serve to indicate the status of the listed summer chum salmon stocks for recovery planning purposes, and for evaluation of the effects of proposed actions in this Opinion. These status and extinction risk ratings will be used as standards for evaluating hatchery actions until VSP critical and viable population thresholds (as per McElhany et al. 2000) for the listed population are derived. Using VSP principles, critical and viable population thresholds for summer chum will be developed in future years by the NMFS-administered Technical Recovery Team responsible for long term listed salmon ESU recovery planning in western Washington. When developed, the critical threshold will generally represent a state where a population is at relatively low abundance or productivity. At the viable threshold, a population is functioning properly and at a self-sustaining abundance level. Derivation of these thresholds for abundance will be based upon the specific ESU and historic information on population distribution and abundance. In general, if population abundance is less than 500 to 5,000 per generation, there is an increased risk of extinction. If the salmon population generation length is four years (the approximate generation length for chum salmon), the annual spawner abundance at this critical level would be in the range of 125 to1,250 fish. From Table 2, average annual abundance levels for all of the listed summer chum salmon stocks are within, or below this critical abundance level range. At viable levels, abundance would range from 5,000 to 10,000 fish per generation, or (for fish with a four year generation length) 1,250 to 2,500 spawners per year. None of the summer chum salmon stocks in the action area exhibited average annual spawner escapements within this approximate viable population range. Life history information and additional population trend data for the listed summer chum ESU considered in this Opinion are presented in Appendix A. Factors for decline of the listed summer chum salmon ESU referenced above are described in greater detail in the co-managers' SCSCI (WDFW and PNPTT 2000). Greater detail regarding life history traits, and the status of individual stocks that comprise the summer chum ESU are also presented in the co-managers' recovery plan (WDFW and PNPTT 2000). NMFS' use of life history trait and population trend

data to define west coast chum salmon ESUs, including Hood Canal summer chum, are presented in Johnson et al. (1997).

2. Puget Sound Chinook Salmon

The Puget Sound chinook salmon ESU was listed as "threatened" on March 25, 1999 (64 FR 14308). The life history traits and status of listed chinook salmon that may be adversely affected as a result of the summer chum salmon artificial propagation programs considered in this Opinion are detailed in Appendix A. Additional details on chinook salmon life history traits used by NMFS for the determination of ESUs are presented in Myers et al. (1998).

The overall abundance of naturally produced Puget Sound chinook salmon is believed to have declined substantially from historical levels. Many populations within the ESU are presently small enough that genetic and demographic risks are likely to be relatively high (Myers et al. 1998). The poor abundance status of spring and summer-run populations are of particular concern. Contributing to current, depressed abundances are: widespread stream blockages reducing access to up-river spawning reaches; habitat degradation caused by poor forestry practices, agriculture, and urbanization; potential over-harvest in commercial and recreational fisheries; and potential increased risk of loss of fitness and genetic diversity among populations as a result of the widespread use of a limited number of stocks by hatchery programs in the region. These potential factors for decline are discussed in greater detail in the NMFS chinook salmon status review document (Myers et al. 1998).

Chinook salmon in the action area are mainly of hatchery-origin. Most watersheds within the region are lowland tributaries of low to moderate flow. These watersheds lack characteristics necessary to support self-sustaining chinook salmon populations, with habitats more suited for coho and chum salmon production. Only the Dungeness River has been identified as supporting an indigenous chinook salmon population. This native population is critically depressed (WDF et al. 1993) and the subject of a supplementation and captive broodstock program to recover the population. The hatchery stock propagated through the programs is listed, and essential for recovery of the ESU (March 24, 1999; 64 FR 14308). Spawner escapement in the Dungeness River has averaged 114 over the last five years (range 50-183) compared to an escapement goal of 925. Several other watersheds in the action area may have historically supported self-sustaining chinook salmon populations (Skokomish, Hamma Hamma, and Duckabush rivers). Native populations in these watersheds may no longer be present, and have potentially been replaced with naturally spawning hatchery-origin fish of Green River lineage. The progeny of hatchery-origin chinook salmon adults spawning naturally in Skokomish, Hamma Hamma, and Duckabush rivers are listed.

B. Critical Habitat

Critical habitat was designated in the Federal Register as a final rule for the Hood Canal summer chum salmon ESU on February 16, 2000 (65 FR 7764). Critical habitat designated in the Federal Register Notice includes all river reaches accessible to listed chum salmon (including estuarine areas and tributaries) draining into Hood Canal as well as Olympic Peninsula rivers between and including Hood Canal and Dungeness Bay, Washington. Also included are estuarine/marine areas of Hood Canal, Admiralty Inlet, and the Strait of Juan de Fuca to the

international boundary and as far west as a straight line extending north from Dungeness Bay. Excluded are areas above Cushman Dam in the Skokomish River Basin or above longstanding, naturally impassable barriers in the above, defined area (i.e. natural waterfalls in existence for at least several hundred years).

Critical habitat was also designated in the above Federal Register Notice as a final rule for the Puget Sound chinook salmon ESU on February 16, 2000 (65 FR 7764). Designated critical habitat for chinook salmon includes all marine, estuarine, and river reaches accessible to chinook salmon in Puget Sound. Puget Sound marine areas include South Sound, Hood Canal, and North Sound to the international boundary at the outer extent of the Strait of Georgia, Haro Strait, and the Strait of Juan de Fuca to a straight line extending north from the west end of Freshwater Bay, inclusive. Excluded are areas above Tolt Dam in the Snoqualmie River, Landsburg Diversion Dam on the Cedar River, Alder Dam on the Nisqually River, and Elwha Dam on the Elwha River, or above longstanding, naturally impassable barriers in the above, defined area.

III. Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that affect the survival and recovery of threatened species in the action area. In addition to artificial propagation actions, the activities having the greatest impact on the environmental baseline fall into two categories: habitat degradation effects on water quality and the condition of migration, spawning, incubation, and rearing conditions; and harvest impacts on adults. The fish are also affected by fluctuations in natural climatic conditions. In addition to hatchery actions, the following discussion reviews recent developments in each of the sectors, and outlines their anticipated impacts on natural conditions and the future performance of the listed ESUs.

A. Hydropower Impacts

Adverse effects attributable to hydropower development in the designated Hood Canal summer chum critical habitat area are limited to the Skokomish River watershed. Two dams completed in 1926 and 1930 at RMs 19.6 and 17.3, respectively, represent the upper limit of salmonid migration in the North Fork of this river. After the construction of the North Fork dams, virtually all flow was diverted from the system at the lower dam until 1988, when 30 cfs was provided below the project (WDFW and PNPTT 2000, quoting FERC 1996). Summer chum salmon are believed to have been extirpated from the Skokomish River system in the late 1960s or early 1970s. WDFW and PNPTT (2000) concludes that there is currently no evidence of a viable summer chum stock in the system. The lack of adequate migration and spawning flows in the North Fork of the Skokomish River after the construction of the two dams in the basin is presumed to be a major contributor to the loss of summer chum salmon in that stream.

Changes in the operation of dams in the North Fork of the Skokomish River have been proposed to provide improved flow regimes for migrating, spawning, and rearing anadromous fish in river reaches below the dams. At the present time, the status of these proposed changes to the Federal, state, tribal, and private entities involved in developing appropriate salmon mitigation strategies is undetermined. The co-managers have proposed a protection/restoration strategy in the SCSCI designed to minimize the effects of hydropower dam operation on listed summer chum salmon (WDFW and PNPTT 2000). General habitat recovery objectives proposed by the co-managers that may act to reduce adverse effects of dam operation include: 1) providing free and unimpeded access to migrating adult and emigrating juvenile chum through elimination of existing human-caused barriers and maintenance of adequate flow; and 2) improving the stability, quantity, and quality of spawning habitat by providing adequate stream flow. If implemented, the survival benefits to the listed summer chum ESU would be restricted to one population that has been extirpated from the Skokomish River system. Future benefits of adjustments in hydropower dam operation in the Skokomish watershed to the recovery of the ESU would accrue after a summer chum population was reintroduced to the system as a self-sustaining population.

B. Habitat Impacts

Land management activities affect salmon survival in a number of ways, to the detriment of their productivity in freshwater and estuarine areas. Forestry practices, road-building, urbanization, diking, residential development, channelization, water withdrawal, and flow regime management projects can increase sedimentation, destabilize stream-banks, reduce organic litter and woody debris, increase water temperatures, simplify stream channels, create low and increased peak flow conditions, and affect the condition and extent of riparian, wet-land, and nearshore estuarine areas (WDFW and PNPTT 2000). Short and long term changes in habitat resulting from these and other land use activities in areas designated as Hood Canal summer chum critical habitat have reduced the range of summer chum salmon, affected their survival and productivity in streams and estuaries, and have caused or contributed to the extirpation of populations of summer chum salmon from streams in the region (see WDFW and PNPTT 2000). Cumulative, human-caused habitat impacts have likely reduced the resiliency of the individual summer chum salmon populations comprising the ESU, and in combination with other factors for decline, have led to the current depressed status of the listed stocks.

The habitat assessment conducted by the Point No Point Treaty Tribes and WDFW in the SCSCI concluded that channel, riparian forest and subestuarine conditions were moderately to severely degraded in all the watersheds due to a history of logging, road building, rural development, agriculture, water withdrawal, and channel manipulations throughout the ESU (WDFW and PNPTT 2000). Within Hood Canal, the Big and Little Quilcene, and Skokomish were considered the most degraded watersheds, with the Big Beef, Union and Hamma Hamma River watersheds only marginally better. The Union stock, the only stock considered “healthy” in the listed summer chum ESU, is of particular concern because of rapid urbanization occurring in the watershed. The Tahuya and Dewatto watersheds are considered to be recovering and in good

condition, which should increase the chances of success for recovery efforts. The other systems in the region are moderately degraded, with areas of good habitat.

Several initiatives are currently in process or being proposed to address the effects of land use activities on listed fish species, including summer chum salmon. For example, the "Forest and Fish Report" is an effort by the State of Washington to implement changes in forest management activities that are intended to provide additional protections to listed salmonids (USFWS et al. 1999). The report mandates that all existing forest roads be inventoried for potential impacts on salmonids through culvert inadequacies, erosion, slope failures, and that any needed improvements be completed within 15 years.

The co-managers have identified limiting habitat factors for each summer chum watershed in the Hood Canal and eastern Strait of Juan de Fuca regions, and have recommended a protection and restoration strategy ("factors for recovery") for implementing habitat elements through the SCSCI (WDFW and PNPTT 2000). NMFS Habitat Conservation Division staff, and several land management entities within the action area, are currently using the "Habitat" section of the SCSCI as one reference document to help guide planning of land use activities to protect summer chum salmon.

NMFS is currently reviewing the SCSCI to determine the acceptability of recovery actions proposed and under implementation through the plan, including habitat restoration and protection measures. NMFS has not yet analyzed what role that habitat degradation has played in contributing to the decline of summer chum salmon, and how recovery of the ESU might benefit from any proposed protective or restoration strategies. Specifically, NMFS is unable at this time to quantify improvements in productivity that should result from improvements in habitat conditions. It is reasonable to expect, however, that improvements in land management on state, Federal, and private land within the Hood Canal summer chum critical habitat area will result in improved overall survivals for listed summer chum considered in this Opinion. As noted previously in this Opinion, NMFS and the co-managers recognize that artificial propagation measures alone will not lead to the recovery of the listed summer chum ESU. Commensurate, timely improvements in the condition of habitat critical for summer chum salmon survival are necessary to recovery the listed populations to healthy levels.

C. Natural Conditions

Summer chum salmon considered in this Opinion may be particularly susceptible to changes in climate, including those affecting ocean, estuarine, and freshwater conditions. As the southern-most representatives of summer-timed chum salmon in the northeast Pacific region, these fish may naturally lead a somewhat tenuous existence, and may be less resilient when facing a changing environment. Major declines and subsequent low abundances of Hood Canal summer chum beginning in 1979, and Strait of Juan de Fuca summer chum beginning in 1989, show relatively consistent responses across a number of streams with varying environments and habitat types. The uniform nature of these declines suggests the possibility of a regional environmental impact, encompassing either fresh and/or marine waters important for summer chum survival (WDFW and PNPTT 2000).

The phenomena of the El Nino-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) have received recent attention because of increasing evidence that these fluctuations in ocean conditions can have profound effects on the growth and survival of Pacific salmon. ENSO events vary greatly in intensity, and have been shown to impact salmonid growth and survival through changes in food abundance and predator impacts, and can also affect the freshwater environment. ENSO events are associated with generally warmer and drier weather conditions along the Pacific Northwest coastal zone, and can cause reduced snow pack and lower stream flows in western Washington. The PDO phenomenon results in shifts in sea surface temperatures and plankton abundance on a decadal scale, affecting the growth and survival of salmon during migrations and feeding in the north Pacific Ocean, and exerting a major influence on the freshwater environment through changes in air temperatures, wind conditions, and precipitation.

In an analysis of the contribution of ENSO and PDO events to the decline, and presently depressed status of summer chum salmon, the co-managers concluded flow regimes in freshwater spawning and incubation areas, including low flow conditions during spawner entry and intensified peak flows during incubation, may have been affected by these phenomena, to the detriment of summer chum. In particular, the effects of climate on Strait of Juan de Fuca stream flows were determined to have likely contributed to the decline in summer chum salmon stock status. They also concluded that it is unlikely that ENSO-related ocean survival conditions are a significant contributor to the status of summer chum, although noting that there are insufficient data available to evaluate potential PDO and ENSO effects on summer chum marine survival rates.

D. Fisheries

Terminal area fisheries in Hood Canal targeting other salmon species, including fall chinook and coho salmon, have contributed to the decline of summer chum in that portion of the listed species range. After 1974, an added level of fishery exploitation began to occur in marine and freshwater areas within Hood Canal, resulting in high exploitation rates on adult summer chum salmon through the 1980s. The designation during the latter part of this period of summer chum salmon as a secondary management unit in Hood Canal led to the subordination of summer chum escapement needs to harvest management objectives set for other salmon species. When fisheries occurred in Hood Canal mainstem areas during the period of decline, exploitation rates ranged from 9.5% to 58.6% on stocks within and originating from the Area 12/12B/12C Management Unit and from 0.2% to 73% in the Area 12D Management Unit. Exploitation rates in the Quilcene Bay Area (Management Unit 12A) ranged from 0.2% to 88.4% in the 1970s and 1980s. The lack of meaningful terminal area harvest over the period of decline in Strait of Juan de Fuca terminal areas makes it unlikely that fisheries in and adjacent to summer chum streams in that portion of the ESU are factors for decline. Fisheries in Canadian marine waters directed at other salmon species (sockeye and pink salmon) have negatively affected Strait of Juan de Fuca summer chum salmon abundance (WDFW and PNPTT 2000).

The co-managers have been managing terminal and extreme terminal area fisheries since 1992 to minimize effects on summer chum salmon, reducing total annual exploitation rates to under 5% of the total summer chum salmon return. Under the SCSCI, harvest management provisions have been developed to allow rebuilding and maintenance of self-sustaining summer chum populations throughout Hood Canal and eastern Strait of Juan de Fuca, while maximizing harvest opportunities on commingled salmon species. The harvest management strategy uses a conservative, four-way control mechanism: 1) a base set of conservative fishing regulations; 2) abundance and escapement thresholds that trigger adjustments to the fishing regime; 3) exploitation rate objectives that will result in changes to the harvest regime if not met, and 4) overall stock assessment criteria that will affect all plan provisions, including harvest, if not satisfactorily met through periodic plan reviews (WDFW and PNPTT 2000). The "Baseline Conservation Regime" referred to in 1), above, has been developed to guide the management of fisheries affecting summer chum. The regime is implemented through time and area closures, summer chum salmon release requirements and harvest gear restrictions. The expected summer chum population exploitation rate in freshwater and marine area terminal area fisheries under this regime is 2.1% (range 0.5% to 3.5%) in the Hood Canal region and 0% in the Strait of Juan de Fuca region (WDFW and PNPTT 2000).

E. Ocean Fisheries

Fisheries targeting unlisted salmon species for harvest in areas seaward of critical habitat identified for Hood Canal summer chum may take summer chum incidentally. For Hood Canal summer chum stocks, incidental harvest has occurred in pre-terminal commercial fisheries primarily directed at Fraser River-origin sockeye and pink salmon in the Strait of Juan de Fuca. The co-managers rated the impact of these fisheries during the period of decline of Hood Canal summer chum stocks as "low" (WDFW and PNPTT 2000). The impact of these sockeye and pink fisheries on summer chum originating from Strait of Juan de Fuca streams was rated "moderate." A "moderate" impact rating was assigned because exploitation rates in U.S. and Canadian fisheries within the Strait of Juan de Fuca increased substantially coincident with the 1989 decline in summer chum escapements to region streams. Estimated exploitation rates of summer chum in Canadian preterminal sockeye and pink salmon fisheries have ranged form 0% to 43% and in U.S. sockeye and pink salmon fisheries from 1% to 10.1% (WDFW and PNPTT 2000).

Two recent NMFS biological opinions evaluated the effects of marine area fisheries on listed Hood Canal summer chum and Puget Sound chinook salmon. The 1999 Pacific Salmon Treaty (PST) fishery agreement was evaluated by NMFS for effects on listed fish in November,1999 (NMFS 1999c). Pacific Marine Fisheries Commission (PFMC)-managed Pacific Coast ocean and Puget Sound salmon fisheries during the 2000-2001 regulatory cycle were evaluated for effects on listed fish in a second NMFS opinion (NMFS 2000c). Fishery constraints were applied through the PST agreement to protect listed summer chum salmon. These included a requirement for the release of all chum salmon incidentally captured in Canadian and U.S. non-Indian commercial sockeye and pink salmon fisheries, and a proposal for the same requirement for U.S. Treaty Indian fisheries. The co-managers defined expected exploitation rates for Canadian and U.S. preterminal area fisheries in the SCSCI as part of a base conservation

management regime for recovering summer chum salmon. The expected annual summer chum exploitation rate for Canadian PST preterminal area fisheries is 6.3% (range 2.3 - 8.3%), with an average rate of 2.5% (range 0.5 - 3.5%) for U.S. preterminal area fisheries. Any deviations from these expected exploitation rates will be addressed by the co-managers through the Pacific Salmon Treaty fisheries management process. NMFS concluded that, due to constraints set on harvest levels, fishery actions associated with the 1999 PST agreement were not likely to jeopardize the continued existence of listed Hood Canal ESU summer chum and Puget Sound ESU chinook salmon (NMFS 1999b).

NMFS concluded that Hood Canal ESU summer chum are not caught in PFMC-managed Pacific Ocean fisheries (NMFS 2000c). NMFS also concluded that Puget Sound fisheries during the 2000-2001 regulatory cycle (conducted in accordance with SCSCI fishery actions that protect listed species) did not pose a significant risk to Hood Canal ESU summer chum salmon (NMFS 2000c). As a final conclusion to the 2000-2001 fishery biological opinion, NMFS determined that the PFMC-managed ocean and Puget Sound fisheries were unlikely to jeopardize the existence of Hood Canal ESU summer chum and Puget Sound ESU chinook salmon and are not likely to destroy or adversely modify designated critical habitat (NMFS 2000c).

F. Artificial Propagation Actions

The current hatchery system in the geographic area encompassed by the listed Hood Canal summer chum salmon ESU includes 16 Federal and non-Federally funded salmon hatchery programs, and associated satellite facilities. The first hatcheries in the region were initiated in the early 1900s in the Dungeness and Skokomish rivers, and most of the major fish production facilities have been in operation for between twenty and forty years.

This Opinion evaluates the effects of the proposed Federal hatchery actions in the context of listed summer chum and chinook salmon status and likely population trends. The relative health of the listed summer chum and chinook salmon ESUs is critical to determining whether or not the proposed hatchery actions are likely to jeopardize the species or adversely modify their critical habitat. With this function of the environmental baseline in mind, NMFS does not attempt to quantitatively distinguish effects attributable to the past operation of hatchery programs and other factors from the likely future effects. As an introduction to the evaluation of hatchery effects, Section V.A. describes potential generic effects of hatchery actions on fish populations. This generic effects discussion is followed by Section V.B., where the specific effects of the proposed Federally funded hatchery programs on the listed populations and their critical habitats are evaluated, in the context of their current status and likely population trends.

The specific effects of interrelated and interdependent non-Federally funded hatchery programs in the action area (see Table 1) are also evaluated in Section V.B. Specific effects of the non-Federal hatchery actions identified in Section V.B. are presented to indicate current and future artificial propagation effects on listed fish status and their critical habitat for *all* hatchery programs in the action area for the purposes of the environmental baseline.

Through the SCSCI, the co-managers have implemented non-Federally funded summer chum salmon supplementation and reintroduction programs that appear to be increasing the abundance and distribution of summer chum in the action area (WDFW and PNPTT 2000). General measures applied within these non-Federally funded summer chum recovery programs to minimize adverse effects on listed summer chum salmon are summarized as follows:

1. The summer chum salmon supplementation and reintroduction programs are conducted to minimize adverse genetic, ecological, and demographic effects on naturally-produced, listed summer chum salmon and chinook salmon.
2. The programs are conducted to minimize adverse genetic and ecological effects on summer chum salmon propagated through the programs.
3. Monitoring and evaluation programs are conducted for juvenile summer chum salmon releases and resultant adult returns in the action area that identify potential ecological and genetic effects on listed natural-origin summer chum salmon, and potential ecological interactions with listed chinook salmon.
4. Monitoring and evaluation programs are conducted to identify the ecological and genetic effects of the programs on summer chum brought into the hatchery for artificial propagation.
5. Broodstock collection operations for the proposed programs are evaluated to determine summer chum and chinook salmon effects associated with the removal of adults.

The co-managers have also implemented reforms to non-Federally funded hatchery operations producing unlisted salmon in the action area that should benefit listed summer chum salmon productivity (WDFW and PNPTT 2000). Operation of Federally funded and non-Federally funded unlisted salmon hatcheries in the action area will lead to the average annual release of 6,123,000 subyearling, 316,000 yearling, and 398,000 fry/fingerling non-indigenous stock fall chinook; 975,000 subyearling and 1,000,000 fry/fingerling indigenous stock chinook; 1,917,639 yearling and 75,000 fry/fingerling coho; 1,500,000 pink salmon; 32,066,121 fed fry and 1,263,000 unfed fry fall chum salmon; and 94,500 yearling, 4,400 2+ smolt, and 200 adult steelhead. General measures applied within these non-Federally funded unlisted salmon recovery programs to minimize adverse effects on listed summer chum salmon are summarized as follows:

1. The programs apply broodstock capture, fish culture, and juvenile fish release measures that minimize the risk of injury and mortality, and the risk of adverse ecological and genetic effects, to listed summer chum salmon.
2. Monitoring and evaluation programs are conducted for unlisted juvenile salmon releases and resultant adult returns in the action area to assess potential ecological interactions with listed summer chum salmon.
3. Broodstock collection operations are evaluated to determine summer chum effects resulting from the removal of hatchery adults.

The co-managers have adopted the SCSCI for implementation of salmon hatchery and harvest programs under their jurisdiction. They have also proposed that the SCSCI be considered by

NMFS as a joint tribal/State recovery plan for listed summer chum salmon developed within the *U.S.* v. *Washington* fisheries management framework (Koenings and Harder 2000). The SCSCI covers Federally funded and non-Federally funded actions in the region, and the full implementation of conservation measures proposed in the plan can positively affect the success of the proposed summer chum salmon hatchery programs. The non-Federally funded summer chum salmon actions, and improvements in non-Federally funded unlisted salmon hatchery production and management, are expected to continue through full implementation of measures proposed in the co-managers' SCSCI (WDFW and PNPTT 2000).

In forming this Opinion, NMFS reviews, with the Federally funded actions, the interrelated and interdependent non-Federally funded hatchery programs in the action area that were included in the SCSCI. Review of the non-Federally funded programs is necessary to adequately assess the cumulative effects of summer chum salmon and other unlisted anadromous salmonid hatchery programs on listed salmon in the action area. In deriving conclusions regarding the effects of the Federally funded hatchery actions on listed salmon, NMFS assumes implementation of the non-Federally funded hatchery operations as described in the SCSCI, including the above described measures implemented to minimize the risks of the programs on listed summer chum salmon.

This Opinion is directed at Federally funded hatchery actions pursuant to section 7 of the ESA. NMFS expects to use the findings and limits included in this Opinion as a resource, and basis, for evaluating and determining whether the proposed Federally funded and non-Federally funded hatchery programs comply with section 4(d) Rule limits (July 10, 2000; 65 FR 42422). Operational measures and limits applied to the Federally funded programs under the 4(d) rule framework will be consistent with the effects evaluations, conclusions, and operational conditions of this Opinion. NMFS expects that operational measures and limits applied to the non-Federally funded hatchery programs under the 4(d) Rule will be consistent with effects evaluations and conclusions of this Opinion, and with operational conditions developed in this Opinion for the Federally funded programs with which they are interrelated and interdependent.

G. Expected Future Performance

Improvements in harvest management practices implemented by the co-managers in recent years are expected to help improve the productivity of summer chum salmon populations considered in this Opinion. Fishery over-exploitation in the action area has been addressed by the co-managers through fishery closures or changes in harvest practices (WDFW and PNPTT 2000). Management measures in PST and ocean fisheries have also been implemented to reduce harvest effects (NMFS 1999b; NMFS 2000c). Reductions in harvest impacts appear to be helping to increase the abundance of summer chum returning to several watersheds (WDFW and PNPTT 2000). Improvements in harvest management are expected to continue through full implementation of measures proposed in the co-managers' SCSCI (WDFW and PNPTT 2000).

Improvements in land use practices, including forestry, road construction, culvert placement, and shoreline development plans and practices implemented by state, Federal, and local land managers, and salmon habitat improvement projects implemented in the region, are also expected to benefit summer chum salmon productivity.

Hatchery and harvest management measures proposed by the co-managers in the SCSCI, and the successful implementation of measures necessary to achieve proper habitat quality and function for summer chum identified in the plan, are expected to have a synergistic, beneficial effect on summer chum salmon productivity. Results expected through successful implementation of the SCSCI include: 1) elimination of further summer chum extirpations; 2) re-introductions of summer chum to past, but currently unpopulated streams; 3) elimination of the negative consequences resulting from hatchery fish interactions; 4) minimization of incidental fishery impacts; 5) gradual improvement in the productivity of freshwater and estuarine habitat; and 6) assurance of the achievement of recovery goals through annual monitoring and adaptive management (WDFW and PNPTT 2000). If successfully implemented and achieved, conservation actions and necessary habitat conditions identified by the co-managers in the SCSCI should contribute significantly to the future recovery of the listed summer chum salmon populations.

H. Summary

Notwithstanding current and future improvements in hatchery, harvest, and potentially, habitat management practices noted above, environmental conditions in the action area are still generally quite poor with respect to summer chum and chinook salmon survival in a number of their life stages. The continuous and cumulative reduction in habitat productive capacity has influenced the ability of summer chum and chinook salmon to recover by reducing population resiliency and lowering survival rates. Habitat loss and degradation due to man-caused land use activities have contributed to the reduction in summer chum and chinook salmon productive capacity. Climate change is leading to detrimental changes in stream flows during critical summer chum salmon life stages, including adult spawning and egg incubation. This factor for decline is not controllable. Given the cumulative impacts of changes in the land and aquatic environments critical to summer chum and chinook salmon survival attributable to habitat degradation and loss, and climate-related changes, the potential for the recovery of the listed species in the action area under current conditions is uncertain.

IV. Effects of Actions

A. Background

The benefits and risks associated with artificial propagation programs are summarized in Section I.A.2: “Overview of Artificial Propagation Issues”. The risks or hazards can be further separated into the 11 categories listed below. A twelfth hazard, “Migration Corridor/Ocean”, applies to Columbia River Basin hatchery operations, and has been omitted from the list of generic hazards applicable to Puget Sound hatcheries below. These categories describe in detail the generic effects of hatchery operation and hatchery management on listed species. Measures to minimize adverse impacts to listed fish associated with each of these generic effects are provided. Applicable generic effects categories are used to analyze the effects of specific hatchery programs within the Hood Canal summer chum salmon ESU. The analysis of the artificial

propagation programs and the measures taken to minimize impacts are addressed in the specific effects section V.B.

1. Operation of Hatchery Facilities
2. Broodstock Collection
3. Genetics
4. Disease
5. Competition/Density-Dependent Effects
6. Predation
7. Residualism
8. Fisheries
9. Masking
10. Nutrient Cycling
11. Monitoring and Evaluation/Research

1. Operation of Hatchery Facilities

Potential hazards to listed natural salmonids associated with the operation of hatchery facilities include: 1) Hatchery facility failure (power or water loss leading to catastrophic fish losses); 2) Hatchery water intake impacts (stream de-watering and fish entrainment); and 3) Effluent discharge effects (deterioration of downstream water quality).

The actual effects that hatchery facility operations have on listed fish depend on the likelihood that the hatchery operation will contact juvenile or adult fish, and whether the program is operated to minimize the risk of adverse effects on listed fish.

(1) Flow reductions, flooding and poor fish culture practices may all cause hatchery facility failure or the catastrophic loss of listed fish under propagation. Measures to reduce the risk of hatchery facility failure leading to catastrophic loss are:

- Minimizing the time adult fish are held in traps.
- Propagate hatchery populations at more than one location.
- Minimize hatchery failure through on-site residence by hatchery personnel to allow rapid response to power or facility failures.
- Use of low pressure/low water level alarms for water supplies to notify personnel of water emergencies.
- Install back-up generators to respond to power loss.
- Train all hatchery personnel in standard fish propagation and fish health maintenance methods.

(2) Hatchery water intake impacts result from water withdrawals for hatcheries within spawning and rearing areas which can diminish stream flow from points of intake to outflow. If great enough, such withdrawals can impede migration and affect spawning behavior of listed fish. Water withdrawals may also have impacts to other stream-dwelling organisms important as food for juvenile salmonids as well, including habitat loss and displacement, and physical injury at intake locations. Screening of hatchery intakes is critical to ensure that fish are not injured

through impingement or permanently removed from streams. To prevent these outcomes, water rights issued for regional hatcheries are generally conditioned to prevent de-watering of salmon migration, rearing, or spawning areas. Hatcheries can also be designed to be non-consumptive. Water withdrawn for use can be returned after it flows through the facility near the point of withdrawal to minimize risks to natural-origin fish and other aquatic fauna. The risk of water withdrawal hazards can generally be minimized through compliance with water right permits. NMFS screening criteria for water withdrawal devices set forth conservative standards that help minimize the risk of damage to natural-origin salmonids and other aquatic fauna through screen entrainment (NMFS 1995, NMFS 1996).

(3) Effluent discharge effects result when hatchery effluents change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). The exact effect of the effluent on listed salmonids and other stream-dwelling organisms unless specifically monitored is usually unknown. The magnitude of the receiving water flow volume relative to the discharge volumes from the hatcheries determines the level of impact to receiving waters. Any adverse effects of hatchery effluent are probably localized at the immediate point of discharge, as effluent is rapidly diluted in the receiving streams and rivers. The Clean Water Act requires hatcheries (i.e. "aquatic animal production facilities" as defined by the Environmental Protection Agency) to obtain a NPDES permit for the discharge of hatchery effluent to surface waters. These permits are intended to protect aquatic life and public health and assure that every facility treats wastewater. The permits include site-specific discharge limits, monitoring and reporting requirements, and are subject to enforcement actions if the facility fails to comply with the provisions of their permit (EPA 1999). To operate all hatcheries must have a NPDES permit. In addition, hatcheries within the Columbia River Basin operate under the policies and guidelines developed by the Integrated Hatchery Operations Team (IHOT 1995) to reduce the effects on listed fish from the operation of hatchery facilities. The risk of this hazard to listed fish may generally be minimized through compliance with applicable NPDES permit requirements and (for Columbia River Basin hatcheries) IHOT policies and guidelines.

2. Broodstock Collection

The collection of broodstock for hatchery programs can impact listed salmonids through: 1) the method used to collect the broodstock; and 2) through the removal of adults from the spawning population.

(1) There are a number of methods for collecting broodstock. Typically, salmonid broodstock required for hatchery programs are collected from volunteers returning to the hatchery or through use of a weir, or ladder-trap combination associated with a barrier, such as a dam. These devices can effectively block the upstream migration of returning adult fish, forcing them to enter a trap and holding area. Trapped fish are counted, and either retained for use in the hatchery or released upstream of the weir or barrier to spawn naturally.

The potential adverse impacts from the use of weir or trap come from: a) the physical presence of the facility; and b) the operation of the facility.

a) Impacts to migrating listed adult salmon and steelhead from the physical presence of the weirs or traps include:

- delays in upstream migration;
- rejection of the weir or fishway structure, inducing spawning downstream of the trap (displaced spawning);
- falling back downstream after passing upstream of the weir; and
- injury or death from attempts to jump the barrier (Hevlin and Rainey 1993, Spence et al. 1996).

b) Impacts due to the operation of the weir or trap include:

- physical harm that may result from capture and retention in the fish holding area within a weir or trap, or from snagging, netting or seining methods used for certain programs;
- harm that may result from delay in upstream migration, if the fish are reluctant to enter the trap;
- harm resulting from excessive holding durations;
- physical harm resulting from handling prior to release upstream; and
- increased susceptibility after release to displacement downstream by current and to predation, as the fish recover from handling.

Many of the potential negative effects can be reduced through the proper design and operation of the weirs and traps (see Hevlin and Rainey 1993). The installation and operation of weirs and traps for broodstock collection are very dependant on water conditions at the trap site. High flows in the spring can delay the installation of a weir and can make the trap inoperable during periods of high flows. A weir or trap can potentially be operated in two modes: operate the trap continuously and collect up to 100% of the run, while passing those fish not needed for broodstock upstream to spawn naturally; or operate the weir for a number of days each week to collect broodstock, then operate the weir with the panels lowered or the trap open to provide unimpeded passage for the rest of the week. The mode of operation can be determined during the development of site-based broodstock collection protocols and can be adjusted based on in season escapement estimates and environmental factors.

By operating the weirs and traps as described above, the potential impacts of weir rejection, fall back and injury are reduced by allowing unimpeded passage for a period each week. To further reduce the impacts of weir or trap operation, trained hatchery personnel should be present at the facility to remove debris, prevent poaching and ensure safe and proper facility operation. To reduce delay and handling stress all fish encountered during broodstock collection should be held for a minimal duration in the traps, generally less than 24 hours, and fish excess of broodstock needs should be allowed to recover from handling and be immediately released upstream to spawn naturally. Often it may be necessary to hold fish longer or remove them from the spawning run as the hatchery weir or trap is used to remove stray fish or adjust the ratio of natural to hatchery fish that are allowed to spawn naturally.

Other methods to collect adult broodstock for artificial production programs include the use of beach seines, hook and line, gillnets and collection while snorkeling. All these methods can adversely effect listed fish through physical injury, migrational delay, changes in holding and spawning behavior and increased susceptibility to predation and poaching. Some artificial production programs collect juveniles as a source of broodstock. Programs can collect developing eggs or fry by hydraulically sampling redds, or by capping redds to collected emerging juvenile fish (Young and Marlowe 1996; Shaklee et al. 1995; WDFW et al. 1995; WDFW 1998a). Seines, screw traps and hand nets can also be used to collect juveniles. Each of these methods can adversely affect listed fish through handling and harm to fish remaining in the river. Juveniles collected with these methods tend to be used for captive broodstock programs, reared to adults and spawned in a production facility with the resulting progeny being released to migrate naturally to the ocean (Hard et al. 1992; NMFS 1999b; Young and Marlowe 1996; Shaklee et al. 1995; WDFW et al. 1995; WDFW 1998). The collection of juveniles for broodstock eliminates the potential adverse effects of selection through artificial matings that can occur when using adults for broodstock (NRC 1996).

(2) The removal of adult fish for broodstock from the naturally-spawning population has potential adverse impacts, including a) numerical reduction of the natural population (mining), b) selection effects, and c) removal of nutrients from upstream reaches (Spence et al. 1996, NRC 1996, Kapusinski 1997).

In some basins natural-origin spring chinook populations are not replacing themselves and are to the point where extinction of one or all of the extant runs appears likely without artificial production programs, assisted by changes in hydroelectric dam operations, harvest activities, and competing land use actions. Risks to the donor natural-origin populations, including numerical reduction and selection effects, are in some cases subordinate to the need to expeditiously implement the artificial production programs that will prevent extinction of the populations and the ESU.

a) The effects of numerical reduction can be minimized by the operating agency in order to preserve remaining natural-origin populations through the implementation of one or more of the following measures for numerical reductions:

- broodstock removals that are limited within the region through designation of "non-intervention" areas where artificial production programs will not be applied. The designation of "non-intervention" areas will prevent numerical reduction impacts to some of the region's populations;
- for those areas where supplementation and/or captive broodstock programs are applied, the upstream escapement of a predetermined number of adults per population is maintained as a minimum level for natural spawning; and
- natural production should be allowed to continue concurrent with the artificial production programs by providing passage for or by releasing to spawn naturally, a minimum number of adult fish into natural spawning areas within the basin.

b) Selection effects include the intentional and unintentional selection of broodstock based on run timing, age, morphology and sex ratio. Selection effects can potentially change population characteristics of the natural population as well as cause the hatchery-produced fish to diverge from the naturally-produced population (see genetic effects section below). Measures to minimize selection effects include:

- setting priorities for choice of donor population based on three criteria (Kapuscinski and Miller 1993). The criteria for identifying the best donor population as compared to the target population that is supplemented are based on the greatest similarity of the two populations in terms of (1) genetic lineage, (2) life-history patterns, and (3) ecology of the originating environment;
- removal of adult broodstock at traps for artificial production programs shall be random, and representative of the run-at-large with respect to migration timing, age class, morphology, and sex ratio; and
- the total number of natural-origin spawners collected for broodstock should be < 50% of the natural spawners, with the appropriate rate determined by genetic and demographic risks (Kapuscinski and Miller 1993). The total number of natural fish that can be collected for broodstock is managed through HGMPs to meet program goals and future VSP designations.

c) The collection of broodstock can impact listed populations through the removal of nutrients. These impacts are discussed in more detail in this section under "11. Nutrient Loading".

NMFS believes that the implementation of measures to address impacts from the presence and operation of weirs and traps, and the removal of adults from the natural spawning population, where appropriate, should adequately protect listed populations and minimize the effects of broodstock collection.

3. Genetics

A defining characteristic of anadromous salmonids is a very high fidelity of returning adults to their natal streams. The ability of anadromous salmonids to home with great accuracy and maintain high fidelity to their streams of origin has encouraged development of locally adapted genetic characteristics which allow the fish to use specific habitats.

The genetic risks to naturally-produced populations from hatchery propagation can be separated into 1) the reduction in the genetic variability (diversity) among populations, 2) the reduction in the genetic variability (diversity) within populations and 3) domestication effects (Hard et al. 1992; Cuenco et al. 1993; NRC 1996; Waples 1996).

1) The loss of genetic diversity among populations is the reduction in the difference in quantity, variety and combinations of alleles among populations (Busack and Currens 1995). The loss of genetic diversity among populations is caused by the introduction of genes from outside the population (e.g., from hatchery releases), at rates greater than what would occur naturally. This introduction can cause the loss of genetic uniqueness of the natural population with a concurrent reduction in performance (fitness) of the fish. Excessive gene flow into a population can reduce

the fitness of individual populations through outbreeding depression. Outbreeding depression arises because natural salmonid populations adapt to the local environment and this adaptation is reflected in the frequency of specific alleles that improve survival in that environment. When gene flow between unrelated populations occurs, alleles that may have developed in a different environment are introduced. These new alleles may not benefit survival of a receiving, indigenous population, leading to outbreeding depression.

Another source of outbreeding depression is the loss of combinations of alleles called coadapted complexes. Gene flow can introduce new alleles that can replace alleles in the coadapted complexes leading to a reduction in performance (Busack and Currens 1995). Out breeding depression from gene flow can occur when eggs and fish are transferred among populations and/or when out-of-basin hatchery populations are released to spawn with the local population.

Evidence exists for local adaptation of salmonid populations, but empirical data on outbreeding depression in fish that involves anything but extremely distantly related populations is lacking (Busack and Currens 1995). Pacific Northwest hatchery programs historically fostered the loss of genetic diversity among populations through routine transfer of eggs and fish from different populations between hatcheries to meet production needs. Release of hatchery fish into watersheds outside the original distribution of the introduced fish has also resulted in gene flow above natural levels (genetic introgression), reducing diversity among populations. Research based primarily on findings in the Kalama River, Washington for summer-run steelhead has suggested that interbreeding between non-indigenous Skamania hatchery stock steelhead (a highly selected, inbred stock) and native natural-origin fish may negatively affect the genetic diversity and long term reproductive success of natural-origin steelhead (Leider et al. 1990; Hulett et al. 1996). Non-indigenous stock hatchery and native natural-origin steelhead crosses may be less effective at producing adult off-spring in the natural environment compared to natural-origin fish (Chilcote et al. 1986; 1997).

Qualifying the risks of genetic introgression to natural-origin fish, Campton (1995) noted the need to distinguish the biological effects of hatcheries and hatchery fish from indirect and biologically independent effects of human factors related to management. His review of the scientific literature for steelhead indicated that most genetic effects detected to date appear to be caused by hatchery or fish management practices such as stock transfers and mixed stock fisheries on hatchery and natural-origin fish, and not by biological factors intrinsic to hatcheries or hatchery fish (Campton 1995). Loss of among population genetic diversity as a result of these types of hatchery practices has been documented for western trout, where unique populations have been lost through hybridization with introduced rainbow trout (Behnke 1992). Phelps et al. (1994) found evidence for introgression of non-native hatchery steelhead stock into a number of natural populations within the southwest Washington region. However, in other areas where hatchery production has been extensive, native steelhead genotypes have been shown to persist (Phelps et al. 1994).

The risk of loss of genetic variability among populations, and the potential for and consequences of outbreeding depression, can be minimized through application of the following measures:

- Hatchery programs should propagate and release only indigenous fish populations;
- The transfers of donor stock for reintroduction should be limited to avoid the situation that one or few stocks within an ESU predominate;
- Hatchery populations should be acclimated to the watershed where the fish are planted to ensure that propagated fish retain a high fidelity to the targeted stream;
- Local adaptation should be fostered by using returning spawners rather than the transferred donor population as broodstock for restoration programs;
- Natural populations, representing significant proportions of the existing total abundance and diversity of an ESU, should be maintained without hatchery intervention;
- All salmonids produced in hatchery programs should be visually marked to allow for monitoring and evaluation of straying and natural spawning contribution of adult returns (Kapuscinski and Miller 1993; Flagg and Nash 1999.).

NMFS conducted a scientific workshop in 1995 which focused on the biological consequences of artificially elevated levels of straying into natural salmonid populations (Grant 1997). A key question addressed in the workshop was how much gene flow can occur above natural levels and still remain compatible with long-term conservation of local adaptations and diversity among populations. A value of 5% gene flow is much higher than what generally occurs between natural populations and non-local populations and would quickly lead to replacement of not only neutral genes, but locally-adapted ones as well, based on what is known about selection in other animals (Grant 1997). NMFS notes that gene flow is expected to be much less than the percentage of out- of-basin strays. Based on the current science, NMFS believes that hatchery stray rates between ESUs must be managed such that less than 5% of a naturally spawning population consists of hatchery fish from another ESU. Furthermore, whenever feasible, the percentage or number of non-endemic adult strays into a particular population should be as low as possible to minimize genetic introgression.

Although still subject to further evaluation, NMFS has preliminarily proposed that the standard for stray rates of hatchery fish originating from within an ESU should be managed such that not more than 5% - 30% of the naturally spawning population consists of hatchery fish. Within this range, stray rates should be managed based on similarity of the hatchery population to the receiving natural population. For example, if the hatchery population is derived from the receiving natural population and gets regular infusion of natural fish in its broodstock, then strays rates can be at the higher end of this range (although lower rates are preferred). Conversely, if the hatchery population is derived from a population other than the receiving population, then strays should be managed to the lower end of the range. Also, if the hatchery population is derived from the receiving natural population, but has been isolated, without regular infusion of natural fish into the broodstock, then it should be managed to the lower end of the 5% - 30% range.

Hatchery programs implemented for the specific purpose of enhancing the listed, naturally spawning population may by their very design, provide for a greater proportion of hatchery fish in the naturally spawning population to reduce the demographic risks of extinction. The desired proportion of hatchery fish in the spawning population must be specifically detailed in the

associated HGMP for such a program. In practice this proportion (or range) may be varied to experiment with the different approaches.

2) Artificial propagation also has the potential to increase the risk of loss of within population genetic diversity caused through a) genetic drift, b) inbreeding depression, or c) domestication selection. Loss of within population genetic diversity (variability) is the reduction in quantity, variety and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population, and variety is the number of different kinds of alleles in the population.

a) There are generally two ways that within population genetic diversity can change. The first means is random genetic drift, and the other is through inbreeding. Random genetic drift occurs because the progeny of one generation represents a sample of the quantity and variety of alleles in the parent population. Since the next generation is a sample and not a copy of the parent generation, rare alleles could be lost, especially in small populations where the rare allele is less likely to be represented in the next generation (Busack and Currens 1995).

In hatchery programs the effective population size can be used to identify potential sources of random genetic drift. Small effective population size in hatchery programs can contribute to genetic drift by the use of small numbers of broodstock, using more females than males (or the alternative), pooling gametes, changing the age structure, and allowing progeny of some matings to have greater survival than allowed others (Gharrett and Shirley 1985; Simon et al. 1986 and Withler 1988 cited in Busack and Currens 1995; Waples 1991; Campton 1995). Hatchery stocks have been found to have less genetic diversity than natural-origin populations (Waples et al. 1990) indicating the potential for random genetic drift in hatcheries. The loss of genetic diversity within a hatchery population could be due to a genetic bottleneck, which occurs when only a very small number of fish are used for broodstock. Potential, negative effects of artificial propagation on within population diversity may be indicated by changes in morphology (e.g., Bugert et al. 1992) or behavior of salmonids (e.g., Berejikian 1995). Busack and Currens (1995) observed that it would be difficult to totally control random loss of within population genetic diversity in hatchery populations, but by controlling the broodstock number, sex ratios and age structure, loss could be minimized.

b) Within population genetic diversity can change due to inbreeding, which is the breeding of related individuals. Inbreeding may not lead directly to changes in the quantity and variety of alleles in a population but inbreeding increases individual and population homozygosity. The homozygosity contributes to changes in the frequency of phenotypes in the population which are then acted upon by the environment. If the environment is selective towards specific phenotypes then the frequency of alleles in the population can change (Busack and Currens 1995). Waldman and McKinnon (1993) observed that genetic changes in a population from inbreeding depression can result from the expression of homozygous genotypes for rare, harmful alleles that are normally hidden in the population of heterozygotes. These genetic changes can also come from lower performance of the population (fitness) since heterozygotes tend to perform better than homozygotes.

Empirical evidence for inbreeding depression or substantial loss of genetic variability in any natural or hatchery populations of Pacific salmon or steelhead is lacking (Hard and Hershberger 1995, quoted in Myers et al. 1998). Genetic baselines derived from allozyme data for discrete populations were only recently developed (late 1980s), and no comparisons between "pristine" and existing hatchery population allele frequencies are possible.

Measures to minimize the effects of interbreeding between hatchery and natural stocks include but are not limited to the following:

- Release fewer or no hatchery fish;
- Release hatchery fish only at the hatchery or at locations where they are unlikely to interbreed with natural fish when returning as adults;
- Advance or retard time of spawning for hatchery fish, to minimize overlap in spawning time between hatchery and natural fish;
- Acclimate hatchery fish prior to release to improve homing precision;
- Acclimate and release hatchery fish at locations where adults returns can be harvested at high rates (harvest augmentation programs), locations away from natural production areas and sites where returning adults can be sorted and removed from the spawning population.

c) The other major genetic hazard associated with the artificial propagation of salmon is domestication. Domestication is defined as the change in quantity, variety and combination of alleles within a captive population or between a captive population and its source population in the wild that are the result of selection in an artificial environment (Busack and Currens 1995). Domestication is also defined as selection for traits that favor survival in an artificial environment and reduce survival in natural environments (NMFS/Pollard 1999). Domestication can result from maintaining fish in an artificial environment for all or part of their lives. The artificial environment imposes different selection pressures on the fish than would the natural environment. The concern is that domestication effects will decrease the performance of hatchery fish and their descendants in the wild. Busack and Currens (1995) identified three types of domestication selection 1) intentional or artificial selection; 2) biased sampling during some stage of culture; and 3) unintentional selection.

1) Artificial selection is the attempt to change the population to meet management needs, such as selecting for time of return or spawning time. The concern is that hatchery fish selected to perform well in a hatchery environment tend not to perform well when released into the wild, due to differences between the hatchery and the natural-origin populations. Potential adverse impacts to the natural-origin population may occur when the hatchery fish spawns in the wild, and the resulting performance of the natural-origin population is reduced due to outbreeding depression (Busack and Currens 1995).
2) Domestication due to biased sampling generally occurs as a result of error, and can occur during any stage of hatchery operation. Non-random selection of broodstock is a common source of biased sampling. In general, broodstock selection should be random, but bias occurs when selection is based on particular traits.

3) Genetic changes due to unintentional selection can be caused by the hatchery environment, which allows more fish to survive as compared to the natural environment.

Reisenbichler and Rubin (1999) cite five studies indicating that hatchery programs for steelhead and stream-type chinook salmon (i.e. programs holding fish in the hatchery for one year or longer) genetically change the population and thereby reduce survival for natural rearing. The authors report that substantial genetic change in fitness results from traditional artificial production of anadromous salmonids held in captivity for one quarter or more of their life. Bugert et al. (1992) documented morphological and behavioral changes in hatchery spring chinook salmon released as yearlings relative to natural adults, including younger age, smaller size, and reduced fecundity at adult return. Leider et al. (1990) reported diminished survival and natural reproductive success compared to native natural-origin steelhead for the progeny of non-native hatchery steelhead in the lower Columbia River region. Poorer survival for naturally produced offspring of hatchery fish could have been due to long term artificial and domestication selection in the hatchery steelhead population, as well as maladaptation of the non-indigenous hatchery stock in the recipient stream (Leider et al. 1990). Chilcote (1997) reported a strong negative correlation between the proportion of naturally spawning hatchery steelhead and stock productivity, through an examination of spawner-recruit relationships for 26 Oregon steelhead populations. Berejikian (1995) reported that natural-origin steelhead fry survived predation by prickly sculpins (*Cottus asper*) significantly better than size-matched off-spring of locally-derived hatchery steelhead which were reared under similar conditions. Alteration of the innate predator avoidance ability through domestication was suggested by the results of this study. However, Joyce et al. (1998) found that an Alaskan spring chinook salmon stock under domestication for four generations were not significantly different from offspring of natural-origin spawners in the ability to avoid predation. The domesticated and natural-origin chinook groups tested also showed similar growth and survival rates in freshwater performance trials.

There are fish culture practices and management strategies that can be applied to minimize the risks of domestication effects and the level of genetic differences between hatchery and natural fish. These measures include but are not limited to the following:

- Adults used for broodstock can be randomly selected from throughout the natural population migration, to provide an unbiased sample of the natural population with respect to run timing, size, age, sex ratio, and other traits identified as important for long term fitness;
- Insure that returning adults used as broodstock by a hatchery continually incorporate natural-origin fish over the duration of the program to reduce the likelihood for divergence of the hatchery population from the natural population;
- Limit the duration of a supplementation program to a maximum of three salmon generations (approximately 12 years) to minimize the likelihood of divergence between hatchery broodstocks and target natural stocks;
- Employ appropriate spawning protocols to avoid problems with inbreeding, genetic drift and selective breeding in the hatchery (e.g., Simon et al. 1986, Allendorf and Ryman 1987, Gall 1993). Methods include collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of

at least 1:1 male to female mating schemes (Kapuscinski and Miller 1993), and avoidance of intentional selection for any life history or morphological trait;

- Use spawning protocols that equalize as much as possible the contributions of all parents to the next breeding generation;
- Use only natural fish for broodstock in the hatchery each year to reduce the level of domestication;
- Set the minimum broodstock collection objectives to allow for the spawning of the number of adults needed to minimize the loss of some alleles and the fixation of others (Kapuscinski and Miller 1993);
- Set minimum escapements for natural spawners and maximum broodstock collection levels to allow for at least 50% of escaping fish to spawn naturally each year, to help maintain the genetic diversity of the donor natural population;
- Use hatchery methods that mimic the natural environment to the extent feasible (e.g., use of substrate during incubation, exposure to ambient river water temperature regimes and structure in the rearing ponds);
- Limit the duration of rearing in the hatchery by releasing at early life-stages to minimize the level of intervention into the natural salmonid life cycle, minimizing the potential for domestication.

NMFS believes that the measures identified for minimizing the potential adverse genetic effects of hatchery produced fish on naturally-produced fish should be applied to protect listed species. The actual measures selected will depend on a number of factors including but not limited to:

- The program's objectives (i.e. recovery, reintroduction or harvest augmentation).
- The source of the broodstock, its history and level of domestication.
- The spawning protocols proposed for the hatchery program.
- The status of the natural population targeted by the hatchery program.
- The ability of fish managers to remove or control the number of hatchery adults in the natural spawning population.
- The proposed rearing practices for the hatchery program.
- The total number of hatchery fish released into the sub-basin.

More detailed discussions on measures to implement these strategies can be found in Reisenbichler (1997), Reisenbichler and McIntyre (1986), Nelson and Soule (1987), Goodman (1990), Hindar et al. (1991) and Waples (1991) among others.

4. Disease

Under certain conditions, hatchery effluent has the potential to transport fish pathogens out of the hatchery, where natural fish may be exposed to infection. Interactions between hatchery fish and natural fish in the environment may also result in the transmission of pathogens, if either the hatchery or natural fish are harboring a fish disease. This latter impact may occur in tributary areas where hatchery fish are planted and throughout migration corridors where hatchery and natural-origin fish may interact. As the pathogens responsible for fish diseases are present in both hatchery and natural populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976, Hastein and Lindstad 1991). Hatchery-

origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery population. Under natural, low density conditions, most pathogens do not lead to a disease outbreak. When fish disease outbreaks do occur, they are often triggered by stressful hatchery rearing conditions, or by a deleterious change in the environment (Saunders 1991). Consequently, it is possible that the release of hatchery fish may lead to the loss of natural fish, if the hatchery fish are carrying a pathogen, if that pathogen is transferred to the natural fish, and if the transfer of the pathogen leads to a disease outbreak. 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 natural-origin fish (Steward and Bjornn 1990).

To address concerns of potential disease transmission from hatchery salmonids to natural-origin fish in the Pacific Northwest, a number of fish health policies have been implemented. These policies established guidelines to insure that fish health is monitored, sanitation practices are applied, and that hatchery fish are reared and released in healthy condition (PNFHPC 1989; IHOT 1995; WDFW 1996; NWIFC and WDFW 1998). Standard fish health monitoring under these policies include monthly and pre-release checks of propagated salmonid populations by a fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the populations. Specific reactive and proactive strategies for disease control and prevention are also included in the fish health policies. Significant fish mortality to unknown cause(s) are sampled for histopathological study. Incidence of viral pathogens in salmonid broodstocks are determined by sampling fish at spawning. Populations of particular concern may be sampled at the 100% level and may require segregation of eggs/progeny in early incubation or rearing. Compliance with NPDES permit provisions at hatcheries also acts to minimize the likelihood for disease epizootics and water quality impacts that may lead to increased natural-origin fish susceptibility to disease outbreaks. Full compliance with the regional fish health policies minimizes the risk for fish disease transfer.

5. Competition/Density-Dependent Effects

Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse effects of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility of limited resources to natural-origin fish, or through indirect means, as in when utilization of a limited resource by hatchery fish reduces the amount available for natural-origin fish (SIWG 1984). Specific hazards associated with adverse competitive effects of hatchery salmonids on listed natural-origin salmonids may include food resource competition, competition for spawning sites, and redd superimposition. In an assessment of the potential ecological effects of hatchery fish production on natural-origin salmonids, the Species Interaction Work Group (SIWG 1984) categorized species combinations as to whether there is a high, low, or unknown risk that competition by hatchery fish will have a significant negative impact on productivity of natural-origin salmonids in freshwater and nearshore marine areas (Tables 3 and 4).

Table 3. Risk of hatchery salmonid species competition on natural-origin salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Wild Species					
	Steelhead	Pink	Chum	Sockeye	Coho	Chinook
Steelhead	H	L	L	L	H	H
Pink	L	L	L	L	L	L
Chum	L	L	L	L	L	L
Sockeye	L	L	L	L	L	L
Coho	H	L	L	L	H	H
Chinook	H	L	L	L	H	H

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a significant impact occurring.

Table 4. Risk of hatchery salmonid species competition on natural-origin salmonid species in nearshore marine areas (SIWG 1984).

Hatchery Species	Wild Species					
	Steelhead	Pink	Chum	Sockeye	Coho	Chinook
Steelhead	H	U	U	L	U	U
Pink	U	H	H	U	U	U
Chum	U	H	H	U	U	U
Sockeye	L	U	U	H	U	U
Coho	U	U	U	U	H	U
Chinook	U	U	U	U	U	H

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a significant impact occurring.

Adult fish -

Salmonids have evolved a variety of strategies to partition available resources between species that are indigenous to a particular watershed. The addition of homing or straying adult hatchery-origin fish can perturb these mechanisms and impact the productivity of natural-origin stocks. For adult salmonids, impacts from hatchery/natural-origin fish competition in freshwater are assumed to be greatest in the spawning areas where competition for redd sites and redd superimposition may be concerns (USFWS 1994). Adult salmonids originating from hatcheries

can also compete with natural-origin fish of the same species for mates, leading to an increased potential for outbreeding depression, to the detriment of the natural-origin fish. Hatchery-origin adult salmonids may home to, or stray into, natural production areas during natural-origin fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning gravel, displace natural-origin spawners from preferred, advantageous spawning areas, or adversely affect listed salmonid survival through redd superimposition. Superimposition of redds by similar-timed or later spawners disturbs or removes previously deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970).

Recent studies suggest that hatchery-origin fish may be less effective in competing for spawning sites than natural-origin fish of the same species, possibly indicating the effects of domestication selection in the hatchery environment (Fleming and Gross 1993; Berejikian et al. 1997). These studies were based on comparisons of natural-origin salmonid adults and captive-brood origin hatchery fish. Hatchery-origin salmonid adults returning to spawn after a period of rearing in the wild may exhibit different competitive effectiveness levels. The risk of straying by hatchery-produced species may be minimized through acclimation of the fish to their stream of origin, or desired stream of return. Homing fidelity may be improved through the use of locally adapted stocks, and by rearing of the fish for an extended duration (e.g., eyed egg to smolt) in the "home" stream prior to release or transfer to a marine area net-pen site for further rearing. The risk of redd superimposition can be minimized through high removal rates of the hatchery-origin fish, and by propagation and release of only indigenous species and stocks. Indigenous-origin hatchery adults that are not removed upon return may be assumed to still carry traits that foster temporal and spatial resource partitioning with naturally-spawning fish populations (see SIWG 1984). The risk of redd disturbance may therefore be minimal with escapement of indigenous-origin hatchery fish, if the home stream has the physical characteristics (e.g., stream flow, usable channel width) that will allow such partitioning at the time of spawning.

Juvenile fish -
For salmonids rearing in freshwater, food and space are the resources in demand, and thus are the focus of inter- and intra-specific competition (SIWG 1984). Newly released hatchery smolts may compete with natural-origin fish for food and space in areas where they interact during downstream migration. Natural-origin fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, of equal or greater size, and (if hatchery fish are released as non-migrants) the hatchery fish have taken up residency before natural-origin fry emerge from redds (Pearsons et al. 1994). Release of large numbers of hatchery pre-smolts in a small area is believed to have greater potential for competitive effects because of the extended period of interaction between hatchery fish and natural fish. In particular, hatchery programs directed at fry and non-migrant fingerling releases will produce fish that compete for food and space with natural-origin salmonids for longer durations, if the hatchery fish are planted within, or disperse into, areas where natural-origin fish are present. A negative change in growth and condition of natural-origin fish through a change in their diet or feeding habits could occur following the release of hatchery salmonids. Any competitive impacts likely diminish as hatchery-produced fish disperse, but resource competition may

continue to occur at some unknown, but lower level as natural-origin juvenile salmon and any commingled hatchery juveniles emigrate seaward (USFWS 1994). Hatchery-origin smolts and sub-adults can also compete with natural-origin fish in estuarine and marine areas, leading to negative impacts on natural-origin fish in areas where preferred food is limiting (Dawley et al. 1986). Steward and Bjornn (1990) concluded that hatchery fish kept in the hatchery for extended periods before release as smolts (e.g., yearling salmon) may have different food and habitat preferences than natural-origin fish, and that hatchery fish are unlikely to out-compete natural-origin fish. Interactions with juvenile hatchery-origin salmonids may lead to behavioral changes in listed natural salmonids that are detrimental to productivity and survival (Pearsons et al. 1994).

Hatchery fish might alter natural-origin salmon habitat use and behavioral patterns, making them more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter natural-origin salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Steward and Bjornn 1990; Hillman and Mullan 1989). In a review of the potential adverse effects of hatchery releases on natural-origin salmonids, Steward and Bjornn (1990) indicated that it was indeterminate from the literature whether natural-origin parr face significant risk of displacement by introduced hatchery fish, as a wide range of outcomes from hatchery-natural-origin fish interactions has been reported. The potential for negative effects on the behavior, and hence survival, of natural-origin fish as a result of hatchery fish releases depends on the degree of spatial and temporal overlap in occurrence of hatchery and natural-origin fish. The relative size of affected natural-origin fish when compared to hatchery fish, as well as the abundance of hatchery fish encountered, also will determine the degree to which natural-origin fish are displaced (Steward and Bjornn 1990). Actual effects on natural-origin fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

En masse hatchery salmon smolt releases may cause displacement of rearing natural-origin juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). Pearsons et al. (1994) reported displacement of juvenile natural-origin rainbow trout from discrete sections of streams by hatchery steelhead released into an upper Yakima River tributary, but no large scale displacements of trout were detected. Small scale displacements and agonistic interactions that were observed between hatchery steelhead and natural-origin trout resulted from the larger size of hatchery steelhead, which behaviorally dominated most contests. They noted that these behavioral interactions between hatchery-reared steelhead did not appear to have significantly impacted the trout populations examined, however, and the population abundance of natural-origin salmonids did not appear to have been negatively affected by releases of hatchery steelhead.

Competition between hatchery and natural-origin salmonids in freshwater may only be of high risk for coho, chinook, steelhead, and sockeye, since pink and chum salmon do not rear for extended periods in freshwater (SIWG 1984). Studies indicate that hatchery coho salmon have

the potential to adversely affect certain natural-origin salmonid species through competition. Information suggests that juvenile coho salmon are behaviorally dominant in agonistic encounters with juveniles of other stream-rearing Pacific Northwest salmonid species, including chinook salmon, steelhead (*O. mykiss*), and cutthroat trout (*O. clarki*), and with natural-origin coho (e.g., Stein et al 1972; Allee 1974; Swain and Riddell 1990; Taylor 1991). Dominant salmonids tend to capture the most energetically profitable stream positions (Fausch 1984, Metcalfe et al. 1986), providing them with a potential survival advantage over subordinate fish. However, where interspecific populations have evolved sympatrically, chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions with coho salmon (Nilsson 1967, Lister and Genoe 1970, Taylor 1991). Along with the habitat differences exhibited by coho and steelhead, they also show differences in foraging behavior. Peterson (1966) and Johnston (1967) reported that juvenile coho are surface oriented and feed primarily on drifting and flying insects, while steelhead are bottom oriented and feed largely on benthic insects.

SIWG (1984) acknowledged that the risk of adverse competitive interactions in marine waters is difficult to assess, because of a lack of data collected at times when juvenile hatchery fish and natural-origin fish likely interact, and because competition depends on a variety of specific circumstances associated with hatchery/natural-origin fish interaction, including location, fish size, and food availability. In marine waters, the main limiting resource for natural-origin fish that could be affected through competition posed by hatchery-origin fish is food. The early marine life stage, when natural-origin fish have recently entered the estuary and populations are concentrated in a relatively small area, may create short term instances where food is in short supply, and growth and survival declines as a result (SIWG 1984). This period is of special concern regarding food resource competition posed by hatchery-origin chum and pink salmon to natural-origin chum and pink salmon populations (Cooney et al. 1978; Simenstad et al. 1980; Bax 1983). The degree to which food is limiting after the early marine portion of a natural-origin fish's life depends upon the density of prey species. This does not discount limitations posed on natural-origin fish in more seaward areas as a result of competition by hatchery-origin fish, as data are available that suggests that marine survival rates for salmon are density dependent, and thus possibly a reflection of the amount of food available (SIWG 1984).

Measures to minimize the risk of adverse competitive interactions include:

- The release of hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile natural-origin fish in freshwater (Steward and Bjornn 1990).
- Operate hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs within nearly the entire population (Bugert et al. 1991).
- Rearing on parent river water, or acclimation for several weeks to parent river water, also contributes to the smoltification process and reduced retention time in the streams.
- Release hatchery smolts after the major seaward emigration period for natural-origin salmonid populations to minimize the risk of interaction that may led to competition.

- Release hatchery smolts in lower river areas, below upstream areas used for stream-rearing young-of-the-year natural-origin salmon fry.

6. Predation

Risks to natural-origin salmonids attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases in freshwater and estuarine areas. Hatchery-origin fish may prey upon juvenile natural-origin salmonids at several stages of their life history. Newly released hatchery smolts have the potential to prey on natural-origin fry and fingerlings that are encountered in freshwater during downstream migration, or if the hatchery fish residualize prior to migrating. Hatchery-origin smolts, sub-adults, and adults may also prey on natural-origin fish of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas where they commingle. Hatchery salmonids planted as non-migrant fry or fingerlings, and progeny of naturally spawning hatchery fish also have the potential to predate upon natural-origin salmonids in freshwater and marine areas where they co-occur. In general, natural-origin salmonid populations are most vulnerable to predation when natural-origin populations are depressed and predator abundance is high, in small streams, where migration distances are long, and when environmental conditions favor high visibility (SIWG 1984). SIWG 1984 categorized species combinations as to whether there is a high, low, or unknown risk that direct predation by hatchery fish will have a significant negative impact on productivity of natural-origin salmonids. Risk levels assigned by species in freshwater and marine areas are presented in Tables 5 and 6, respectively.

Table 5. Risk of hatchery salmonid species predation on natural-origin salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Wild Species					
	Steelhead	Pink	Chum	Sockeye	Coho	Chinook
Steelhead	U	H	H	H	U	U
Pink	L	L	L	L	L	L
Chum	L	L	L	L	L	L
Sockeye	L	L	L	L	L	L
Coho	U	H	H	H	U	U
Chinook	U	H	H	H	U	U

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a significant impact occurring.

SIWG (1984) rated most risks associated with predation as unknown, because, although there is a high potential that hatchery and natural-origin species interact, due to a high probability of spatial and temporal overlap, there was relatively little literature documentation of predation interactions in either freshwater or marine areas. Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large

relative to natural-origin fish (SIWG 1984). Salmonid predators are generally thought to prey on fish approximately 1/3 or less their length (USFWS 1994). Due to their location, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation by hatchery released fish. Their vulnerability is believed to be greatest as they emerge and decreases somewhat as they move into shallow, shoreline areas (USFWS 1994). Emigration out of hatchery release areas and foraging inefficiency of newly released hatchery smolts may minimize the degree of predation on salmonid fry (USFWS 1994).

Table 6. Risk of hatchery salmonid species predation on natural-origin salmonid species in nearshore marine areas (SIWG 1984).

Hatchery Species	Wild Species					
	Steelhead	Pink	Chum	Sockeye	Coho	Chinook
Steelhead	U	H	H	H	U	U
Pink	L	L	L	L	L	L
Chum	L	L	L	L	L	L
Sockeye	L	L	L	L	L	L
Coho	U	H	H	H	U	U
Chinook	U	H	H	H	U	U

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a significant impact occurring.

Although considered as of "unknown" risk by SIWG (1984), data from hatchery salmonid migration studies on the Lewis River, Washington (Hawkins and Tipping 1998) provide evidence of hatchery coho yearling predation on salmonid fry in freshwater. The WDFW Lewis River study indicated low levels of hatchery steelhead smolt predation on salmonids. In a total sample of 153 out-migrating hatchery-origin steelhead smolts captured through seining in the Lewis River between April and June 24, 12 fish (7.8 %) were observed to have consumed juvenile salmonids (S. Hawkins, WDFW, pers. comm., July 1997). The juvenile salmonids contained in the steelhead stomachs appeared to be chinook fry. Sampling through this study indicated that no emergent naturally-produced steelhead or trout fry (30-33 mm FL) were present during the first two months of sampling. Hawkins (1998) documented hatchery spring chinook yearling predation on natural-origin fall chinook juveniles in the Lewis River. A small number of spring chinook smolts were sampled (11), and remains of 10 salmonids were found (includes multiple observations of remains from some smolts). Predation on smaller chinook was found to be much higher in natural-origin smolts (coho and cutthroat predominately) than their hatchery counterparts. Steward and Bjornn (1990) referenced a report from California that estimated, through indirect calculations rather than actual field sampling methods, the potential for significant predation impacts by hatchery yearling chinook salmon on natural-origin chinook and steelhead fry. They also reference a study in British Columbia that reported no evidence of

predation by hatchery chinook smolts on emigrating natural-origin chinook fry in the Nicola River. In addition, Bakkala (1970 - quoting Hunter 1959 and Pritchard 1936) reported that young coho salmon in some British Columbia streams averaged two to four chum fry per stomach sampled.

Predation by hatchery fish on natural-origin smolts or sub-adults is less likely to occur than predation on fry. Coho and chinook salmon, after entering the marine environment, generally prey upon fish one-half their length or less and consume, on average, fish prey that is less than one-fifth of their length (Brodeur 1991). During early marine life, predation on natural-origin chinook, coho, and steelhead will likely be highest in situations where large, yearling-sized hatchery fish encounter sub-yearling fish or fry (SIWG 1984). Juanes (1994), in a survey of studies examining prey size selectivities of piscivorus fishes, showed a consistent pattern of selection for small-sized prey. Hargreaves and LeBrasseur (1986) reported that coho salmon smolts ranging in size from 100-120 mm FL selected for smaller chum salmon fry (sizes selected 43-52 mm FL) from an available chum fry population including larger fish (available size range 43-63 mm FL). Ruggerone (1989; 1992) also found that coho smolts (size range 70-150 mm FL) selected for the smallest sockeye fry (28-34 mm FL) within a available prey population that included larger fish (28-44 mm FL). However, extensive stomach content analyses of coho salmon smolts collected through several studies in marine waters of Puget Sound, Washington do not substantiate any indication of significant predation upon juvenile salmonids (Simenstad and Kinney 1978). Similarly, Hood Canal, Nisqually Reach, and north Puget Sound data show little or no evidence of predation on juvenile salmonids by juvenile and immature chinook (Simenstad and Kinney 1978). In a recent literature review of chinook salmon food habits and feeding ecology in Pacific Northwest marine waters, Buckley (1998) concluded that cannibalism and intra-generic predation by chinook salmon are rare events. Likely reasons for apparent low predation rates on salmon juveniles, including chinook, by larger chinook and other marine predators are suggested by Cardwell and Fresh (1979). These reasons included: 1) due to rapid growth, fry are better able to elude predators and are accessible to a smaller proportion of predators due to size alone; 2) because fry have dispersed, they are present in low densities relative to other fish and invertebrate prey; and 3) there has either been learning or selection for some predator avoidance.

Large concentrations of migrating hatchery fish may attract predators (birds, fish, and seals) and consequently contribute indirectly to predation of emigrating natural-origin fish (Steward and Bjornn 1990). The presence of large numbers of hatchery fish may also alter natural-origin salmonid behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (Hillman and Mullan 1989; USFWS 1994). Hatchery fish released into natural-origin fish production areas, or into migration areas during natural-origin fish emigration periods, may therefore pose an elevated, indirect predation risk to commingled listed fish. Alternatively, a mass of hatchery fish migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring listed natural-origin fish.

Hatchery effects through predation can be minimized through application of the following measures:

- Release actively migrating smolts through volitional release practices.
- Insure that a high proportion of the population is smolted prior to release using minimum coefficient of variation population size limits. Smolts tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and natural-origin fish present within, and downstream of, release areas.
- Delay hatchery fish releases until the major seaward emigration period for natural-origin salmonid populations has been completed, minimizing interaction that may led to predation.

- Hatchery smolts could also be released in lower river areas, below upstream areas used for stream-rearing young-of-the-year natural-origin salmon fry, reducing the likelihood for interaction between the hatchery and natural-origin fish.

7. Residualism

Most conventional artificial propagation programs hatch artificially spawned eggs and rear the resulting juveniles to pre-smolt or smolt stage. The smolts are released into rivers and streams with the anticipation that they will soon migrate to the ocean. In many cases, some portion of the hatchery-produced juveniles "residualize," or become residents of the receiving water for an extended period of a year or more. The general effects of hatchery-produced fish on natural fish, as described by Steward and Bjornn (1990) may be exacerbated if a substantial portion of the hatchery-produced juvenile salmonids residualize.

As discussed in sections V.A.5 and 6, above, particular concern has been identified when resident trout and hatchery steelhead, released into spawning and nursery areas, fail to migrate (residualize), and potentially prey upon or compete with listed salmon and steelhead fry. Steelhead residualism has been found to vary greatly, but is thought to typically average between 5% and 10% of the number of fish released (USFWS 1994). Releasing hatchery steelhead smolts that are prepared to migrate and timing the release to occur during high flow conditions may minimize impacts to listed fish from steelhead programs.

Coho salmon in most situations, do not have the same potential to residualize as steelhead, but approximately 6% of the coho planted as parr residualized in the receiving stream in the Clearwater River drainage for a year after release (Johnson and Sprague 1996). Coho salmon parr stocked in 1995, were observed two years after release in snorkel surveys and screw traps (BIA 1998) and about 2,000 age two coho smolts were counted at Snake River mainstem dams (FPC in BIA 1998). So far there appears to be a minimal tendency for residualism by coho salmon smolts released into the Yakima and Methow rivers (T. Scribner, YIN, pers. comm.).

Ocean-type chinook salmon, like the fall chinook of the Snake River and mid-Columbia River regions generally begin migration towards salt water soon after emergence, however some may spend up to one year before undertaking the smolt migration (Healey 1991). In the Snake River, Conner et al (1992) report a small percentage of hatchery-produced fall chinook smolts spend more than a year as residents in the Snake River before smolting. Although most stream-type chinook juveniles become smolts in the spring one year after emergence, some may spend a

second year in fresh water, particularly slower- growing individuals. This effect may be related to cooler water temperatures in more northern or higher elevation waters (Healey 1991).

In fish hatcheries, an attempt is made to standardize the life history of fish produced. Spring/summer chinook salmon eggs are spawned in August and September with a target of producing smolts approximately 20 months later in April. Fall chinook are spawned in November with a target of producing smolts by the following spring, in about 6 months. Coho typically are spawned in November and December and smolts are released 15 to 18 months later. Summer steelhead are typically spawned in March through May and smolts are released in 11 or 12 months. As noted above, the freshwater portion of the life history of most anadromous salmonids is quite variable in nature. While most ocean-type chinook migrate within a few months of emergence, some remain in freshwater for a full year and while most stream-type chinook and coho migrate in the spring, one year after they emerge from the gravel, some will stay a second or even a third year (Groot and Margolis 1991). Steelhead have the most variable fresh water life history of all the anadromous salmonids, typically spending one to three years in fresh water, but with some individuals spending up to 7 years in fresh water before spending 1 to 3 years in the ocean (Busby et al. 1996). As with chinook, the slower growing steelhead or those living in cooler waters may exhibit extended freshwater residence.

The variability in life history exhibited by naturally produced anadromous salmonids probably has some adaptive and survival advantages. By allowing slow-growing fish extra time in freshwater this strategy may insure smolts that are large enough to improve migration survival. That not all spawners are the same age allows transfer of genetic material among age classes of a population and protects against loss of an entire spawning year to a single natural catastrophe. Adaptability to cooler water or less productive water by extending freshwater residency may allow anadromous fish to occupy a greater variety of habitats. The current conventional wisdom on hatchery management would support the standardization of life history and the rearing protocols which produce smolts on a single, uniform, schedule, but this practice may be intentionally selecting away from the genetic heritage of the fish. As more hatchery programs are converted to conservation purposes using locally adapted and listed broodstocks, and as artificial propagation practices include more natural rearing environments, hatchery managers may have to accommodate variable life histories in production protocols.

In the case of artificial propagation programs for unlisted steelhead, particularly the programs that rear composite, domesticated and out-of-basin stocks, hatchery managers should continue to develop rearing and release protocols that reduce residualism and improve the smolting response, including acclimation, volitional release and growth schedules that produce healthy smolts that are of the proper size and stage of development at the appropriate time to initiate the smolt migration.

Acclimation ponds and volitional release strategies are currently the subject of active research in the Columbia River Basin. It is unclear at this time whether or not acclimating and volitionally releasing steelhead smolts can significantly reduce the proportion of residualized steelhead in all cases. WDFW appears to be able to significantly reduce the number of residualized steelhead

released by using a combination of acclimation, volitional release strategies, and active pond management whereby remaining steelhead are not released when sampling indicates the majority of remaining fish in pond are males. This action is taken because preliminary WDFW research indicates that the majority of residualized steelhead are males. ODFW monitoring has not confirmed WDFW results (USFWS 1994). The ODFW saw no reduction in steelhead residualism rates in 1993 from acclimated fish in comparison to direct stream releases; however, they did not employ active pond management strategies (USFWS 1994). Providing juvenile holding facilities and acclimation ponds at sites with large release numbers may provide benefits even if residualism is not reduced. As an example, by having juvenile holding facilities at the release sites, the physiological condition of the smolts can be considered, volitional release strategies could be employed, and local environmental conditions could be used as indicators of when to release fish so they immediately begin migration.

The level of smolt development exhibited by yearling spring/summer chinook has been shown to be an important factor affecting migratory behavior. Developmentally advanced yearling chinook migrate from Dworshak National Fish Hatchery to Lower Granite Dam significantly faster than less developed counterparts (Giorgi 1991; Smith et al. 1993). Current release strategies are influenced to a large extent by when transport vehicles are available and not necessarily when smolts are developmentally ready to migrate.

In a 1995-98 Biological Opinion for Columbia River hatcheries, NMFS recommended that hatchery steelhead smolts be released at sizes between 170 and 220 mm total length (TL), approximately 163-212 mm FL, based primarily on the work of two IDFG researchers, Cannamela (1992, 1993) and Partridge 1985). The maximum size recommendation was based on reports of higher residualism among steelhead over 240 mm TL and higher predation rates by residual steelhead over 250 mm TL. New analysis by IDFG suggests that the 220 mm maximum size is less than the ideal size to release smolts (Rhine et al. 1997). In several tests, Rhine reports that residual steelhead are significantly smaller than smolts. Of those steelhead smolts carrying PIT tags, 52.1% of fish released at 163-211 mm were detected at downstream dams, 66% of steelhead 212-250 mm TL were detected and 83.3% of steelhead greater than 250 mm TL were detected. Bigelow (1997) reported similar results in PIT tagged steelhead smolts released from Dworshak Hatchery. Over 70% of steelhead under 180 mm TL were not detected at downstream sites, while approximately 85% of smolts over 180 mm TL were detected.

This information suggests that release of juvenile steelhead less than 180 mm TL will contribute to residualism and the ideal release size may be larger than 220 mm TL. However, concern for both residualism and predation by very large smolts (over 250 mm TL) is still valid. Jonasson et al. (1996) reported predation on natural-origin juvenile steelhead by residual hatchery steelhead as small as 189 mm FL, but in general the larger residual fish tended more toward predation. Overall, Jonasson et al. (1996) reports a low level of piscivory by residuals less than 230-250 mm TL.

Based on this information the recommended steelhead smolt size range should be 180 mm to 250 mm TL. Further, if predation increases as size of fish released from hatcheries increases, then

hatchery managers should avoid release of larger smolts in waters that support rearing fry of listed species. Hatchery managers should continue to evaluate the impacts of size at release on predation and residualism along with other measures to increase smolt success.

Smolts that residualize not only pose a potential threat to naturally produced salmonids, they have a lower probability of returning as adults and fulfilling the intended purpose of fishery enhancement or mitigation. Healthy hatchery-produced smolts that migrate to the ocean soon after release have a good chance to return as adults, while those that select an extended stream residence often do not survive (Steward and Bjornn 1990). If a high percentage of hatchery-produced smolts successfully return as adults, less production is required to meet mitigation or treaty trust responsibilities.

8. Fisheries

Fisheries managed for, or directed at, the harvest of hatchery origin fish has been identified as one of the primary factors leading to the decline of many natural-origin salmonid stocks (Flagg et al. 1995; Myers et al. 1998). Depending on the characteristics of a fishery regime, the commercial and recreational pursuit of hatchery fish can lead to the harvest of natural-origin fish in excess of levels compatible with their survival and recovery (NRC 1996). Listed salmon and steelhead may be intercepted in mixed stock fisheries targeting predominately returning hatchery fish or healthy natural stocks (Mundy 1997). Fisheries can be managed for the aggregate return of hatchery and natural-origin fish, which can lead to higher than expected harvest of natural-origin stocks.

Certain management actions can reduce the effects on listed stocks from harvesting hatchery produced fish (Rutter 1997).

- Hatchery fish can be externally marked so that they can be differentiated from unmarked, natural-origin fish.
- With external hatchery fish marking, fisheries can be conducted to selectively harvest only hatchery produced fish with natural-origin fish being released.
- Fisheries can be managed for the cumulative harvest rate from all fisheries to ensure impacts are not higher than expected (Mundy 1997).
- To ensure harvest rates are not increased because of a large return of hatchery fish, fisheries can be managed based on the abundance and status of natural-origin fish.
- Hatchery fish can be released from terminal areas so that returning adults can be harvested with little or no interception of natural-origin fish. Fisheries can occur near acclimation sites or in other areas where released hatchery fish have a tendency to concentrate, which reduces the catch of natural-origin fish.
- The number of fish released from hatcheries can be reduced or eliminated, if fisheries targeting hatchery fish cannot be managed compatible with the survival and recovery of listed fish.

<u>Catchable Trout Fisheries Impacts</u>

To meet mitigation obligations for lost recreational harvest opportunities, many hatchery programs also produce rainbow trout (and other trout species) for recreational fisheries. Most

programs produce rainbow trout that are of sufficient size to meet minimum length regulations for retention in the fisheries. These rainbow trout are generally referred to as catchable trout. The release of hatchery rainbow trout for recreational fisheries can adversely affect listed salmonids through competition and predation and through effects to listed juvenile steelhead from fisheries impacts.

The competition and predation effects from the release of catchable trout are similar to those described for steelhead in Sections 5, 6 and 7 above. Measures to minimize these effects include:

- Release catchable trout in standing water bodies, isolated from listed fish populations.
- Release catchable trout in areas away from rearing and migrating juvenile salmonids.
- Release catchable trout at times when listed fish are not present in the river reach.
- Release catchable trout at locations that will permit efficient harvest.

These measures should minimize some of the effects of competition and predation that may result from the release of catchable trout.

Aside from the above effects the most significant effect of releasing catchable trout in waters home to listed steelhead is the inadvertent harvest of juvenile steelhead in catchable trout fisheries. Cramer and Willis (1998) observed that the release of catchable trout attracts anglers to release locations and that harvest rates of juvenile steelhead are generally proportional to angler effort. In a study of effects to juvenile steelhead from catchable trout fisheries in the Wenatchee River, Washington, Don Chapman Consultants (1989) concluded that sport anglers remove 61 to 87% of natural-origin steelhead longer than 125 mm and kill 2 to 28% of steelhead larger than 100 mm by hook and release. Furthermore, it was found that anglers harvest 72 to 91% of the hatchery rainbow trout soon after release. Cramer et al. (1997) noted that this quick removal of hatchery trout leaves only juvenile steelhead as the targets for fishermen attracted by the reports of high angler success. This observation is supported by Don Chapman Consultants (1989) finding that “although catchable trout did not displace natural-origin steelhead by direct interaction for space, hatchery trout attracted anglers that killed a large fraction of the juvenile steelhead in the river.” Their underwater observations also indicated that natural-origin steelhead were more susceptible to angling that hatchery trout because steelhead reacted faster to lures and bait. Pollard and Bjornn (1973) made similar observations, noting in a study on the Crooked Fork of the Lochsa River, Idaho, that most of the larger juvenile steelhead trout present in the retention area of the river were caught at a faster rate than the smaller age I steelhead and the hatchery trout given the same level of effort.

Fisher (1961, as described by Cramer et al. 1997) surveyed angler effort in the Big Sur River, California, observing that anglers caught an estimated 90% of the catchable trout released, but natural-origin trout made up 24% of total catch. The angler catch of natural-origin fish was 7 times greater than the number of natural-origin fish counted as outmigrants to the river during the same period. This experiment was conducted during the peak spring migration period for steelhead smolts. All these studies show that natural steelhead are more susceptible to angling

than catchable trout when the two are present together and that angler effort is directly related to the presence of catchable trout releases.

Hook and release mortality studies for catchable trout fisheries were reviewed by Cramer et al. (1997), the studies showed that mortality from hook and release depended on the fishing method (e.g., 3.9% for fly-caught, 21.6% of trout caught on actively-fished bait and 32.1% of trout caught on passively fish bait in pond setting). The study by Schisler and Bergersen (1996, in Cramer et al. 1997) also found that mortalities increased as water temperatures increased. Cramer et al. (1997) observed that the mortality associated with the fishing methods was lower in river habitats compared to ponds because deep hooking was less likely to occur. Overall, Cramer et al. (1997) in their review, concluded that mortality for trout caught on lures was about twice that for flies, but only about one-fifth of that for trout caught on bait. To reduce hook and release mortalities in catchable trout fisheries, State fisheries agencies can limit the use of gear types and location of fisheries.

State fisheries agencies have made changes to the management of recreational fisheries to address these effects, these changes include the following:

- Increase the minimum size for retention from 6 inches to 8 to 10 inches, with some fisheries restricted to 12 inches or greater. This is to protect listed steelhead generally smolt at a size of 6 to 8 inches.
- Managers have delayed the season opening from the end of April to late May or early June to protect the majority of the outmigrating steelhead smolts.
- The number of fish that can be retained (the bag limit) has also been reduced to 2 fish/day.
- Catchable trout are no longer stocked in some basins to eliminate the adverse effects from catchable trout fisheries.
- Hatchery managers in some areas are marking all hatchery rainbow trout released and requiring that only marked hatchery trout can be retained and all unmarked steelhead/trout be released.
- Fisheries managers have reduce impacts through bait restrictions in trout fisheries require artificial lures and flies only and eliminating the use of bait.
- Fisheries managers have closed headwater rearing areas to all angling to protect juvenile steelhead and other salmonids.

Cramer et al. (1997) estimated that in the 1980s angling mortality to juvenile steelhead in popular Oregon streams ranged from 35 to 60 % and 15 to 20% in popular Washington streams. The mortality in Washington streams was lower because many of the above measures were all implemented. When the above measures were implement over the last 2 to 5 years in Oregon steelhead streams the mortality to juvenile steelhead declined to a ranged of 5 to 15%, with Washington streams declining to a range of 5 to 10%.

9. Masking

Under certain circumstances, the production of hatchery fish may lead to escapements of adult hatchery fish to natural spawning areas where they may intermingle with natural-origin fish of the same species. Continuous, annual escapements of the hatchery fish to natural spawning areas

may confound the ability to determine the annual abundance of the natural-origin fish, if present and commingled with the hatchery fish. This situation may lead to an over-estimation of the actual abundance and productivity of the natural fish population, and as a corollary, a lack of ability to assess the health and production potential of critical habitat for the natural population. This latter factor exists because the hatchery fish are not subject to the same spawning and early life history productivity limits experienced by the natural population in the natural freshwater environment. The abundance and productivity of the natural fish population, and the health of the habitat that sustains the natural fish, is therefore "masked" by the continued infusion of hatchery-origin fish.

Masking of natural fish status by naturally spawning hatchery fish produced for harvest augmentation purposes was one basis for the recommended listing of the Puget Sound chinook salmon ESU as "threatened" under the ESA (Myers et al. 1998). Annual spawning ground censuses of fall chinook populations had historically aggregated naturally spawning hatchery and natural-origin fish. When an identifying mark was applied to a proportion of the hatchery fish, efforts were made to subtract out hatchery fish from escapement estimates through expanded mark recovery estimates. In many instances, however, the release of unmarked hatchery fall chinook groups predominately of a single stock led to the situation where salmon spawning escapement abundances were artificially sustained, and the actual annual abundances of the indigenous naturally produced fall chinook populations in some watersheds were over-estimated or unknown.

Attempts to identify and remedy anthropogenic factors adversely affecting fish habitat may be impeded through masking of natural fish status. For example, instability and degradation of spawning gravel areas through flooding during critical spawning or egg incubation periods may not be recognized as a limiting factor to natural production if annual spawning ground censuses continuously demonstrate good salmon escapements to affected stream reaches. If the vast majority of the adult fish observed were of direct hatchery origin, the poor natural productivity status of the spawning areas will not be evident without additional, expansive monitoring efforts.

Resolution of the masking issue can be achieved through a number of measures:

- Provide an effective means to easily differentiate hatchery fish from natural-origin fish on the spawning grounds. A readily visible external mark applied to all hatchery fish prior to release, combined with an effective spawning ground census program designed to derive separate estimates of hatchery and natural fish, is one avenue available. Mass marking of hatchery fish using an internal mark (e.g., otolith banding) may also be used to differentiate hatchery from natural-origin fish on the spawning grounds, if a statistically valid adult sampling design to collect and analyze mark recovery data is also implemented.
- Limit the number of hatchery fish escaping to natural spawning areas by releasing fish into watersheds not used by the natural fish population of concern.
- Remove hatchery fish through selective fisheries.
- Imprint hatchery fish to return to lower river or tributary areas not used by natural fish in a watershed.

- Reduce or limit hatchery fish release numbers, leading to decreased adult hatchery fish returns, reducing masking effects.

10. Nutrient Cycling

The flow of energy and biomass from productive marine environments to relatively unproductive terrestrial environments supports high productivity in the ecotone where the two ecosystems meet (Polis and Hurd 1996). Anadromous salmon are a major vector for transporting marine nutrients across ecosystem boundaries (i.e. from marine to freshwater and terrestrial ecosystems). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland. Nutrients and biomass extracted from the decomposing carcasses, eggs and milt of spawning salmon stimulate growth and restore the nutrients of aquatic ecosystems. Nutrients originating from salmon carcasses are also important to riparian plant growth. Direct consumption of carcasses and secondary consumption of plants and small animals that are supported by carcasses is an important source of nutrition for terrestrial wildlife (Cederholm et al. 1999).

Current escapements of natural-origin and naturally spawning hatchery-origin anadromous salmonids in the Columbia Basin are estimated at about 7 % of the historic biomass (Cederholm et al. 1999). Throughout the Pacific Northwest, the delivery of organic nitrogen and phosphorus to the spawning and rearing streams for anadromous salmonids has been estimated at 5 to 7 % of the historic amount (Gresh et al. 2000). Cederholm et al. calculate the historical spawning escapement at 45,150 mt (metric ton) of biomass annually added to the aquatic ecosystems of the Columbia compared to 3,400 mt annually with current spawning escapements.

Artificial propagation programs in the basin add substantial amounts of fish biomass to the freshwater ecosystem. Fro example, the annual hatchery salmonid juvenile production cap of nearly 200 million smolts applied in the Columbia River region, at 25 gr/smolt average weight, adds about 5,000 mt of biomass to the Basin. Returning adults from artificial propagation programs in that region have totaled 800,000 to 1,000,000 in recent years (ODFW 1998). At the average weight of 6.75 kg used by Cederholm, 5,400 to 6,750 mt of fish biomass is potentially returned to the Columbia River annually due to artificial propagation programs. Of course, most of the hatchery smolt production is expected to leave freshwater and migrate to the marine ecosystem, but undoubtedly some of the nutrients from these fish are retained in freshwater and terrestrial ecosystems as post-release mortalities and consumption by predators such as bull trout, ospreys and otters. Also, much of the adult return from hatchery production may be removed from the ecosystem by selective fisheries or taken at hatchery weirs and traps.

However, the potential to utilize the marine-based nutrients that are imported to freshwater ecosystems in the carcasses of hatchery returns may be of value for stimulating ecosystem recovery. Experiments have shown that carcasses of hatchery produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Bilby et al. 1998). Hatchery carcasses may also replace some of the nutrient deficit in riparian plant and terrestrial wildlife communities where natural-origin spawners are lacking. The contribution of artificial propagation programs has the potential to exceed the contribution of naturally produced fish in

replenishing the nutrient capital of aquatic ecosystems in the short term, but should not be regarded as a long term solution to replacing the nutrient subsidy provided by natural-origin salmon.

Utilization of carcass outplants and evaluation of results may be incorporated into many of the artificial propagation programs evaluated in this opinion. Managers considering carcass outplants must follow disease control guidelines and should not transfer carcasses between drainages. Managers should also consider other habitat conditions of target streams including the presence of small woody debris that helps retain carcasses as they decompose, the likely natural density of spawner carcasses and the presence of nutrient enrichment such as agricultural runoff.

11. Monitoring and Evaluation

Monitoring and evaluation programs are necessary to determine the performance of artificial propagation programs. The Artificial Production Review (NPPC 1999) listed four criteria for evaluating both augmentation and mitigation programs:

1) Has the hatchery achieved its objectives?
2) Has the hatchery incurred costs to natural production?
3) Are there genetic impacts associated with the hatchery production?
4) Is the benefit greater than the cost?

Historically, hatchery performance was determined solely on the hatcheries ability to release fish (NPPC 1999), this was further expanded to include hatchery contribution to fisheries (e.g., Wallis 1964, Wahle and Vreeland 1978, Vreeland 1989). Recent program wide reviews of artificial propagation programs in the Northwest have identified the failure of regional salmon managers to conduct adequate monitoring and evaluation to determine if the hatchery objectives are being met (ISG 1996, NRC 1996). The lack of adequate monitoring and evaluation has resulted in the loss of information that could have been used to adaptively manage the hatchery programs (NRC 1996).

Under the ESA, monitoring and evaluation programs for artificial production are not only necessary for adaptive management purposes but are required to insure that artificial propagation activities do not limit the recovery of listed populations. Monitoring and evaluation of artificial propagation activities is necessary to determine if management actions are adequate to reduce or minimize the impacts from the eleven general effects discussed previously, and to determine if the hatchery is meeting its performance goals. Monitoring and evaluation activities will occur within the hatchery facilities as well as in the natural production areas. Monitoring and evaluation within the hatchery can include measurements to evaluate hatchery production (i.e. fish survival, size at age, condition, disease prevention, genetic makeup, total released, and percent smolted).

Monitoring and evaluation programs to determine impacts to listed populations from artificial propagation activities can have potential adverse effects to listed fish though sampling and

marking. Sampling within the hatchery can include direct mortalities (e.g., genetic analysis, disease pathology, smolt condition) and indirect take (e.g., sorting, marking, transfers). Marking of hatchery fish prior to release is required for all programs, with management requiring 100% marking for some releases. Marking is necessary to evaluate a number of objectives including sorting broodstock, determining hatchery stray rates, hatchery contributions to commercial fisheries, and for the implementation of selective fisheries that target hatchery fish. There are a number of methods available to mark hatchery fish (Nielson 1992, Parker et al. 1990). The methods used depend on the type of information required or on the management goal for the hatchery fish. To support selective fisheries, identification when collecting broodstock, tag recovery in fisheries and tag recovery on the spawning grounds external marks are required (PSMFC 1992). Internal tags and marking methods (PSMFC 1992, Volk 1990, Bilton 1986) can be used to evaluate fisheries contribution, broodstock origin (post spawning) and contribution to natural spawning via carcass recovery. Each marking method has unique risks associated with the tag and the method of application (Parker et al. 1990, Jacobs 1990) and these risks must be considered when developing monitoring and evaluation plans.

In many artificial propagation programs the goal is to increase natural production (supplementation, augmentation, restoration) by using hatchery fish to increase the number of natural spawners. Monitoring and evaluation for this goal requires the sampling of naturally produced adults and juveniles in natural production areas. In the Columbia River Basin, many of these naturally produced populations are listed under ESA.

Monitoring and evaluating naturally produced fish is required to determine if the artificial production program is having any adverse effects on the natural population. Genetic and life history data must be collected from the natural population to determine if the hatchery population has diverged from the natural population and if the natural population has been altered by the incorporation of hatchery fish into the spawning population. To collect these data, the natural population needs to be sampled. Sampling methods can include the use of weirs, electro-fishing, rotary screw traps, seines, hand nets, spawning ground surveys, snorkeling, radio tagging and carcass recovery. Each sampling method can be used to collect a variety of information. Sample methods, like tagging methods, can adversely affect listed fish, including fish targeted for data collection and fish coincident in the sampling area taken incidentally.

NMFS has developed some general guidelines for collecting listed adult and juvenile salmonids which have been incorporated as terms and conditions into section 10 and section 7 permits for research and enhancement activities. Though necessary to monitor and evaluate impacts to listed populations from artificial propagation programs, monitoring and evaluations programs should be designed and coordinated with other plans to maximize the data collection while minimizing take of listed fish.

B. Specific Action Effects Analysis

The standards for determining jeopardy are set forth in Section 7(a)(2) of the ESA as defined at 50 CFR 402.02. This section of the Opinion applies those standards in determining whether the proposed hatchery actions are likely to jeopardize the continued existence of the threatened

salmon species (ESUs) that may be adversely affected by the actions, or through adverse impacts to critical habitat. This analysis considers the direct, indirect, interrelated and interdependent effects of the proposed actions and compares them against the Environmental Baseline to determine if the proposed hatchery programs will reduce appreciably the likelihood of survival and recovery of the listed salmon in the wild by reducing the reproduction, numbers or distribution of the listed ESUs.

An evaluation of the likely effects of the hatchery programs described in the "Proposed Actions" section of this Opinion is presented. The determination of likely effects of the described hatchery programs is made through consideration of: the status of the affected listed salmon populations; the general beneficial and adverse effects of hatchery practices and production summarized above; information describing operational actions, take levels and effects provided for the hatchery programs by the co-managers and USFWS in HGMPs; and, hatchery program descriptions, current and proposed hatchery operational protocols, hatchery risk assessment frameworks, and measures applied to minimize the risk of hatchery-induced hazards to listed salmon proposed within the co-managers' SCSCI (WDFW and PNPTT 2000).

The NMFS VSP paper (McElhany et al. 2000) provides a framework for identifying the biological requirements of listed salmonids, assessing the effects of management and conservation actions, and ensuring that such actions provide for the survival and recovery of listed species. The VSP paper develops the concept of threshold abundance levels as one of several indicators of population status (others being productivity, spatial structure, and diversity). The VSP threshold concept includes a critical threshold and a viable population abundance level. The critical threshold generally represents a boundary below which uncertainties about population dynamics increase and therefore extinction risk increases substantially. Actions affecting populations that are functioning at or below a critical threshold must not be allowed to appreciably increase genetic and demographic risks facing the population and must be designed to permit the population's achievement of viable function. This requirement applies, unless it is demonstrated that the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to the affected population (July 10, 2000; 65 FR 42422). The viable population threshold is a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required, with the caveat that abundance is not the only relevant or necessary indicator of recovery. Actions affecting populations that are at or above the viable threshold must be designed to maintain the population at or above that level.

VSP-derived determinations regarding critical and viable population thresholds, and population structure, have not been made for the summer chum and chinook salmon ESUs that are of concern in this Opinion. Lacking these determinations, Section III of this Opinion describes summer chum and chinook extinction risk and stock structure parameters that are used as benchmarks for the evaluation of jeopardy. This information for summer chum salmon is drawn from the co-managers' SCSCI, which identifies stocks based on substantial reproductive isolation (identified by distributional and genetic differences) (WDFW and PNPTT 2000). The importance of maintaining population structure within the summer chum ESU was highlighted

throughout the SCSCI. The SCSCI also provided stock status and extinction risk determinations for each stock (see Section III). The following evaluation considers these individual stock status definitions and extinction risk status determinations to judge the effects of each hatchery program. This approach is consistent with the VSP concept intent to recognize and protect the diversity of populations that may exist within an ESU and, in assessing the effect of an action, to stratify the ESU adequately to represent the unique population characteristics of the ESU.

As noted in Section III, based on average spawner abundance levels, nearly all of the summer chum stocks that are the subject of these recovery actions are below what can be preliminarily considered viable population thresholds. In evaluating the effects of the proposed actions, it is recognized that the specific intent of the summer chum salmon-directed hatchery programs is to preserve the listed populations and enhance the prospects for their recovery. Demographic risks to the listed summer chum populations are proposed to be decreased through these actions. The estimated benefits to summer chum salmon stock recovery for the supplementation and reintroduction programs are summarized in Section V.B.1.j. The following analysis weighs the potential effects of a hatchery-induced hazard on individual listed summer chum against the benefits to the target summer chum population in increasing the abundance of the population, and in moving their status into a viable population range.

The first portion of this section (V.B.1) evaluates the effects of Federally funded and non-Federally funded summer chum salmon artificial propagation programs described in Section II A on the survival and recovery of listed summer chum and chinook salmon. The second portion of this section (V.B.2) evaluates the effects of Federally funded and non-Federally funded unlisted salmon artificial propagation programs described in Section II B on the survival and recovery of listed summer chum salmon.

Ten of the eleven generic artificial propagation effect categories introduced in Section V.A. are used in the following evaluation. Evaluation of "Nutrient Cycling" covered in Section V.A. is not included for the proposed hatchery programs. Based on the best science currently available (Bilby et al.1998; Cederholm et al. 1999), spawned salmon carcass distribution programs conducted as part of the proposed actions and designed to cycle nutrients into summer chum watersheds are beneficial to the region's ecosystem. Co-manager regulatory requirements for compliance with water quality regulations and fish disease prevention protocols for all salmon carcass distribution programs insure that these nutrient enhancement programs are protective of natural-origin fish. In addition, it should be noted that not all effects described in the generic effects section apply to all hatchery programs. Many of the observed effects identified in the generic effects section have been minimized through measures included as proposed actions by the agencies. The following evaluations focus on the specific effects associated with each hatchery program, and the types of measures implemented that address those effects. A summary of the analysis of impacts and minimization measures is presented at the end of each of the specific effects sections. Any recommended measures and actions needed to reduce impacts to listed summer chum or chinook salmon are identified.

1. <u>Hood Canal Summer Chum Salmon Artificial Propagation Programs</u>

a. Operation of Hatchery Facilities

Hatchery facility failure

As discussed previously in Section V.A.1 ("Operation of Hatchery Facilities"), hatchery facility failure, in the form of power or water supply failure, flooding, screen fouling, smothering of eggs or alevins by sediment during incubation, poor fish cultural practices, or vandalism, has the potential to adversely affect fish under propagation for stock recovery purposes. Natural-origin fish are not affected by this category of hatchery failure, which pertains to effects on listed fish retained in the hatchery. Safety and survival of summer chum salmon adults held through spawning or juvenile summer chum under propagation through the proposed programs to assist in the recovery of the listed summer chum ESU through supplementation or reintroduction are therefore at issue. Summer chum salmon retained in the hatcheries for artificial propagation may be killed or injured as a result of facility failure, to the detriment of efforts to rebuild the abundance of adult summer chum salmon returns that result from hatchery juvenile fish production. For example, a mass failure event at the Hamma Hamma River hatchery operation in 1998 led to the loss of nearly all juvenile summer chum under artificial propagation at the site through inundation of an RSI used to incubate the summer chum. Few summer chum juveniles were released for that brood year to help rebuild the Hamma Hamma River summer chum population. Facility failure will not affect listed chinook salmon, as none of the summer chum programs retain listed juvenile or adult chinook salmon in the hatcheries for artificial propagation.

a) Juvenile summer chum salmon

In all of the summer chum hatchery programs evaluated in this Opinion, the managers will address the safety of juvenile summer chum under propagation through the use of high quality water for incubation and rearing of fish, on-site residence of staff, use of low flow alarms, the use of gravity flow from stable spring sources to provide water for fish rearing, or the existence of a consistent site monitoring regime and protocol, providing a mechanism for rapid response to factors that could cause catastrophic loss at the facility. In addition, summer chum are propagated by personnel trained in proper fish cultural techniques, and in compliance with guiding principles set forth in the SCSCI defining effective mating, incubation, rearing and release strategies (Appendix Report 3.1 in WDFW and PNPTT 2000). The criteria in the plan define practical rearing and release procedures that have been demonstrated to be of greatest benefit to healthy chum fry production in the hatchery environment and the survival of released fish to adulthood. The mating, incubation, rearing and release strategies that are followed are designed to produce the most summer chum fry in the shortest amount of time in the hatchery, while producing fish that are as genetically and ecologically similar as possible to the founding population. The co-managers have defined survival rate goals by life stage for summer chum

propagated through the proposed programs. These goals are indicative of appropriately operated hatchery programs, that are adequately protective of the fish under propagation:

Chum Life Stage	**% Survival by Life Stage**	**Cum. % Survival from Green Egg**
Green egg to eye-up	90.0 %	90.0 %
Eye-up to Swim-up	99.5 %	89.5 %
Swim-up to fry release	95.0 %	85.0 %

In most years, the proposed programs have met or approached the above SCSCI survival rate objectives. Table 7 presents green egg survival to eye-up and total survival rate percentages for the most recent brood year production data available (1998 - data from HGMPs submitted for each program). The expected egg to swim-up fry survival rate for summer chum salmon spawning in the natural environment are also presented for comparison.

Table 7. Green egg survival to eye-up and total survival rate percentages for summer chum artificial propagation programs within the action area (most recent brood year data).

Survival Rate	Quilcene	Hamma Hamma	Lilliwaup	Big Beef	Salmon	Chimacum	Naturally Spawned
Green egg to eye-up	93.5	<10.0 **1/**	92.4	93.5	90.7	90.7	-
Green egg to fry release	90.7	<10.0 **1/**	91.1	92.4	89.0	79.4	10.0 3/

1/ A mass failure above the hatchery led to inundation and loss of most eggs being incubated in 1998.
2/ The Jimmycomelately program is not included, as it was initiated in 1999 and survival data are not yet available.
3/ Estimate from J. Ames, WDFW, pers. comm., and from Table A3.1 of the SCSCI.

An important method applied in several of the proposed projects to minimize the risk of catastrophic loss to a supplemented population is propagation of a stock at more than one location. This practice includes transfer of summer chum eggs taken from spawners at remote sites for incubation to the eyed stage or to swim-up fry at hatchery facilities with proven, high quality and stable water supplies and constant monitoring by hatchery staff. Incubation of the eggs to the eyed stage at these hatchery facilities safeguards the eggs during the most critical egg developmental stage, and provides for the transfer of hardier, eyed eggs back to their origin for continued incubation and rearing, and eventual release. Also, spreading the risk by using stock for release at another location, generally for the purposes of reintroduction, will increase the likelihood that the genome is retained in the event of a catastrophic loss at one facility. Following this practice are the Hamma Hamma program (green transfers to Lilliwaup Hatchery), and the Salmon Creek Chimacum Creek, and Jimmycomelately programs (transfers to Dungeness Hatchery). Additional methods applied by the operators in the proposed programs to minimize the likelihood of hatchery failure are use of low pressure/low water level alarms for water supplies serving summer chum rearing areas, on-site availability of back-up generators in

the event of power loss, the requirement that new hatchery facilities propagating summer chum be sited in areas with a low risk of flooding, use or immediate availability of more than one water source (e.g., spring) to supply water for incubation and rearing, and propagation of summer chum fry in net-pens continuously supplied with sufficient water passively by tidal flow.

Summer chum hatcheries relying on gravity-fed water supplies (e.g., Hamma Hamma, Union, Salmon Creek, Chimacum, Jimmycomelately) carry the risk of flooding, low water events, or plugged intake screening. Although these facilities lack power loss risks, the sites are proposed to be monitored on a twice daily basis (and continuously during flood events) to guard against fish loss. Incubators used at these locations are stocked with eyed eggs only, allowing incubation from fertilized egg to eye-up to occur at larger hatchery facilities where flow conditions and water quality are better controlled.

The Quilcene NFH hatchery operations are monitored full-time by staff stationed on-site as a safeguard to fish under propagation. Water used for fish rearing at Quilcene is supplied by gravity flow, so it is safe from power outages. The hatchery water supplies are monitored with radio response and dial-up alarm systems. The Lilliwaup, Dungeness Complex, and Big Beef Creek summer chum operations are also monitored by staff stationed on-site. Gravity flow water supply systems (or tidal flow for net-pen-reared fish), low flow alarm systems, back-up water sources, initiation of annual production programs using eyed eggs transferred from larger hatcheries with proven, stable water supplies, and site-monitoring protocol applied by the action agencies at the Hamma Hamma, Salmon Creek, Chimacum, Jimmycomelately, Big Beef, and Union River sites combine to minimize the likelihood for catastrophic loss of summer chum at those locations. The use of multiple spring sources at the Hamma Hamma site beginning with 1999 brood year production has decreased the risk of catastrophic loss due to mass failure. Concerns regarding availability of sufficient water for rearing summer chum to the targeted release date and fish size at Big Beef Creek can be addressed through identification and memorialization of flow needs for the reintroduction program through agreement between the parties, and through a requirement for needed flow volume.

b) Adult summer chum salmon

In all of the summer chum hatchery programs evaluated in this Opinion, the managers will address the safety of adult summer chum held through spawning through application of the same practices applied to protect juvenile summer chum at the hatcheries. Protection of adult fish from facility failure is promoted through the use of high quality water for fish holding, on-site residence of staff or a consistent site monitoring regime and protocols to curtail poaching and respond effectively to site failures, use of low flow alarms, and the use of gravity flow from stable spring sources to minimize the risk of pond de-watering.

Based on the measures described above that are applied in the programs, it is very unlikely that any of the facilities will have an event resulting in the catastrophic loss of juvenile summer chum salmon propagated for recovery purposes, or adult summer chum salmon broodstock retained through spawning in the hatcheries, so as to appreciably reduce the likelihood for listed summer chum salmon survival and recovery. Any adverse effects are likely to be short term and limited

so as not to reduce the abundance of the donor summer chum populations or their ability to reproduce in the wild.

Hatchery water intake impacts
As discussed in Section V.A.1., the operation of hatchery facilities may adversely affect natural-origin fish in the natural environment or their habitat through water diversion and water withdrawal impacts. Migrating, spawning, or rearing listed salmon present in stream reaches where hatcheries are located may be injured or killed as a result of hatchery operations through entrainment on hatchery water intake screens, or through stream channel dewatering resulting from excessive hatchery water withdrawal. The adverse effects of the summer chum salmon hatchery water intake and withdrawal operations on natural-origin listed summer chum and chinook salmon present in the natural stream areas and their critical habitat may therefore be of concern.

a) Juvenile summer chum and chinook salmon
Freshwater withdrawal volumes required to operate these hatcheries are permitted by the Washington Department of Ecology, which monitors the status of water appropriations in each watershed, ensuring that over-appropriation is avoided. In all cases, the minimal volumes specifically appropriated to propagate summer chum at each facility are withdrawn from wells, springs or small tributaries that are not accessible to, or used by, listed natural-origin summer chum or chinook salmon. The hatcheries are designed to be non-consumptive, with the water used for rearing returned to the source after it flows through the facility near the point of withdrawal to minimize risks to natural-origin fish. These withdrawals are not likely to lead to de-watering of stream reaches important as critical habitat for natural summer chum and chinook salmon incubation and emigration.

As called for in the SCSCI, screening associated with summer chum production facility water intakes are in compliance with NMFS screening criteria (NMFS 1996). The risk of entrainment of natural summer chum and chinook salmon through water intakes is further minimized through the use of spring, well, and tributary sources that are not used by summer chum salmon, decreasing the likelihood that juvenile fish are encountered and affected. No adverse effects to summer chum and chinook juveniles associated with hatchery screening for these facilities are anticipated or likely. The Salmon Creek and Chimacum programs use small-mesh (1/8" span) net-pens to rear summer chum fry in nearshore marine areas. These net-pens are operated for a maximum of 2 months per year, and the small mesh size used precludes entrainment or capture (potentially leading to migrational delay) of natural-origin summer chum or chinook salmon juveniles. No adverse affects as a result of net-pen operation are likely.

b) Adult summer chum and chinook salmon
Minimal volumes appropriated to propagate summer chum at each facility (approximately 100 to 200 gpm for each of the programs) are withdrawn from wells, springs or small tributaries that are not accessible to, or used by, summer chum or chinook. Also, the hatcheries are designed to be non-consumptive with the water used for rearing returned to the source after it flows through the facility near the point of withdrawal. This latter practice, in particular, minimizes the likelihood

for adverse downstream effects to migrating or spawning natural adult listed fish that might occur through de-watering of stream reaches where the fish are present. Entrainment of listed adult salmon by hatchery screening is unlikely, given the location of all water intakes outside of areas used by summer chum and chinook adults for migration and/or spawning. Net-pens used for the Salmon Creek and Chimacum Creek programs are not in place during the adult summer chum and chinook salmon migrational periods, so no adverse effects to these species are expected.

Based on the measures applied in the programs, it is unlikely that any of the facilities will adversely affect listed summer chum or chinook salmon or their designated critical habitat as a result of water withdrawal practices, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the targeted summer chum populations or their ability to reproduce in the wild.

Effluent discharge effects
From Section V.A.1., the operation of hatchery facilities may also adversely affect natural-origin fish in the natural environment through water quality impacts. Migrating, spawning, or rearing listed salmon present in stream reaches downstream of where hatcheries are located may be injured or killed as a result of adverse downstream water quality changes caused by hatchery effluent. The adverse effects of the summer chum salmon hatchery operations on natural-origin listed summer chum and chinook salmon present in the natural stream areas through degradation of downstream water quality may therefore be of concern.

a) Juvenile and adult summer chum and chinook salmon

Effluent water quality for the hatchery programs is expected to meet all state and Federal standards. Total annual fish production levels above 20,000 pounds per year (all species combined) necessitate compliance with a NPDES permits issued for Quilcene NFH and the Dungeness Complex programs. Effluent quality at the Quilcene, Dungeness and Hurd Creek hatcheries is routinely monitored to insure compliance with permitted standards, which are deigned to be protective of downstream aquatic life. The other WDFW-Co-op group summer chum hatchery programs, including the Salmon and Chimacum program net-pen sites, have modest annual fish production levels. These programs produce summer chum at levels well below the 20,000 pound per year standard identified by Washington Department of Ecology and EPA as the level above which a NPDES permit is required. Low fish production levels at these facilities are not expected to lead to adverse water quality effects to natural summer chum or chinook salmon, or other aquatic life as a result of effluent discharge.

Based on the water quality control and monitoring measures applied in the programs, it is unlikely that any of the facilities will adversely affect listed summer chum or chinook salmon or their designated critical habitat, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the targeted summer chum populations or their ability to reproduce in the wild.

b. Broodstock Collection

As discussed previously in Section V.A.2. ("Broodstock Collection"), broodstock collection associated with hatchery operations may adversely affect natural-origin fish or their critical habitat by injuring or obstructing migrating, spawning or incubating fish and through physical removal during trapping. Of concern for the hatchery programs evaluated in this Opinion are the effects on listed summer chum salmon or chinook salmon, including injury or mortality, as a result of summer chum salmon-directed broodstock collection methods, practices and associated adult fish removal.

Broodstock collection method effects

a) Juvenile summer chum and chinook salmon

Broodstock collection operations directed at summer chum salmon adults occur between July and mid-October, when the fish enter the rivers or adjacent estuaries in preparation for spawning. Newly fertilized ("green") summer chum eggs may be adversely affected by these operations. Summer chum salmon eggs incubate in redds in lower watershed areas where the broodstock operations are conducted from early September through early November (see Appendix A for life history information). Juvenile summer chum spend little time in freshwater and estuarine areas after emerging, likely vacating the action area seaward by May each year. The only vulnerable life stage of concern regarding broodstock collection is therefore the "green" egg stage. Newly fertilized (or "green") salmonid eggs are very susceptible to disturbance from approximately 2 days post-fertilization through blastomere closure (near the point when the eye of the fish becomes pigmented or "eyed"). Broodstock collection activities that lead to excavation of redds, disturbance of redds by foot traffic or netting actions, or the placement of structures causing changes in hydraulic conditions that might disrupt the integrity of existing redds, pose an elevated risk of summer chum juvenile (egg) mortality during this vulnerable egg developmental period.

The Hamma Hamma River is the only watershed where listed chinook salmon juveniles may potentially be affected by a summer chum broodstock collection operation. The other watersheds where summer chum supplementation projects are proposed lack self-sustaining chinook salmon populations. Risks posed by summer chum broodstock collection on the Hamma Hamma River to chinook salmon juveniles are similar to those described above for summer chum juveniles.

The Jimmycomelately, Lilliwaup Hatchery, Salmon Creek Hatchery (also supplying Chimacum Creek), Union River, and Big Beef Creek Hatchery broodstock collection programs use temporary fish weirs positioned in the lower portions of the creeks in advance of summer chum spawning. These weirs are authorized through WDFW Hydraulic Project Approval, State Shoreline Act, and State Environmental Policy Act permit processes to help ensure that they are placed and operated in a manner that minimizes adverse effects to the natural environment, including anadromous fish. The weirs are positioned at or very near the downstream limit of spawning within the donor, targeted watersheds prior to the arrival of spawning adult summer chum, to minimize adverse effects to summer chum spawning or their critical habitat that may result from weir placement and operation.

The Hamma Hamma program does not use a fish weir to collect broodstock, but employs mobile collection methods that have the potential to disturb redds and summer chum in the act of spawning. Snorkelers and block seine crews used to collect broodstock for the Hamma Hamma project avoid walking on redds to the extent feasible while collecting broodstock, and care is taken to avoid disruption of summer chum and chinook salmon in their redd building activities. Adverse effects on juvenile summer chum may occur through this operation, but those effects are minimized through the above measures.

The USFWS Quilcene NFH broodstock collection operation relies on summer chum adults secured in Quilcene Bay, where they are incidentally captured in coho salmon-directed commercial net fisheries, and from fish volunteering to the hatchery. Adverse effects on natural juvenile summer chum from this program are unlikely, as the actions are removed from critical habitat where juvenile summer chum (eggs) are present. No adverse effects on listed chinook salmon juveniles are likely, as there is no self-sustaining chinook salmon population in the Big Quilcene River.

Operations collecting summer chum broodstock using fish weirs are not likely to adversely affect juvenile summer chum or their critical habitat, and self-sustaining listed chinook salmon populations are not present in any of the streams where the weirs are operated.

b) Adult summer chum and chinook salmon

The proposed broodstock collection projects are operated for the primary purpose of obtaining a sufficient number of summer chum salmon adults for the supplementation and reintroduction efforts. Summer chum salmon encountered above the number needed for broodstock are released (fish weirs and Quilcene Bay beach seining) or not collected (Hamma Hamma operation). The only broodstock operation considered in this Opinion that may potentially affect listed chinook salmon is the Hamma Hamma program. Weirs proposed for use are placed near the stream mouths, where the majority of the in-migrating adult summer chum return are encountered. The weirs are attended full time to protect captured fish from poaching and predation. The traps are checked at least daily to monitor fish arrivals, and to insure that the fish are not held for excessive durations. Captured fish are gently removed and passed upstream if surplus to daily adult broodstock collection needs. These measures minimize the risk that migrating listed salmon are delayed significantly in migration, injured as a result of the weir or during trapping, or compromised in the ability to continue their migration and to successfully spawn.

Adult summer chum salmon encountered in Quilcene Bay beach seine operations are removed immediately from the seines and released if not needed by attending USFWS staff as broodstock. The fish are not delayed in migration through this practice. When USFWS staff are not in attendance, tribal and state fishers are required to release all summer chum salmon adults encountered during coho salmon-directed fisheries. Incidental mortalities of summer chum salmon occur in this fishery, but levels have been within acceptable limits set under SCSCI harvest management guidelines.

Summer chum salmon adults are selectively taken as broodstock during operations on the Hamma Hamma River, up to a daily collection limit set by the co-managers. Summer chum salmon not needed as broodstock are therefore left unharmed by the hook and line collection operation. If collected in block seines, surplus summer chum are released immediately by staff attending the net. These same protocols apply to chinook salmon encountered during the Hamma Hamma broodstock collection effort. The Hamma Hamma program may contact listed chinook salmon adults incidental to the collection of summer chum. WDFW and LLTK staff estimate that the incidental handling impact may be up to 75% of returning chinook adults to the river, or 23 chinook assuming recent year average return levels. In addition, up to10 more chinook adults may be handled if they are intercepted in the block seine used for the summer chum broodstock collection. Actual effects on chinook salmon are expected to be minor. The selective nature of the methods employed (hand capture of summer chum by snorkelers, and using block seines), and conduct of the program in the lower river in areas removed from spawning areas predominantly used by natural chinook salmon minimize the risk of adverse effects.

Removal of adults from the spawning population

a) Juvenile and adult summer chum and chinook salmon

Protocols for collecting adult summer chum for use as broodstock, including annual trapping levels and measures that are implemented to reduce impacts to the donor populations, are specified in the HGMPs for each project, and in the SCSCI (WDFW and PNPTT 2000). No impacts to listed chinook salmon will occur as a result of the removal of summer chum adults from the naturally spawning populations.

Following HGMP and SCSCI protocols, operation of all programs is limited to three chum salmon generations, or 12 years, to limit the risk of adverse effects to the founding populations. Adult summer chum are collected so that they represent an unbiased sample of the naturally spawning donor population with respect to run timing, size, age class, sex ratio, and any other traits identified as important for long term fitness. Special emphasis is placed on ensuring that the age group structure and sex ratio of collections are as similar as possible to adult returns of the founding population. All of the above measures help insure that the short and long term risks of inadvertent and intentional selection effects on the donor, natural summer chum population are minimized. Also, for populations greater than 200 spawning adults, maximum collection levels have been set to allow for at least 50 % of escaping fish to spawn naturally each year to minimize broodstock removal effects on the donor populations. For populations greater than 100, but less than 200 spawning adults, a maximum broodstock collection level of 50 spawning pairs was proposed. For small populations (populations less than 100 spawning adults), no maximum collection proportion is set by the co-managers as an emergency measure to prevent extirpation. At this time, this emergency measure is applied within the Lilliwaup program, and recently, the Jimmycomelately programs only. Both of these stocks were identified as at high risk of extinction (WDFW and PNPTT 2000), warranting procurement of 100 % of the spawning adult populations.

Actual, average summer chum broodstock removal levels, as proportions of the average total escapement to the donor summer chum streams, are presented in Table 8. The average percentages of the total 1995-98 average escapement of summer chum removed for use as broodstock ranged from 9.6 % for the Quilcene NFH program, to 28.3 % for the Lilliwaup project.

Proposed annual broodstock collection levels for the program by sex are 250 male (200 from the bay fishery and 50 from the hatchery rack) and 250 females (200 from the bay fishery, 50 from the hatchery rack). Assuming near future returns to the Big Quilcene River will fall within the recent year (1995-98) average natural escapement levels of 5,523, the proposed annual collection of 500 summer chum adults as broodstock will result in the removal of 9.0% of the escaping population. From Table 8, an actual, annual average of over 90 % of the total return of Quilcene stock summer chum have been allowed to spawn naturally during operation of the supplementation program. At these low percent removal levels, considering protocols applied to minimize harm to natural summer chum adults and adult fish brought into the hatchery (USFWS 1999a and "Proposed Actions" section), and taking into account the lack of listed Puget Sound chinook in the Quilcene area, the USFWS program provides adequate safeguards to listed fish.

The Hamma Hamma summer chum program proposes to remove 50 to 100 summer chum adults each year as broodstock at current run sizes, or approximately 13 % to 27 % of the total escaping summer chum population, assuming 1995-98 average levels (374 adults). The Salmon Creek program may remove up to 240 adult fish as broodstock for the Salmon Creek supplementation and Chimacum Creek reintroduction efforts. Assuming that the recent year (1995-98) average total Snow/Salmon stock escapement of 936 fish reflects expected, near future return levels, the Salmon Creek program will result in the annual removal of 26 % of the returning population. As noted above, the critical status of the Lilliwaup and Jimmycomelately populations may led to the annual removal of 100 % of the returning populations, as an emergency measure to forestall extirpation. WDFW proposes to remove 76 adults from the Union River for use as broodstock in a new supplementation program commencing in 2000. The removal of 76 adult fish from the Union River equates to 15 % of the recent five year (1994-1998) average escapement of 517 fish (WDFW and PNPTT 2000). Future broodstock removal levels that are applied at Big Beef Creek to create a localized broodstock will depend upon the success of the reintroduction effort. Assuming a proposed annual fry production goal to meet desired stream seeding numbers of 103,000 fed fry (Table A3.1 from WDFW and PNPTT 2000), approximately 100 adult summer chum will be removed from Big Beef Creek to sustain production. In the interim, broodstock necessary to sustain the Big Beef Creek program are secured through the Quilcene NFH program. The first adult summer chum returns to Chimacum Creek as a result of reintroduction were observed in 1999 and 2000, and broodstock removal plans using localized broodstock to supplant Salmon Creek transfers are uncertain. The SCSCI includes a fed fry release level of 86,000 in order to create a desired return of 700 adults to the creek. Approximately 76 adult summer chum would be needed to produce this number of fry each year, assuming a 1:1 sex ratio and a fecundity of 2,500 eggs per female.

From Table 8, approximately 82 % of the Hamma Hamma stock, 89 % of the Snow/Salmon stock, and 72 % of the Lilliwaup stock have been allowed to spawn naturally during the actual operation of the WDFW-Co-op group supplementation programs directed at these stocks. Broodstock removal levels for these programs, with the exception of the Lilliwaup and Jimmycomelately programs directed at critical stock recovery, are expected to remain low relative to total return sizes.

Additional, proposed measures designed to protect listed summer chum adult populations during broodstock collection include protocols for the removal of spawners for reintroduction programs for streams where summer chum have been extirpated. Donor broodstock may be available for use for reintroductions *if* escapement to the donor stream will: 1) meet an identified spawner escapement objective, 2) provide the egg-take needs of any on-going supplementation program operating in the donor stream; and 3) provide a minimum of 25 pairs required for a reintroduction program.

Table 8. Actual summer chum adult broodstock removal levels as a proportion of total natural escapement in Hood Canal summer chum ESU streams (1995-98 averages).

Project	Natural Escapement of Donor Stock	Broodstock Removal Level	Percent Removed
Quilcene NFH (includes Big Beef)	5,523	586	**9.6 %**
Hamma Hamma 1/	374	23 1/	**17.5 %** 1/
Lilliwaup	33	13	**28.3 %**
Salmon Creek (includes Chimacum)	768	98	**11.3 %**
Jimmycomelately 2/	103	**2/**	**N/A**

1/ Broodstock removal and percent of total return averages are for 1997 and 1998 only (project initiated in 1997).
2/ The Jimmycomelately project was initiated in 1999.

Based on the type and location of the broodstock collection operations, and risk minimization measures implemented as specified in the HGMPs for each of the programs, it is unlikely that the broodstock collection actions will adversely affect listed summer chum or chinook salmon or their designated critical habitat, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the listed summer chum or chinook salmon ESUs or their ability to reproduce in the wild.

c. Genetic Effects

Reduction in genetic variability among and within populations, and domestication effects

Drawing from generic hatchery effect issues presented in Section V.A.3., there is a potential for adverse population genetic effects through the proposed programs. Specifically, remaining locally adapted, natural-origin summer chum populations in the region could potentially be replaced by a smaller number of relatively homogenous populations as a result of supplementation. In addition, the inability to differentiate between natural-origin and supplementation program-origin summer chum adults could prevent identification of potential among (through straying) and within (through disproportionate hatchery-origin fish returns) population diversity reduction risks.

The co-managers conducted a hazard assessment process directed at each summer chum stock that included evaluation of factors that might lead to an increased genetic risk by the proposed supplementation and reintroduction programs (WDFW and PNPTT 2000). For projects proposed under the SCSCI, the likelihood for genetic hazards was determined by considering genetic risk minimization criteria defined in the plan. Judgements were then made regarding the probability that each criterion will be met, given the plan's risk aversion guidelines. A specific criterion was assigned a "high" probability estimate where the project, or the procedure required by the criterion, is well understood and there was certainty that the resources and knowledge were available to meet the criterion. A "moderate" probability was assigned where there was less certainty that the resources or knowledge is, or would be, available. Finally, when there was a high level of uncertainty that risk minimization criteria could be met, a "low" probability ranking was assigned. The following effects analysis addresses instances where the co-managers found moderate or low probability of meeting a genetic risk minimization criterion (from the SCSCI (WDFW and PNPTT 2000)).

a) Juvenile and adult summer chum salmon

For the USFWS Quilcene NFH, a moderate probability of successfully monitoring marks and thus identifying origin of returning spawners was identified by the co-managers in the SCSCI. A moderate ranking was assigned because a marking program had not yet been fully implemented. This indicated a moderate risk for the potential genetic hazard of reduction in effective population size (within population diversity reduction). Identification of hatchery fish straying levels into adjacent watersheds, potentially leading to among population reduction effects, was also a concern. The USFWS and WDFW have since implemented a program to monitor the Quilcene watersheds and adjacent Hood Canal streams for the incidence of externally marked summer chum (all Quilcene NFH summer chum are marked as juveniles with an adipose fin clip) (USFWS 1999a). This mark recovery program allows for monitoring of hatchery and natural-origin fish proportions and stray rates in natural spawning areas. This program will also allow monitoring of hatchery fish proportions in annual broodstock collections to assess, and allow for responses to, the risk of effective population size reduction. The SCSCI genetic risk assessment indicated a high probability of meeting all other criteria at Quilcene NFH to avoid genetic hazards (WDFW and PNPTT 2000).

For the Lilliwaup Hatchery summer chum salmon supplementation program, the co-managers' risk assessment indicated a high to moderate probability of meeting most criteria to avoid genetic hazards. The exception was the low probability of success determined for the detection of

straying fish, owing primarily to lack of current resources for adequate sampling to detect straying. This potential hazard is being addressed as a proposed action through implementation of mass marking and mark recovery programs by the co-managers (LLTK 1999d). Also, the critically low abundance status of the Lilliwaup population, and the watershed's distance from adjacent summer chum streams, minimize the level of concern for straying, and potential among population diversity reduction effects, as a result of this recovery program.

The co-managers identified significant problems with collecting broodstock and potentially with sampling spawners for marks in the Hamma Hamma Hatchery program. Also, broodstocking goals were not met for brood years 1997 and 1998; the first two years of the project. This situation poses a high risk for: 1) project failure in general (not able to effectively collect broodstock); 2) the genetic hazard of reduction in effective sample size (where a small, non-representative component of the population is enhanced because broodstocking objectives are not met); and 3) the genetic hazard of domestication (where the monitoring of traits to assess project effects is affected). Problems identified regarding broodstock collection are being addressed by WDFW and its co-operators, beginning with brood year 1999. LLTK and WDFW are applying measures that will lead to the collection of broodstock at goal levels, and representative of the native run at large. Monitoring and evaluation of the genetic effects of the program are also being implemented. These operational changes necessary to minimize the risk of adverse genetic effects have been included as part of the proposed action for the Hamma Hamma summer chum salmon supplementation program (LLTK 1999b).

For Salmon Creek Hatchery, the probabilities for meeting genetic risk reduction criteria set by the co-managers were generally ranked as high. The exceptions were for the proportion of hatchery-origin fish on the spawning grounds (difficult to control) and for the detection of hatchery-origin fish straying. To respond to these potential risks, the co-managers have included, as part of the proposed actions, a program to monitor and evaluate hatchery fish straying and incidence in natural spawning areas. These measures include marking of all hatchery summer chum and a program to recover marked chum in Salmon Creek and in adjacent spawning areas (WDFW 2000b). Limitation of the Salmon Creek supplementation program to a 12 year duration (through the 2003 brood year) should minimize genetic diversity reduction risks associated with potential high proportions of supplementation program summer chum in natural spawning areas.

The new Jimmycomelately supplementation program was generally given high and moderate probabilities of success for meeting genetic risk criteria. Some moderate ratings were assigned because project design and planning had not yet been completed for the project at the time of the SCSCI assessment, and therefore uncertainty existed regarding some criteria. A single low probability rating was assigned in the SCSCI regarding detection of hatchery fish straying, owing to currently inadequate sampling capability. This measure is being addressed as a proposed action (WDFW 2000d) through implementation of mass marking and mark recovery programs. Also, the critically low abundance status of the Jimmycomelately population, and lack of adjacent summer chum streams, minimize the level of concern for straying effects as a result of this recovery program.

The proposed Union River supplementation project was judged within the SCSCI to have a moderate to high probability of avoiding most genetic hazards. The exceptions were future determination of the proportion of hatchery-origin fish on the spawning grounds (difficult to control) and the detection of hatchery-origin fish straying (there is currently an inadequate surveying capability). The co-managers have proposed to address these concerns through mass marking of the hatchery-origin summer chum, recovery and evaluation of marked fish in natural spawning areas, and limitation of the supplementation program to a 12 year duration (WDFW 2000e).

The SCSCI defines broodstock collection and spawning, incubation, juvenile fish rearing, and smolt release procedures that are being applied in all summer chum hatchery programs to maintain genetic characteristics of the natural, founding summer chum populations. An objective of supplementation proposed under that plan is to maintain existing diversity among the region's summer chum populations. Diversity-based management measures are being implemented to meet this objective for each of the supplementation programs proposed. These measures respond to the genetic risks identified for each of the projects above, and will generally minimize the likelihood for inbreeding and outbreeding depression and potential negative effects on natural-origin fish fitness.

The co-managers and the USFWS propose to minimize the risk of loss of genetic variability between populations, and the potential for and consequences of outbreeding depression, through application of the following measures (from WDFW and PNPTT 2000):

1. All supplementation programs will propagate and release only the indigenous summer chum population;
2. The transfers of each donor stock for reintroduction are limited to only one target watershed outside of the freshwater spawning range of the donor stock to avoid the situation that one or few stocks within the ESU predominate;
3. Supplemented and reintroduced populations are acclimated to the watershed desired for out-planting to insure that the summer chum retain a high fidelity to the targeted stream;
4. For reintroduced populations, where logistically and technically feasible and in accordance with the tenets of the SCSCI, local adaptation should be fostered by using returning spawners rather than the original donor population as broodstock if the reintroduction program is still in progress;
5. Unsupplemented populations within the ESU are recognized, representing significant proportions of the existing total abundance and diversity; and,
6. All summer chum produced in hatchery programs are marked to allow for monitoring and evaluation of adult returns. Otolith marking protocols will allow differentiation of hatchery-origin fish between programs.

The following diversity-based management methods are proposed to be implemented by the USFWS and the co-managers to reduce the potential for alteration or loss of genetic diversity within the supplemented summer chum salmon population:

7. The duration of each supplementation program is limited to a maximum of three chum salmon generations (~12 years) to minimize the likelihood for divergence between hatchery broodstocks and target natural stocks;
8. Adults for broodstock are collected so that they represent an unbiased sample of the naturally spawning donor population with respect to run timing, size, age, sex ratio, and any other traits identified as important for long term fitness. Special emphasis is placed on ensuring that the age group structure and sex ratio of collections are as similar as possible to those of adult returns of the founding population for the given week of the run;
9. Returning adults produced by a supplementation program are used, with natural chum, as broodstock over the duration of the program (9 years post initial return of three year olds). The three generation limit for the duration of a program is intended to address the concern that repeated enhancement of the same population segment will result in a decrease in effective population size. It also limits to a few generations, the exposure of natural fish to the potentially deleterious selective effects of hatchery conditions (i.e. domestication effects);
10. Spawning protocols, including collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of at least 1:1 male-female mating schemes, and avoidance of intentional selection for any life history or morphological trait are applied to help insure that hatchery broodstocks are representative of natural stock diversity. Spawning protocols applied, including factorial mating methods, will equalize as much as possible the contributions of parents to the next breeding generation;
11. Minimum broodstock collection objectives are set to allow for the spawning of the number of adults needed to minimize loss of some alleles and the fixation of others. Maximum collection levels are set to allow for at least 50 % of escaping fish to spawn naturally each year (populations > 200). For small populations, no maximum is set as an emergency measure;
12. Hatchery methods will mimic the natural environment to the extent feasible (e.g., use of substrate during incubation and exposure to ambient river water temperature regimes during rearing). Post swim-up rearing is limited to a maximum of 75 days, to minimize the level of intervention into the natural chum life cycle, ensuring that the potential for domestication selection is minimized; and
13. All summer chum produced in hatchery programs are marked to allow for monitoring and evaluation of adult returns. Otolith marking protocols will allow differentiation of hatchery-origin fish between programs.

Intervention into the natural summer chum life cycle, as proposed in the summer chum supplementation programs, will levy some measure of genetic risk to the natural populations. The most egregious action, pertaining to the proposed removal for use as broodstock of up to 100 % of certain natural populations that appear to be on the verge of extirpation, may lead to significant genetic changes in the founding populations. These changes may include a reduction in effective population size, leading to the loss of genetic diversity and, perhaps, fitness of the population to survival environmental fluctuations (Busack and Currens 1995). Potential adverse

effects associated with domestication are also a concern, as the entire population is brought under an artificial propagation regime.

For summer chum salmon populations on the verge of extinction chosen for aggressive supplementation actions (i.e., allowances for up to 100% broodstock removal), there are unavoidable risks of adverse genetic effects. NMFS considers the risks acceptable because without the supplementation programs, the targeted summer chum populations are not likely to survive. Also, the above described risk minimization measures applied by the co-managers during operation of the supplementation programs will lessen the risks of adverse genetic effects. As identified in Section III ("Species Status"), Section II ("Proposed Actions"), and in "Appendix A," the summer chum stocks that are proposed for supplementation are at moderate or high risk of extinction. At the time when the programs were first proposed, total summer chum spawning escapements within the ESU had declined to under 1,000 by the early 1990s, and two additional stocks (Tahuya River and Dewatto River) were recently extirpated. Total returns of several key stocks within the ESU had declined to just a few individuals (e.g., the 1988-91 average for Quilcene stock was 45 fish, and 154 for the Hamma Hamma stock).

The supplementation and reintroduction programs are necessary to boost the abundance of adult spawner returns for stocks comprising the ESU, preventing further extirpations. In particular, the Lilliwaup and Jimmycomelately populations are currently at extreme risk of extirpation. Average escapements for these stocks between1996-99 averaged under 50 fish, with escapements in two years within this span under 10 fish. These stocks are unlikely to persist on the short term without supplementation. In addition to preserving and recovering the stocks, operation of the summer chum supplementation programs as proposed in the HGMPs, and consistent with protocols defined in the SCSCI, should minimize the likelihood for adverse genetic effects to natural summer chum, and summer chum under propagation.

Based on currently available information, NMFS believes that implementation of these risk minimization measures (summarized above), and, in particular, the proposed limitation on the duration of the supplementation programs to 12 years, are likely to decrease the likelihood for significant, adverse genetic effects to the founding populations. It is unlikely that the proposed actions will adversely affect listed summer chum, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the listed summer chum ESU or the ability of its component populations to reproduce in the wild.

d. Disease

Fish disease incidence and transmittal

As discussed previously in Section V.A.4.. ("Disease"), fish hatchery practices may adversely affect natural-origin fish brought into the hatcheries for propagation, or fish rearing or migrating in the natural environment, through fish disease pathogen amplification and disease transfer. Of concern for the hatchery programs evaluated in this Opinion are the effects of fish disease on listed summer chum salmon or chinook salmon, including acute and chronic mortality, as a result of hatchery summer chum salmon production.

a) Juvenile summer chum and chinook salmon

Risks of fish disease incidence in the propagated summer chum populations, and transmittal to listed natural-origin fish may be posed by the projects. These risks may occur while juvenile summer chum are under propagation in the hatchery, and through horizontal transmission of fish pathogens (if present) to natural-origin fish while the hatchery fish are under propagation, or after they are released.

Losses of swim-up fry during their earliest stage of development were reported for the Quilcene program in 1998. The cause of this loss was not positively identified, but was thought to be related to stresses to incubating fish posed by heavy sediment loads in inflowing water during a flood event. The only other losses to disease at Quilcene were in the first year of the program (1992-3), when bacterial gill disease became a problem in certain rearing vessels. Gill bacteria (*Flavobacterium brachiophilus*) are isolated from juvenile fish examined by fish health specialists every year at Quilcene, but are controlled with improved flow management (USFWS 1999a). No other significant losses of summer chum under propagation in the proposed program have been reported.

A significant loss of summer chum juveniles due to fish disease during propagation occurred for Snow/Salmon stock summer chum reared for reintroduction to Chimacum Creek in 1997. Significant losses in this program were experienced due to bacterial gill disease that year, as a consequence of low water availability at the hatchery relative to the number of fish under propagation (WOS 1997). The program was moved to another, more suitable location since that incident, where flow volumes are sufficient to meet pond loading criteria necessary to avoid bacterial gill disease.

The other annual summer chum hatchery projects administered by WDFW and USFWS have been conducted without diseases epizootics that led to significant fish losses.

The proposed WDFW and USFWS summer chum hatchery programs comply with guidelines defined in the SCSCI for the production of healthy fish (Appendix Report 3.1 in WDFW and PNPTT 2000). These guidelines include egg incubation and fish rearing density levels that minimize the risk of fish disease out-breaks. Feed application rate levels are also included in the plan, defining maximal rates for the prevention of bacterial gill disease in rearing fry populations. The proposed supplementation and reintroduction projects also comply with "Salmonid Disease Control Policy of the Fisheries Co-managers" guidelines (NWIFC and WDFW 1998). These guidelines define rearing, sanitation, and fish health practices that minimize the incidence of disease outbreaks in propagated juvenile populations, thereby decreasing the risk of fish pathogen transmission to co-occurring natural-origin juvenile summer chum and chinook salmon populations. Fish are monitored daily during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. Preferred and maximum pond loading and feeding parameters specified in the SCSCI are adhered to at all times. All hatchery-origin summer chum are examined by a WDFW or USFWS fish health specialist within three weeks prior to release to certify disease status and health

condition. The propagation and release of viable, healthy summer chum fry is promoted through compliance with these fish health maintenance guidelines.

b) Adult summer chum and chinook salmon

The potential occurrence of fish disease transmission from hatchery-origin summer chum to natural adult summer chum may be of concern if diseased fish are spawned in the hatchery, potentially leading to amplification of disease in the extant natural and hatchery populations. An additional concern is the horizontal transmission of fish disease from summer chum held or propagated in the hatchery to listed natural summer chum and chinook adults downstream of the hatchery, if diseased juvenile fish are being propagated.

The causative agents for furunculosis (*Aeromonas salmonicida*) and bacterial kidney disease (*Renibacterium salmoninarum*) are commonly isolated from returning summer chum adults at Quilcene NFH, but have not been isolated from hatchery-reared juveniles. Monitoring of '99 brood summer chum spawned at Quilcene NFH indicated the presence of infectious hematopoietic necrosis virus (IHN), a regulated pathogen under the co-managers' policy. As a result of this finding, all egg lots having the potential to have originated from an infected spawner were quarantined. Transfers of Quilcene eyed eggs to Big Beef Creek in 1999 were limited to only those proven to be negative for this disease. All other monitoring of the incidence of regulated pathogens in summer chum adults used as broodstock for the programs has shown no incidence of disease.

To reduce the likelihood for the amplification of fish disease, the incidence of viral pathogens in all summer chum collected for broodstock is determined by sampling fish at spawning in accordance with procedures set forth in the "Salmonid Disease Control Policy of the Fisheries Co-managers" (NWIFC and WDFW 1998). Ovarian fluid, kidney, and spleen samples are collected from a representative sample of the total number of fish spawned for evaluation by WDFW Fish Health Division or USFWS staff for disease certification purposes. Compliance with monitoring and disease control response measures set forth in the co-managers' disease control policy, and as called for in the SCSCI, minimizes the likelihood for transmission of fish disease to natural-origin summer chum and chinook adults.

Based on currently available information, it is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon through disease effects, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the listed summer chum or chinook salmon ESUs or their ability to reproduce in the wild.

e. Competition/Density-Dependent Effects

Specific competition/density-dependent effects

Drawing from generic hatchery effects described in Section V.A.5. ("Competition/Density Dependent Effects"), fish produced in hatcheries may adversely affect natural-origin fish as a result of competition for food resources or habitat. Of concern for the hatchery programs evaluated in this Opinion are the potential effects, including injury and mortality, of hatchery-

origin summer chum salmon competition with listed natural-origin summer chum salmon or chinook salmon for food in nearshore marine areas during juvenile fish emigration. Also of concern are potential effects, including injury and mortality, resulting from hatchery summer chum salmon adult competition with natural-origin adult summer chum salmon for spawning locations.

a) Juvenile summer chum and chinook salmon

SIWG (1984 - see Tables 3 and 4) reported a low risk that competition between juvenile hatchery chum salmon and natural-origin chum and chinook salmon in freshwater will have a significant negative impact on the productivity of the natural-origin salmon. For early marine life, a high risk of adverse competitive impacts between hatchery-origin chum and natural-origin chum and was assessed, although risks to chinook salmon were still rated as low (SIWG 1984).

Simenstad et al. (1980) hypothesized that limited prey resources and inadequate foraging success in the Hood Canal estuary were responsible for higher mortality rates for the earliest emigrating chum fry relative to later migrating fall chum stocks. They also suggested that even expanded populations of zooplankton present later in the Hood Canal chum fry emigration period could be over-exploited given high enough densities of juvenile chum salmon. Analysis of historical Hood Canal hatchery fall chum and natural-origin summer chum production and abundance data summarized by WDFW (1997) indicated the speculative nature of judgements regarding the competitive effects, either positive or negative, of hatchery-origin chum fry releases on summer chum fry survival. Hatchery fall chum releases in Hood Canal during the summer chum emigration period (pre-April 1) in some recent years likely exceeded the probable numbers of natural-origin summer chum salmon fry that resulted in any one year from escapements that have occurred between 1968 and 1996. This was especially true for brood year 1992, when early releases of fall chum salmon from the Hood Canal hatcheries totaled 28.6 million fry, compared to an estimated summer chum fry emigration of 420,000. If adverse competitive impacts to summer chum result from fall chum releases, hatchery fall chum fry production of brood year 1992 should have had the greatest, most observable impact on summer chum success of any year in the WDFW data base. However, the 1992 brood year summer chum were highly productive, making up the majority of adults in the large returns to Hood Canal in 1995 and 1996 (WDFW and PNPTT 2000). Although carrying capacity studies are needed to reach a more informed conclusion, the above suggests that the hatchery fall chum releases had minimal, if any, adverse effects on summer chum survival.

A key production strategy of the programs evaluated in this Opinion is to mimic natural life history characteristics by releasing fed summer chum fry from the hatcheries within the estimated natural summer chum emigration period. Through this practice, natural-origin and hatchery-origin summer chum fry will overlap in emigration timing in the action area.
The risk that supplemented chum will compete with natural-origin summer chum fry for food after release is minimized by the co-managers through the release of hatchery fish at a larger size (averaging approximately 56 mm FL) than the natural-origin fry (35-39 mm FL range). Larger (>50 mm) chum fry have been shown to prey predominately on pelagic organisms in Hood Canal, whereas newly emerged, smaller chum fry feed on epibenthic organisms in the estuary

(see Appendix A). Larger hatchery-origin chum have also been shown to migrate and forage within a different estuarine realm (offshore) than natural-origin fry, which initially migrate in very shallow nearshore areas (as summarized in Appendix A). These differential migration behavior patterns have been reported in beach seine and tow net studies conducted in Hood Canal throughout the February through June summer and fall chum emigration periods (Schreiner 1977; Bax et al. 1978; Bax et al. 1979; Bax et al. 1980). Spatial separation between the larger hatchery chum and smaller natural-origin fry minimizes the likelihood for competition for food between hatchery-origin and natural-origin chum fry during emigration.

As indicated in the following table, average release dates and individual fish sizes for the hatchery summer chum programs have generally complied with target size and release timing criteria defined in the SCSCI. These criteria are designed to maximize survival, while minimizing the risk of adverse competitive effects to natural-origin summer chum (USFWS 1999a; LLTK 1999a; 1999b; WDFW 2000a; 2000b; 2000c; 2000d). The Chimacum program retains a goal of 1.0 gram average release size, but fish have been released at a smaller size as a fish health maintenance and disease aversion measure during the initial two years of operation.

Program Averages	Quilcene	Lilliwaup	Hamma	Big Beef	Salmon	Chimacum	JCL
Fish Size (gms)	1.27	1.0	1.0-1.5	0.96	1.3	0.6	1.0
Release Date	April 1	March	March	Feb-March	April 14	April 8	-

b) Adult summer chum and chinook salmon

Hatchery-origin adult summer chum salmon may compete with natural-origin summer chum for spawning sites or access to mates. This interaction is not negative in the context of the proposed programs, as intermixing between supplemented and natural-origin broodstock of the same stock on the spawning grounds is an anticipated and desirable outcome. This inter-mixing on the spawning grounds meets the program objective of increasing the number of naturally spawning summer chum in the region. SIWG (1984) assigned a low risk of adverse competitive or density dependent effects on listed chinook salmon adults as a result of hatchery-origin summer chum returns. The risk of adverse competitive effects on chinook salmon, if any, is confined to the Hamma Hamma River program.

Straying of non-indigenous, supplemented adult summer chum between watersheds, including those summer chum production areas not proposed for supplementation, is not expected to be a significant concern regarding competition. Naturally-produced chum may exhibit straying levels ranging from 2 to 46 % (Tallman and Healey 1994). However, several sources indicate that chum salmon homing to hatchery release sites is quite strong. In addition, selective breeding that may occur in hatcheries using gametes from returned migrants has been shown to result in a decrease in straying with time (Tallman and Healey 1994). Salo (1991), reporting on a 1952 study of tagged fall chum released from, and returning to, Minter Creek Hatchery in south Puget Sound, noted no strays into adjacent streams in two seasons of monitoring. Studies of fall chum released from Wolcott Slough by USFWS showed the same result, with no strays reported in

adjacent streams (Salo 1991, citing Wolcott 1978). Studies by Fuss and Hopley (1991) corroborated the above work indicating the high fidelity of chum salmon to their stream of origin, finding that over five consecutive brood years, an extremely small percentage of returning adult coded wire tagged fall chum released from Hoodsport Hatchery strayed to streams adjacent to the release site. Out of 6,600 tagged fish recovered over the five brood years studied, only 4 were recovered in Hood Canal streams outside of the hatchery. None of the tagged fish released at Hoodsport Hatchery during this study were recovered at other adjacent southwest Hood Canal hatcheries producing fall chum salmon (Enetai, McKernan, and George Adams). Recoveries of adipose clip marked adult summer chum released in 1993 (USFWS 1999a) and 1997 (T. Johnson, WDFW, pers. comm.) from Quilcene NFH indicated that the fish have a low tendency to stray to other Hood Canal tributaries where they might pose a risk to the indigenous stocks.

Summer chum adults resulting from the proposed programs are of the same stock as natural spawners in the river, and are produced for the purpose of augmenting the naturally spawning population. Competition between natural and hatchery-origin fish for suitable spawning sites and mates on the spawning grounds is therefore not a risk factor. Summer chum salmon produced through the programs are acclimated to the streams where they are released, and likely pose an insignificant risk of adverse competitive effects to non-supplemented populations in adjacent watersheds through straying. Of the proposed programs, the Hamma Hamma supplementation program is the only summer chum release project sited on a river where an indigenous self-sustaining chinook population may be present. The large amount of suitable spawning habitat available in the river, and resource partitioning anticipated during spawning by the two species, decrease the likelihood for adverse competitive effects, including redd superimposition and competition for spawning sites.

It is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon through competitive effects, so as to appreciably reduce the likelihood for their survival and recovery. Any adverse effects are likely to be short term and limited so as not to reduce the abundance of the listed summer chum or chinook salmon ESUs or their ability to reproduce in the wild.

f. Predation

Specific predation effects

As discussed previously in Section V.A.6. ("Predation"), fish produced in hatcheries may adversely affect natural-origin fish by preying on co-occurring natural-origin fish, or by attracting fish predators to areas where hatchery and natural-origin fish intermingle, increasing the risk of predation to the natural-origin fish.. Of concern for the hatchery programs evaluated in this Opinion are the potential effects, including injury and mortality, of hatchery-origin summer chum salmon predation on listed natural-origin summer chum salmon or chinook salmon. Also of concern are potential enhanced predation effects, including injury and mortality, to listed summer chum and chinook salmon resulting from attraction of salmon predations such as harbor seals to migration areas where hatchery and natural-origin adult summer chum salmon and listed chinook salmon cooccur.

a) Juvenile summer chum and chinook salmon

SIWG (1984 - see Tables 5 and 6) determined that there is a low risk that predation by hatchery-origin chum salmon will adversely affect the productivity of natural-origin salmon populations. Chum salmon are opportunistic feeders, and may prey on fish as sub-adults when in the ocean (Salo 1991) and outside of the action area. However, predation on natural-origin chum fry or chinook salmon juveniles by juvenile, supplemented summer chum released at the life stage and time proposed by the agencies is an unlikely event during their fresh or marine area emigration period in the action area. Juvenile chum salmon emigrating from Hood Canal at a size indicative of rearing and origin from a hatchery (> 45 mm FL) generally feed upon neritic zooplankton in open water areas, and fish of any life stage have not been shown to be an important prey item (Simenstad et al. 1980). In addition, salmonid predators prey on food items less than or equal to one-third of their length (Witty et al. 1995). The average size range for supplemented fed chum fry liberated at 390 to 450 fpp is 50 to 53 mm (Fuss 1997), compared to a size of 37 to 41 mm for newly emerged and migrating natural-origin summer chum fry (Bakkala 1970). The release of summer chum juveniles at a target average size of 53 mm (or 1.0 gram average size) as called for in the SCSCI will help insure that predation on natural-origin fry remains highly unlikely.

Proposed juvenile release levels from each summer chum program are of a small magnitude (generally less than 100,000 fed fry per year) relative to the area into which the fish are being released (the marine waters of Hood Canal or the Strait of Juan de Fuca). Monitoring by the USFWS indicates that the hatchery-origin fish leave freshwater areas where they might intermingle with natural-origin fish within hours post-release (USFWS 1999a). Also, due to their larger size, hatchery-origin fed fry will not likely migrate in the same estuarine areas as natural-origin fry (see life history information presented in Appendix A). Given small release numbers, observed fast hatchery fish emigration, and night-time fish release practices, it is unlikely that the release of hatchery summer chum will lead to an attraction of predators to natural-origin fish.

b) Adult summer chum and chinook salmon

In recent years, summer chum predation by harbor seals (*Phoca vitulina*) in Hood Canal has received increased attention by wildlife and fish managers as a potential factor for decline. Studies have been implemented to assess the impacts of pinniped predation on summer chum adjacent to many of the major summer chum production streams in Hood Canal. Preliminary results of these studies show that the present, high abundance of harbor seals in Hood Canal, and substantial levels of adult salmon predation by these animals at the mouths of summer chum streams when the fish return to spawn, may indicate that harbor seals are an important factor that could slow recovery of the listed ESU. The extent to which the summer chum hatchery-based recovery programs may affect, either positively or negatively, existing predation levels is unknown. Further study is needed regarding the actual effects of harbor seal predation on the summer chum populations to gauge whether or not the hatchery programs are contributing indirectly to predation. Given low summer chum population numbers, and static numbers of harbor seals consuming summer chum salmon (S. Jeffries, WDFW pers. comm.), increased numbers of summer chum adults produced by the supplementation and reintroduction programs

may buffer predation effects on the natural-origin populations by providing an alternative prey source.

Based on the low likelihood for predation by hatchery-origin summer chum on listed juvenile fish, NMFS believes that it is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon, so as to appreciably reduce the likelihood for their survival and recovery, as a result of predation. Any adverse effects resulting from indirect predation effects (e.g., harbor seal attraction) are likely to be short term and limited so as not to reduce the abundance of the listed summer chum or chinook salmon ESUs or their ability to reproduce in the wild.

g. Residualism

The generic effects of hatcheries on the tendency of salmon to residualize, and the adverse effects of residualism, including increased risks of predation and competition, to natural-origin fish, are discussed in Section V.A.7. Drawing from this section, of concern are the effects, including natural-origin fish injury and mortality, of the proposed summer chum salmon programs in increasing the propensity of summer chum juveniles to residualize in listed summer chum and chinook salmon rearing areas.

Specific risks of residualism effects

a) Juvenile and adult summer chum and chinook salmon

Residualism, or the tendency of summer chum salmon to remain and rear in the immediate area of the hatchery release area after liberation, could, if it occurred, possibly pose an elevated risk of predation effects to listed juvenile salmon. However, any adverse effects from residualism would only be of concern if sub-adult summer chum were piscivorus, and if the hatchery fish remained in the action area for a full year post-release, when there would be a potential for interaction with smaller, emigrating natural salmon juveniles that might be vulnerable to predation in the estuarine or marine areas of Hood Canal or the Strait of Juan de Fuca.

Johnson et al (1997) cited studies of juvenile chum salmon captured and tagged in June in central Puget Sound indicating that juveniles moved northward to the Strait of Georgia and the west coast of Vancouver Island shortly after release. In the same studies, some juvenile chum salmon tagged in central Puget Sound and Hood Canal in June remained in nearshore marine waters in central Puget Sound and Hood Canal beyond the usual time of ocean migration, although the extent of any residualism was unclear. Genetic analysis of large chum salmon juveniles collected in central Puget Sound during the summer months in subsequent years that appeared to be delaying their migration indicated that all of the fish originated from late-timed fall and winter chum stocks (J. Shaklee, WDFW, pers. comm.). It is surmised that because late fall and winter chum enter the estuary the latest of the Puget Sound populations, enhanced productivity present in Puget Sound commensurate with this late emigration timing increased the likelihood that fry from those stocks would remain in Puget Sound marine waters to rear.

There is no information that indicates that summer chum salmon, either hatchery or natural origin, residualize in freshwater or marine waters to any extent within the action area. Natural-

origin juvenile summer chum spend little time in freshwater areas after emerging (Appendix A). Similarly, summer chum salmon juveniles emigrate seaward soon after liberation from the summer chum hatchery programs. Studies by the USFWS in the Big Quilcene River showed that summer chum released en masse from the Quilcene NFH at RM 2.8 vacated the river in eight to twelve hours (USFWS 1994). Seaward emigration for chum salmon fry during March and April in Hood Canal marine areas also has been shown to be rapid (see Appendix A for life history information), and not indicative of any tendency to remain within Hood Canal.

Based on the best available information, NMFS believes that it is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon, so as to appreciably reduce the likelihood for their survival and recovery, as a result of hatchery-origin summer chum salmon residualism.

h. Fisheries Effects from Program Releases

As discussed in Section V.A.8. (generic effects discussion of "Fisheries" effects), under certain circumstances, the production of salmon by hatcheries for the purpose of fisheries harvest augmentation may indirectly lead to an increased risk to commingled natural-origin salmon. An increased incentive for hatchery-origin salmon-directed fisheries may lead to elevated fishery-related mortality of the commingled natural-origin fish. The proposed programs are conducted for conservation purposes only, and do not produce fish for the purposes of fisheries harvest.

Specific fisheries effects

a) Juvenile and adult summer chum and chinook salmon

Summer chum are produced through the proposed programs as one facet of an ESU-wide conservation plan, including hatchery, harvest, and habitat measures, aimed at recovery of the listed summer chum ESU. The primary objective of the summer chum programs reviewed in this Opinion is to supplement production of severely depleted, at-risk summer chum salmon populations, and to reintroduce summer chum into watersheds where historical populations have been lost (WDFW and PNPTT 2000).

These proposed programs are directed at recovery of the listed summer chum salmon ESU only, and are not designed to provide surplus fish for harvest in any fisheries, nor an incentive for such fisheries. NMFS therefore believes that it is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon, so as to appreciably reduce the likelihood for their survival and recovery, as a result of increased fisheries.

i. Masking

The potential for fish produced by hatcheries to mask the status of natural-origin adult salmon populations of the same species, and the adverse effects of "Masking" on the ability to appropriately manage natural stocks and their habitat are discussed in Section V.A.9. Drawing from this section, of concern is the potential inability to differentiate summer chum salmon produced through the hatchery programs from natural-origin summer chum salmon, and effects on natural-origin summer chum salmon stock status and hatchery summer chum salmon program

effectiveness determinations. The effects of masking on listed chinook salmon by the summer chum programs reviewed in this Opinion is not an issue they are a separate species.

To address the need to differentiate hatchery from natural-origin summer chum salmon, and to effectively evaluate the status of summer chum salmon adult returns, the USFWS and WDFW have implemented programs to: 1) mass mark juvenile summer chum salmon produced by the proposed programs, and 2) monitor summer chum spawning streams for the incidence of returning marked adult fish. HGMPs submitted for the eight summer chum hatchery programs reviewed in this Opinion describe on-going mass marking and mark recovery program actions. Mass marking will continue to be implemented for all of the summer chum programs, and initial marked adult returns are already being monitored for the Quilcene, Salmon Creek, and Big Beef Creek programs (e.g., WDFW 2000b).

All Quilcene NFH-origin summer chum are externally marked by USFWS staff as juveniles with an adipose fin clip to determine their contribution to the naturally spawning Quilcene population (USFWS 1999a). An adipose fish clip allows for the visual identification of returning adult fish in spawning streams. Marked Quilcene NFH fish are enumerated and recorded with total salmon counts during biweekly spawning ground surveys conducted in westside Hood Canal streams in the action area during August, September and October by WDFW Fish Program and USFWS stream survey personnel. The results of mark recovery programs for marked Quilcene NFH summer chum adult returns in westside Hood Canal streams are considered by USFWS and the co-managers to indicate the general tendency for supplementation program-origin summer chum salmon to stray (WDFW and PNPTT 2000).

All of the other summer chum hatchery programs reviewed in this Opinion differentially mark juvenile summer chum releases with an otolith mark. Thermal regulation of water used to incubate the summer chum eggs applies banding to the otolith bone. Different thermal marking regimes are employed at each hatchery to apply distinctive banding patterns to the otoliths of summer chum produced by the hatchery. The USFWS and the co-managers will use mark recovery programs for otolith marked fish to monitor hatchery and natural-origin fish proportions in returning adult populations to each supplemented summer chum watershed. Otoliths are removed from a representative proportion of dead, naturally spawned summer chum adults during regular, biweekly spawning ground surveys conducted in summer chum streams in the action area during August, September and October by WDFW Fish Program and by USFWS staff. Otoliths removed from the summer chum are read by WDFW Fish Program staff to ascertain the origin of the fish (natural or hatchery-origin). Information gathered through the mark recovery programs will improve knowledge regarding the status of the natural summer chum salmon populations in each summer chum stream, and whether the hatchery programs are effective in increasing adult summer chum return abundances.

WDFW and USFWS have developed of an effective means to differentiate hatchery fish produced in all of the summer chum salmon programs evaluated in this Opinion from natural-origin summer chum through the mass marking programs. On-going monitoring of marked summer chum return rates decreases the likelihood for hazards to the natural-origin summer

chum salmon populations associated with population status masking. NMFS therefore believes that it is unlikely that the proposed actions will adversely affect listed summer chum or chinook salmon, so as to appreciably reduce the likelihood for their survival and recovery, as a result of masking effects.

j. Monitoring and Evaluation

As discussed previously in Section V.A.11., monitoring and evaluation and research of adult and juvenile hatchery fish conducted as part of a hatchery program may adversely affect co-occurring natural-origin fish through harassment, capture, handling, or release. Of concern for the hatchery programs evaluated in this Opinion are the effects of monitoring and evaluation and research on listed summer chum salmon or chinook salmon, including injury and mortality, resulting from their incidental contact during these activities.

Monitoring and evaluation program objectives and effects

Much of the monitoring and evaluation work conducted by the co-managers involves collection and recording of biological data pertaining to fish captured, propagated, and released as part of the summer chum supplementation or reintroduction programs. These actions are not expected to affect listed chinook salmon. The "Proposed Actions" section describing the USFWS Quilcene program (Section II) thoroughly describes monitoring and evaluation work that will generally be performed within all hatchery operations, consistent with the SCSCI (WDFW and PNPTT 2000). This work is specifically directed at responding to concerns regarding the uncertainty of summer chum supplementation and reintroduction efforts. To respond to this uncertainty, the following four elements are proposed to be addressed: 1) the estimated contribution of supplementation and reintroduction program-origin chum to the natural population during the recovery process; 2) changes in the genetic, phenotypic, or ecological characteristics of populations (target and non-target) affected by the supplementation/reintroduction program; 3) the need and methods for improvement of supplementation/reintroduction activities in order to meet program objectives, or the need to discontinue a program because of failure to meet objectives; and 4) determination of when supplementation has succeeded and is no longer necessary for recovery.

Monitoring and evaluation proposed to address these four elements are directed at adult and juvenile fish already "taken" through the proposed programs, through broodstock collection, or during incubation and rearing. Actions associated with broodstock collection will include the collection of meristic, morphometric, and genetic data from summer chum adults removed for spawning. Monitoring and evaluation affecting juvenile summer chum within the hatchery will include measurements to evaluate hatchery production, such as survival, size at age, condition, fish health status, genetic makeup, and total release levels. The application of a thermal mark on the otoliths of all hatchery fish as a means to differentiate hatchery from natural fish is also included as a standard monitoring and evaluation measure. Application of a thermal mark is accomplished by adjusting, downward, water temperatures during the latter portion of the egg incubation stage, at no risk to the developing fish. Otoliths are removed for analysis from broodstock that are collected to perpetuate the programs in subsequent years. Effects on summer chum associated with these activities are not considered additional to levels previously evaluated

for other hatchery risk factors in this Opinion, and are judged as not posing additional risks of adverse effects to the listed salmon ESUs.

a) Juvenile summer chum and chinook salmon

Two of the proposed programs (Quilcene NFH and Big Beef Creek) include monitoring, evaluation, and research that is in addition to standard practices that are applied at all facilities. These facilities have been proposed by the co-managers as appropriate sites for the conduct of important monitoring, evaluation, and research that will be programmatically used to guide the proposed summer chm salmon recovery efforts using artificial propagation.

Additional monitoring and evaluation actions affecting juvenile summer chum salmon proposed for the WDFW-Co-op Group Big Beef Creek program includes: capture of fry produced in the Big Beef Creek spawning channel by modified fyke nets; capture of fry produced from fish spawning naturally in Big Beef Creek at a weir in fan traps; and passive marking of all fry produced from the spawning channel with stable strontium via a simple immersion procedure. No adverse effects on listed chinook juveniles are expected through these activities, as the watershed lacks an indigenous, self-sustaining population of chinook salmon.

Capture of emigrating summer chum fry and fan traps through the proposed Big Beef Creek survival research programs can lead to mortality through injury in the trap, handling during removal, sampling, and marking from the traps, or through predation by other species, including coho salmon smolts and cottids within the trap, or near the trap entrance. The number of listed summer chum fry that may be taken and adversely affected by the proposed Big Beef Creek trapping programs is uncertain, and dependent upon the number of adults returning to the creek, the number of adult fish allowed to spawn in the channel and in the creek, egg to fry survival rates for summer chum in the channel and creek, and trapping efficiencies.

To estimate the total number of summer chum fry that may be affected during the Big Beef Creek spawning channel survival study, it is necessary to estimate the total number of naturally produced summer chum that may emigrate and be available for trapping. The channel is an extension of the natural spawning area available to summer chum that has been enhanced through the placement of weirs and clean gravel to promote higher egg to fry survival rates for naturally spawning fish. Assuming full loading of the spawning channel (400 adults), an average fecundity of 2,800, and an egg to fry survival rate of 50 % for the progeny of summer chum adults allowed to spawn naturally in the channel (egg to fry survival under natural conditions averages 10% (J. Ames, WDFW pers. comm.), approximately 280,000 natural-origin summer chum fry may emigrate from the channel, and then be available for trapping through the research program at the channel outlet. The 280,000 naturally produced fry may be available for take through capture, handling, marking, and release through trapping. WDFW estimates that their juvenile salmonid trapping operations on larger Puget sound rivers leads to an average mortality rate of 0.5% of the total number of fish collected, including trap, handling and sampling mortalities (Nelson 2000). Assuming 100% trapping efficiency for te estimated 280,000 naturally produced fry emigrating from the Big Beef channel at maximum levels, and a mortality

rate of 0.5% of the fish trapped, up to 1,400 fry may be lethally taken as a result of the proposed research program.

The number of fry that may be collected as emigrants during trapping on mainstem Big Beef Creek is dependent on adult escapement levels. The summer chum population in Big Beef Creek is in the process of being reintroduced, and the priority for natural production on the short term is to first allow natural spawning of any returning adults in the Big Beef spawning channel, where survival conditions for fry are improved. It is likely that natural spawning in Big Beef Creek mainstem will be very low during the reintroduction period. As a consequence, natural fry encounter levels, and potential take levels through capture, handling, sampling and marking associated with proposed trapping will also be low, and much less than levels estimated above for the spawning channel study.

Losses that may occur through trapping will be minimized by WDFW through continuous monitoring, and removal of captured fish from trap holding areas by personnel operating the traps on a frequent basis. Passive marking of spawning channel origin fry will be accomplished by WDFW technical staff through immersion of collected fry in an oxygenated vessel containing extremely low concentrations of stable strontium. This procedure is not expected to lead to significant levels of mortality of fry handled and marked.

Additional monitoring and evaluation actions affecting juvenile summer chum salmon proposed by USFWS for the Quilcene NFH program include mass marking of Quilcene summer chum with an adipose fin clip. No adverse effects on listed chinook juveniles are expected through this activity, as chinook salmon are not propagated at the hatchery, and the Quilcene watershed lacks an indigenous, self-sustaining population of chinook salmon.

USFWS staff have marked hatchery summer chum salmon fry with an adipose clip at Quilcene NFH since 1998 (starting with 1997 brood fry) during February and March by experienced fish marking crews administered by USFWS technical staff. Approximately 400,000 fry each year have been marked each year in this manner. Mass marking of summer chum under propagation at Quilcene NFH through application of an adipose clip can lead to elevated mortality levels. Chum fry mortalities attributable to the marking program have been low (less than 0.1% of the total annual production, or approximately 300 to 400 fry), and well within acceptable levels for tagging operations directed at small (less than 1.0 gram average size) fish (D. Zajac, USFWS, pers. comm., 2000). To minimize injury or mortality, fry are marked when they are large enough where the risk of injury during tagging is minimized. Fry to be marked are anesthetized with MS-222, using standard procedures and concentrations (NWIFC and WDFW 1998) and maintained in oxygenated water to the greatest extent throughout the marking process.

b) Adult summer chum and chinook

Monitoring and evaluation actions that may affect listed summer chum adults include sampling by USFWS and WDFW technical staff of adult broodstock and natural spawners for adipose fin clips, otolith marks, and (at Big Beef Creek) strontium marks. Sampling of returning adults at Big Beef Creek by WDFW staff will include the removal of otoliths and other hard parts for analysis from carcasses of summer chum that have spawned naturally in the spawning channel

and in Big Beef Creek. A random sub sample of spawners used as hatchery broodstock will also be collected and evaluated for otolith and strontium marks. Sampled salmon carcasses are returned to Big Beef Creek, near the recovery or removal location for nutrient enhancement purposes. These mark recovery activities are directed at fish that have been allowed to spawn, or that are destined for use as broodstock in the supplementation program. No additional adverse impacts to summer chum adults are expected. No effects on listed chinook salmon adults are expected, due to the location of sampling, and the lack of an indigenous, self-sustaining chinook population in the Big Beef Creek watershed.

Mark sampling by USFWS staff directed at Quilcene NFH summer chum returns will include examination of adult fish collected at the hatchery for broodstock, and examination of natural summer chum spawners as carcasses in the Big Quilcene, Little Quilcene, Dosewallips, Duckabush, and Hamma Hamma rivers. Sampling of Quilcene broodstock fish by USFWS will occur as a part of the standard spawning program at the hatchery, and no additional take effects as a result of mark sampling are expected. Mark sampling of natural spawners in the rivers will occur during WDFW and USFWS spawning ground foot surveys, conducted each season for the purpose of estimating natural salmon escapement levels. These surveys are conducted every 7 to 10 days, covering the lower river areas where summer chum spawn. WDFW and USFWS surveyors are directed to avoid walking on redds, and minimizing disturbance to spawning fish. Only dead fish are examined for adipose fin-clip marks, and the carcasses are left in place after examination. The tails of marked carcasses sampled are excised to indicate that the carcass has been sampled for subsequent surveys. WDFW and USFWS stream surveyors may encounter natural-origin chinook salmon in the Dosewallips, Duckabush, and Hamma Hamma rivers during surveys for summer chum. These foot surveys are not expected to adversely affect listed chinook salmon adults in any way.

The above monitoring and evaluation and research involves the observation, or capture, handling, sampling and release of adult or juvenile summer chum salmon. These actions will not lead to the removal of listed fish. Projected summer chum salmon mortality rates resulting from these programs are low relative to total adult and juvenile summer chum salmon population estimates. Adequate operational measures designed to minimize the potential for injury and mortality of listed summer chum salmon are implemented through the HGMPs.

Research and monitoring and evaluation have not been identified as factors for decline of the Hood Canal summer chum salmon ESU, and are generally considered an essential part of salmon and steelhead recovery efforts (NRC 1996). For these programs, the USFWS and the co-managers worked with NMFS to develop projects which will benefit the conservation and recovery of the species. The projects will provide information that will enhance the ability to make more effective and responsible decisions to aid listed summer chum salmon. The resulting data will enhance knowledge about Hood Canal summer chum salmon life history, specific biological requirements, genetic make-up, migration timing, responses to anthropogenic impacts and survival in various parts of the ESU's range. This information will also benefit scientific

understanding of listed summer chum salmon productivity in the action area, and of factors limiting summer chum abundance and productivity.

The actual numbers of adults returning each year to the Hood Canal summer chum salmon ESU will be substantially higher than total numbers proposed for monitoring and evaluation and research related take by an order of magnitude or more. It is realistic to expect a similar relationship between juvenile fish abundances and projected take levels occurring through implementation of the HGMPs as well. Actual fish mortalities resulting from the monitoring and evaluation and research programs are expected to be a small fraction of the total monitoring and evaluation and research take (handling and lethal take) for both adults and juveniles. Also, the research activities are distributed throughout the Hood Canal summer chum salmon ESU's freshwater range, thereby further diminishing the impacts of any take. For these reasons, monitoring and evaluation, and research-related takes, are not expected to reduce the Hood Canal summer chum population, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild.

k. Summary of Summer Chum Salmon Artificial Propagation Program Effects

Effects on Listed Salmon

a) Operation of Hatchery Facilities - The physical operation of summer chum salmon hatchery facilities within the action area is not likely to adversely affect juvenile summer chum and chinook salmon or their critical habitat, if those operations are conducted as described in HGMPs submitted for each project, and in accordance with criteria presented in the SCSCI (WDFW and PNPTT 2000). Operation of the programs as described in HGMPs, and in accordance with SCSCI criteria should also safeguard migrating and spawning listed fish in the natural environment. The issues of concern regarding hatchery operational effects on listed fish are hatchery facility failure (summer chum safety and survival during propagation), hatchery water intake impacts, and effluent discharge effects. Hatchery operational measures that adequately limit the risk of adverse effects to listed summer chum and chinook are implemented. Adequate measures are in place, including screening, water withdrawal, and effluent discharge limits, to minimize the effects of the proposed actions on listed natural-origin fish. NMFS expects that the hatchery programs will provide a survival benefit to the listed summer chum populations, increasing the survival of eggs to the fry stage over levels attainable in the wild.

b) Broodstock Collection - Adequate measures are in place, including the location and timing of the operations, to minimize the risk of injury and mortality to listed fish or adverse effects on critical habitat through the broodstock collection actions so as not to appreciably reduce their ability to survive and recover in the wild. Implementation of protocols proposed for each summer chum supplementation and reintroduction project, including limits on the duration of the programs and the low proportion of the natural populations removed as broodstock for all but two of the programs (see Table 8), adequately limit spawner removal effects on the donor, listed summer chum stocks. WDFW-managed programs in the Lilliwaup and Jimmycomelately watersheds will lead to the collection of up to 100 % of returning summer chum as an emergency measure to prevent extirpation. Allowances for the collection of up to

100 % of the total escaping population for small stocks is necessary to prevent extirpation of additional summer chum stocks, including the critically depressed Lilliwaup and Jimmycomelately populations. Although likely to benefit recovery of the species, the removal of adult fish at any level must be considered as likely to adversely affect that listed species. However, in reaching this conclusion, NMFS does not reasonably expect the broodstock collection operations, as proposed, to reduce the likelihood of both the survival and recovery of individual listed salmon stocks or of the entire ESUs in the wild. In addition to anticipated stock recovery benefits, adequate measures are in place, as detailed above, to minimize the effects of the proposed actions on listed summer chum salmon adults. The programs are not likely to adversely affect listed chinook salmon adults, due to the lack of chinook populations in most of the collection areas, and the application of measures in the Hamma Hamma River that avoid adverse effects on the species.

c) Genetics - There is a risk that the proposed supplementation and reintroduction programs are likely to adversely affect the genetic characteristics of certain listed Hood Canal summer chum stocks; in particular those in the Lilliwaup and Jimmycomelately watersheds where allowable broodstock removal levels are high. However, all of the programs have the objective of enhancing depressed or critically depressed summer chum stocks and benefitting the recovery of the listed summer chum salmon ESU. Genetic risk reduction measures included in the HGMPs, and additional measures proposed to reduce hazards identified through the SCSCI, should adequately minimize the risk of adverse effects to listed natural summer chum stocks, so as to not appreciably reduce the likelihood for their survival and recovery in the wild. The hatchery actions described above are expected to improve summer chum salmon survival relative to the environmental baseline Due to species differences, and the very low likelihood for interbreeding between chum and chinook salmon, no adverse genetic effects to listed chinook salmon are likely as a result of the summer chum salmon supplementation and reintroduction programs.

d) Disease - The proposed USFWS and WDFW summer chum salmon programs are not likely to adversely affect listed juvenile or adult salmon populations as a result of fish disease epizootics or transmission. Adequate measures proposed for application by WDFW and USFWS are in place through the SCSCI (WDFW and PNPTT 2000) and the co-managers fish health policy (NWIFC and WDFW 1998) to minimize the effects of the proposed actions on listed juvenile fish. These measures reduce the likelihood for fish disease outbreaks in the summer chum populations when under propagation. These measures also minimize the risk of fish disease transmission to natural origin fish downstream of the hatcheries, or in areas where the hatchery and natural-origin fish intermingle post release. Therefore, NMFS does not expect disease to be a significant risk factor to listed summer chum or chinook salmon that will appreciably reduce the likelihood for their survival and recovery in the wild in the action area.

e) Competition/Density-Dependent Effects - Adverse competitive effects to natural summer chum fry through food resource competition are possible as a result of WDFW and USFWS hatchery program releases of fed summer chum fry. Available information suggests that the risk of adverse effects on listed summer chum are adequately minimized, given hatchery

fish release size and timing protocols applied through the HGMPs. Hatchery chum salmon juveniles are not likely to pose risks to chinook salmon juveniles through competition for food in freshwater or marine areas. NMFS does not expect any significant adverse effects on listed fish due to competition by summer chum salmon adults originating from the proposed programs. The summer chum hatchery programs should pose minimal competitive risks to listed juvenile and adult salmon populations so as to not appreciably reduce the likelihood for their survival and recovery in the wild.

f) Predation - The risk of predation effects on listed summer chum salmon and chinook salmon should be adequately minimized through the release of fed summer chum fry during the summer chum emigration period that are very unlikely to prey upon natural summer chum fry. The proposed USFWS and WDFW summer chum salmon programs are not likely to adversely affect listed juvenile salmon populations either directly or indirectly due to predation by hatchery-origin summer chum juveniles or adults.

g) Residualism - It is unlikely that residualism in freshwater or nearshore marine areas by hatchery-origin summer chum will occur. Residualism by hatchery-origin summer chum is therefore not likely to adversely affect listed summer chum and chinook salmon juveniles or adults so as to not appreciably reduce the likelihood for their survival and recovery in the wild.

h) Fisheries - The summer chum hatchery programs produce fish for conservation purposes only, and are not intended to provide adult fish for harvest. The actions will not result in increased fishery harvests directed at summer chum salmon produced by the programs that could adversely affect listed juvenile and adult fish. The production of fish from these hatchery programs is therefore expected by NMFS to not lead to increased exploitation of listed natural summer chum and chinook salmon of any age class in Pacific Northwest commercial or recreational fisheries that would appreciably reduce the likelihood for their survival and recovery in the wild over the duration of the proposed actions.

i) Masking - The USFWS and the co-managers address concerns regarding masking of natural population status through mass marking of the hatchery-origin summer chum, recovery of marked fish at traps and on the spawning grounds, evaluation of natural and hatchery fish proportions in natural spawning areas, and limitation of the supplementation program to a 12 year duration. These actions are expected to be effective in reducing risks to listed summer chum salmon associated with population status masking, so as to not appreciably reduce the likelihood for their survival and recovery in the wild.

j) Monitoring and Evaluation - Adequate measures are in place to minimize the effects of the proposed monitoring and evaluation and research actions on listed juvenile and adult summer chum salmon collected and propagated through the proposed programs. Additional risks of adverse effects through injury or mortality to juvenile summer chum fry are imposed by proposed monitoring and evaluation actions at Quilcene NFH and Big Beef Creek. Low mortality levels relative to total numbers of juvenile summer chum that may be encountered (estimated at 0.5%) are anticipated from these efforts, and risk minimization measures applied

during trapping and tagging should reduce impacts further. In addition, benefits to scientific knowledge will accrue to listed summer chum recovery efforts as a result of these fish marking and trapping studies. No effects on listed chinook salmon are expected as a result of these monitoring and evaluation and research actions. Monitoring and evaluation, and research-related takes, are not expected to reduce the listed populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild.

Benefits to Recovery

Table 9 summarizes fed fry release goals set as maximal levels under the co-managers' SCSCI (from Table A3.1 in WDFW and PNPTT 2000), and the approximate annual broodstock removal levels required to achieve those fry release levels. Also included are near term broodstock removal goals, and likely fry release levels, given current, depressed adult run sizes for several of the populations. Included in these latter adult removal figures are goals based on genetic risk minimization criteria in the SCSCI (e.g., minimum removal goal of 25 pairs). Estimated adult summer chum salmon recruitment levels to the action area as a result of each release program are also indicated, based on fry release levels, and a fry-to-adult survival rate of 0.81 %, which is the lowest rate presented in Table A3.1 of the SCSCI (WDFW and PNPTT 2000).

Table 9. Proposed annual summer chum salmon broodstock collection, fry release and adult recruit estimates for the proposed supplementation and reintroduction programs.

	Quilcene	**Lilliwaup**	**Hamma**	**Big Beef**	**Salmon**	**Chimacum**	**JCL**	**Union**
GOAL								
Broodstock	500	334	712	**1/**	184	**2/**	76	76
Fed Fry	373,000	376,000	802,000	103,000	123,000	86,000	86,000	86,000
Recruits 3/	3,020	3,046	6,496	834	996	697	697	697
LIKELY								
Adults	500	50	100	**1/**	184	**2/**	50	76
Fry	373,000	50,000	125,000	103,000	123,000	86,000	50,000	86,000
Recruits 3/	3,020	405	1,013	834	996	697	405	697

1/ Broodstock required for this program is collected at Quilcene NFH, and included in the USFWS total.
2/ Broodstock required for Chimacum is collected at Salmon Creek and included in the total for that program.
3/ Estimated adult summer chum return to the action area, based on an assumed fry-to-adult survival rate of 00.81 %. Total returns will accrue as three, four, and five year-old summer chum salmon.

If SCSCI broodstock collection goals are attained, a total of 1,882 adult summer chum will be removed each year for use in the programs. Assuming near term (2000-2005) summer chum run

sizes will equal 11,928, which is the 1995-98 average summer chum run size to the action area (including U.S. waters - from SCSCI run size reconstruction), the proposed programs may lead to the removal of 15.7 % of the Hood Canal ESU summer chum run each year. Remaining adult summer chum, 8,746 or 73.3 % of the initial U.S. run size, will escape to spawn naturally. This escapement proportion assumes that U.S. fisheries incidentally remove 10.9 % of the return each year (about 1,300 fish), as anticipated for base level fisheries proposed in the SCSCI.

As indicated in Table 9, near term broodstock removal levels are likely to be much lower than goal levels defined in the SCSCI due to the poor status of returns to several of the watersheds proposed for supplementation (Lilliwaup, Hamma Hamma, and Jimmycomelately). Actual broodstock removal levels for the programs will therefore likely total 960 fish, or 8 % of the total summer chum return, assuming 1995-98 average run sizes. Fry production will also therefore be less for supplementation programs in those watersheds.

A key objective of the proposed supplementation and reintroduction programs is to assist in increasing the likelihood for, and rate of, recovery of the listed ESU. This objective is proposed to be accomplished by increasing, over a short duration, the abundance of returning adult fish using the egg to smolt survival advantages imparted by artificial propagation. Recovery will also be assisted through reintroduction of summer chum via hatchery releases into currently vacant watersheds historically used by summer chum salmon. Total projected releases from all proposed programs at goal levels will be 2,035,000 per year. Assuming a fry to adult survival rate ranges for these fish of 0.81 % to1.63 % (rates from Table A3.1 in WDFW and PNPTT 2000), from 16,484 to 33,170 adult summer chum salmon (returning to U.S. waters as three, four, and five year old fish) may be produced through the supplementation and reintroduction programs to contribute to the recovery of the ESU. As indicated in Table 9, actual release levels will likely be less for the near term, totaling 996,000 per year, until the summer chum returns increase above their current depressed levels in several watersheds. Consistent brood year releases of 996,000 fry may lead to the return of 8,068 to16,235 adult fish to the ESU.

Potential benefits of the individual proposed artificial propagation programs in assisting recovery of the ESU are also reflected in Table 9. The estimated number of adult summer chum salmon returning to the action area as a result of hatchery releases is presented. These return estimates are based on a conservative fry-to-adult survival rate of 0.81 %, which is one-half of the rate identified by WDFW for Hoodsport Hatchery fall chum salmon over three brood years (1.63 % - Fuss and Hopley 1991). Given harvest management strategies implemented in tandem with the hatchery programs as proposed in the SCSCI, these adult return estimates may also be considered the expected hatchery-origin spawner escapement estimates for each summer chum production stream.

Table 10 compares expected adult summer chum production return estimates by program with the status of the recipient stocks for the most recent five years prior to the implementation of the supplementation programs (1990-94 average return levels from WDFW and PNPTT 2000). The expected benefits of the supplementation and reintroduction programs in increasing abundances of the listed summer chum stocks to pre-decline 1974-78 average escapement levels are

indicated. The criteria applied by the co-managers in initiating supplementation and reintroduction programs was an identified moderate or high risk of extinction of a stock (supplementation) or recent extirpation (reintroduction) (WDFW and PNPTT 2000). In absence of theses programs, the individual natural populations would therefore be expected to continue to decline from the 1990-94 average levels presented below. The low likelihood for natural re-establishment of summer chum in streams where populations have been extirpated would also contribute to a flat or declining abundance status of summer chum salmon adults returning to the ESU without the proposed programs.

Table 10. Expected adult return abundance increases over 1990-94 average escapement levels afforded by proposed summer chum salmon artificial propagation programs.

	Quilcene	**Lilliwaup**	**Hamma**	**Big Beef**	**Salmon**	**Chimacum**	**JCL**	**Union**
Hatchery Returns	3,020	3,046	6,496	834	996	697	697	697
1990-94 avg. Escapement	336	60	144	0	293	0	186	322
% Increase Escapement	798 %	4,977 %	4,411 %	1/	240 %	1/	275 %	116 %

1/ Reintroduction programs for watersheds where populations were extirpated.

Assuming that the majority of the adult returns projected to return for each program escape to spawn naturally, and that spawning adults are successful in replacing themselves (a conservative 1.0 recruit per spawner ratio), significant improvements in the status of the listed populations may accrue. The pre-supplementation program average spawner abundances of all of the stocks were within the approximate critical threshold range under the VSP concept (125 to 1,250 fish for four year generation length fish - see Section III). Potential increases in natural spawner annual abundances afforded by the supplementation and reintroduction programs would move the listed populations much closer to, or in some cases, above the approximated viable threshold range (1,250 to 2,500 fish).

The co-managers have identified criteria that are used to determine when the summer chum salmon artificial production programs have met the above adult return objectives, and when the projects should be terminated to comply with other objectives, including minimization of genetic risks to natural populations (see Section 3.2.2.2 in WDFW and PNPTT 2000). One of these latter objectives is a limitation on the duration of each program to 12 years. The co-managers have also defined monitoring and evaluation criteria that are used to identify the effects of each program, and the status of adult summer chum returns resulting from fish releases (see Section 3.2.2.4 in WDFW and PNPTT 2000). The intent is to adaptively manage the programs, based on monitoring and evaluation results, to meet adult return and impact minimization goals.

As noted in the "Environmental Baseline" of this Opinion, the condition of freshwater habitat important for summer chum productivity in the action area is degraded as a result of many human-caused activities. The co-managers have identified specific habitat-related factors for decline by summer chum watershed, and have recommended factors for recovery to allow recovery of degraded habitat (WDFW and PNPTT 2000). In addition, the co-managers have noted that natural environmental conditions in the region leading to drought during the summer chum adult return period and flooding during critical egg incubation period have also likely adversely affected their productivity. In recognition of these conditions, NMFS and the co-managers are of the opinion that the proposed supplementation and reintroduction programs, acting alone, are not likely to lead to the recovery of the listed ESU. Improvements in habitat conditions afforded by changes in land and water management practices in the region, and the afore-mentioned application of continued harvest management protection measures as proposed in the SCSCI, must occur in concert with the proposed artificial propagation programs for stocks comprising the summer chum salmon ESU to recover to a healthy status.

In summary, the summer chum salmon supplementation and reintroduction actions proposed in the action area should significantly benefit prospects for recovery of the listed Hood Canal summer chum salmon ESU. Proposed risk minimization measures included in HGMPs for the individual programs and in the overarching SCSCI should adequately reduce the risk of adverse ecological and genetic effects to listed summer chum and chinook salmon as a result of the programs. HGMPs submitted by the action agencies for these programs include hatchery operational measures and annual broodstock removal and juvenile fish release levels that fully comply with SCSCI hatchery operation and production measures. The summer chum hatchery programs described in the HGMPs are not reasonably expected to appreciably reduce the likelihood of both the survival and recovery of individual listed salmon stocks or of the entire ESUs in the wild.

l. Consistency of the Proposed Actions with the Summer Chum Salmon Conservation Initiative (SCSCI)

Section 3.2 of the co-managers' SCSCI (WDFW and PNPTT 2000) defines artificial propagation measures that should be applied in the action area to recover listed summer chum populations. This section of the SCSCI also includes hatchery measures proposed for application to minimize the risk of adverse ecological and genetic effects to natural summer chum salmon. The actions and measures proposed by the action agencies and the non-Federal operators, and reviewed in this Opinion, are fully consistent with, and drawn from, the SCSCI.

2. <u>Artificial Propagation Programs Producing Other Salmonid Species</u>

Assessment of the effects on listed summer chum salmon of hatchery programs producing other anadromous salmonid species in the action area is based on project summaries presented in Section II.B. Information included in these summaries was derived from HGMPs submitted to NMFS for the Federal projects, and from information presented in the SCSCI for both the Federally funded and non-Federally funded programs (WDFW and PNPTT 2000).

A particularly valuable section of the SCSCI used extensively to contribute to the following effects analyses is the component of the plan addressing "Ecological Interactions." In that section, the impacts of hatchery salmonid production in the action area on summer chum salmon are assessed. For each species and hatchery program in the action area, the risk of deleterious effects to listed summer chum salmon populations for each hazard is identified as "high," "moderate," or "low." In some instances, risks were assigned as either "high" or "low," and no "moderate" rating was assigned. Criteria used to assign risk levels for each hazard are indicated. One, or a combination of, the listed criteria were used to assign a hazard risk level for each artificial propagation program within the region. Risk aversion measures were proposed for application in instances where risks of hazards to summer chum were assigned as "high" or "moderate." Monitoring and evaluation actions were also proposed to address risks judged as "high" or "moderate," **or** where the uncertainty of the effects on summer chum associated with a particular release program is high. The intent of the assessment was to adjust assessed "high" and "moderate" impact programs through application risk minimization measures, so that the risk of adverse effects on listed natural summer chum becomes "low." Requirements for monitoring and evaluation allow for the adaptive management of programs, if needed, as new information regarding the occurrence and effects of each hazard is gathered.

Assignment of risk aversion and monitoring evaluation measures to programs judged as potentially hazardous to summer chum productivity is consistent with the approach applied by NMFS in the assessment of hatchery programs for ESA purposes. In forming biological opinions to evaluate whether or not hatchery programs jeopardize the survival of listed fish, "Reasonable and Prudent Alternatives" (for "jeopardy" determinations), "Conservation Measures," and (within Incidental Take Statements) "Reasonable and Prudent Measures" and "Terms and Conditions" are developed and applied as discretionary or non-discretionary measures for certain hatchery operations to minimize or avert perceived risks to listed fish. These alternatives and measures included in the NMFS hatchery biological opinions serve the same risk minimization purpose as the risk aversion and monitoring and evaluation measures proposed by the co-managers in the SCSCI. All are mechanisms for reducing the likelihood that the hatchery programs will negatively affect ESA-listed or depressed salmonid populations requiring protection.

The results of the co-managers' risk assessment directed at the effects of hatchery chinook, coho, pink, and fall chum salmon, and steelhead releases on listed Hood Canal ESU summer chum is considered and applied in the following evaluation of unlisted salmon hatchery program effects. Risk minimization and monitoring and evaluation measures included in the SCSCI and applied by the co-managers to minimize the risk of adverse effects of the programs are considered in performing this analysis.

Details regarding the Federally funded and non-Federally funded hatchery programs operated by USFWS and the co-managers in the action area, and evaluated in this section, are summarized in Table 11 (modified from the SCSCI (WDFW and PNPTT 2000) to reflect current programs). Recent year average program release information by species is included, as are estimated

migrational timings for species produced, and the location of the programs relative to summer chum streams.

a. Operation of Hatchery Facilities

Hatchery facility failure

Listed fish effects and concerns regarding hatchery facility failure are summarized in the above section addressing effects of summer chum hatchery programs. Hatchery facility failure is not considered a risk factor to listed summer chum salmon for these hatchery programs. Summer chum salmon are not propagated through these programs, and will therefore not be affected by the failure of the hatchery operations. Only the unlisted species retained and propagated through the hatchery programs may be affected .

Hatchery water intake impacts

Listed fish effects and concerns regarding water intake impacts are summarized in the above section addressing effects of summer chum hatchery programs.

a) Juvenile and adult summer chum salmon

Determination of the effects of this hazard on summer chum salmon is made by considering factors bearing on the likelihood that the hatchery operations will contact summer chum salmon, and whether the programs are appropriately operated to minimize the risk of adverse effects to summer chum within a watershed. Of the major hatchery facilities in the action area, only USFWS' Quilcene NFH and WDFW's Dungeness Hatchery are located in watersheds where summer chum salmon populations are present. Quilcene NFH water supply sources are not accessible to summer chum salmon adults or juveniles, as they are upstream of the upper-most extent of summer chum migration in the Big Quilcene River. Both hatcheries are operated under state water withdrawal permits and no downstream reaches used by summer chum salmon are allowed to be de-watered as a result of hatchery water withdrawal.. Hatchery water intakes at the USFWS and all WDFW hatcheries in the action area are properly screened, and in compliance with NMFS screening criteria, which are designed to protect natural-origin fish. Private and volunteer group co-operative fish rearing projects located on summer chum streams rely on spring or well water sources (Union, Dewatto, Tahuya, Big Beef Creek, and Hamma Hamma), or surface water sources inaccessible to summer chum (Lilliwaup). Water withdrawal practices, and the return of water near the point of withdrawal, are protective of listed natural-origin summer chum salmon. None of the tribal hatcheries considered in the Opinion are located on summer chum streams, and no water withdrawal effects on summer chum will result.

Net-pen projects operated by the Tribes in Quilcene and Port Gamble Bays use tidal flow as the water source for fish rearing. Passive supply of water for fish rearing at these sites is not likely to lead to adverse effects to summer chum, including entrainment. The Port Gamble pens are not located in an area where migrating summer chum are present. The Quilcene Bay pens are locatedin an embayment at the base of two summer chum streams (Big and Little Quilcene rivers), but nearshore-emigrating fry are not expected to encounter the pens due to their off-shore location.

1. Recent year average annual salmon and steelhead production within the Hood Canal summer chum ESU region.

	Agency (Complex)	Stock Origin/ Lineage	Release Numbers (Recent avgs)	Release Class	Release Size (avg. FL)	Release Timing (avg. / range)	Juvenile Marine Migrational Timing	Freshwater Entry Timing (avg. adults)	Summ Chum Stream
ook	**WDFW** (Hood Canal)	Hoodsport	6,123,000	Fing. Smolt	80-86 mm	June 1	June 1 - June 22	Aug 12 -Sep 20	Yes - I No - C
		Hoodsport	226,000	Yearlg.	195 mm	May 2	May 2 - June 4	" "	Net-pe
	Non-Gov Co-ops	Hoodsport	200,000	Fing. Smolt	80-86 mm	June 1	June 1 - June 22	" "	Yes 2
		Hoodsport	398,000	Unfed Fry	37-40 mm	~Dec - Jan	unknown	" "	Yes 3
	WDFW	Native	975,000	Fing. Smolt	≥ 57 mm	Jun 15-Jul 15	June 15 -Aug 30	Aug 8 - Sep 14	Yes 4
	(Dungeness)	Native	200,000	Fingl.	48-56 mm	" "	July-August	" "	Yes
		Native	800,000	Fed fry	47 mm	" "	July-August	" "	Yes
	WDFW (Hood Canal)	Purdy Ck.	422,000	Yearlg.	131-156 mm	June 11	June 11-July 16	Sept 18 - Nov 6	No
	(Dungeness)	Native	447,000	Yearlg.	131 mm	May 30	May 30 -June 10	Sept 22 - Nov 2	Yes 5
	(Snow Creek)	Native	16,000	Fingl.	75-100 mm	Nov, March	" "		Yes 6
	"	Native	16,000	Unfed fry	35-38 mm	mid-March-mid April	" "	" "	Yes 6
	Skokomish Tribe (Quil. Bay)	Quilcene	242,000	Delayed	131-167 mm	April 23-May 30	April 23-June 19	Sept 1 - Nov 9	Net-p
	Pt. Gamble Tribe (Pt. Gamble Bay)	Quilcene	361,000	Delayed	131-167 mm	April 23-May 30	April 23-June 19	Sept 1 - Nov 9	Net-pe
	USFWS - QNFH	Native	445,639	Yearlg.	154 mm	May 2- May 14	May 2-June 3	Sept 1 - Nov 9	Yes

1. Recent year average annual salmon and steelhead production within the Hood Canal summer chum ESU region.

Agency (Complex)	Stock Origin/ Lineage	Release Numbers (Recent avgs)	Release Class	Release Size (avg. FL)	Release Timing (avg. / range)	Juvenile Marine Migrational Timing	Freshwater Entry Timing (avg. adults)	Summ Chum Stream
12/	Native	42,974	Fingl.	79 mm	March-Nov	April-May	Sept 1 - Nov 9	Yes
WDFW (Hood Canal)	Hoodsport	1,000,000	Fed fry	50 mm	March 15	Feb 16 - Apr 25	Sept 15- Oct 15	Yes
(Dungeness)	Native	500,000	Fed fry	40-50 mm	March-Apr	Mar 17 - Apr 25	" "	Yes 8
WDFW (Hood Canal)	Native	15,000,000	Fed fry	48-52 mm	Mar 24 - Apr	Mar 24 - May 10	Nov 7 - Dec 7	Yes
"	Finch Ck.	13,100,000	Fed fry	42-52 mm	Mar 17 - Apr	Mar 17 - May 12	" "	No
Non-Gov Co-ops	Finch Ck.	1,000,000	Unfed fry	38 mm	Feb-Mar (?)	Feb - Mar (?)	" "	Yes 9
Pt. Gamble Tribe (L. Boston Ck)	Finch Ck.	730,000	Fed fry	41-66 mm	Apr 23-30	Apr 23 - May 5	" "	No
Skokomish Tribe	Wolcott Sl	1,380,000	Fed fry	43-56 mm	Apr 9-May 15	Apr 16 - June 1	Dec 1 - Jan 11	No
(Enetai Ck)	Wolcott Sl	263,000	Unfed fry	38-40 mm	Mar ?-April 22	Apr. 7 - May 4	Dec. 1 - Jan 11	No
USFWS - QNFH	Native	1,856,121	Fed fry	47 mm	Apr 22-June 9	Apr 22 - June 26	Dec. 1 - Jan 11	Yes
WDFW								
(Dosewallips R.)	Chambers	12,500	Yearlg.	180-230 mm	Apr 15-May 15	Apr 15 - June 14	Dec 7 - Apr 14	Yes 1
(Duckabush R.)	Chambers	10,000	Yearlg.	180-230 mm	" "	Apr 15 - June 14	" "	Yes 1
(Skokomish R.)	Chambers	50,000	Yearlg.	180-230 mm	" "	Apr 15 - June 14	" "	No 1
(Dungeness R.)	Bogachiel	22,000	Yearlg.	>180 mm	Apr 24-May 14	Apr 24 - May 24	" "	Yes 1
Non-Gov Co-ops								Yes

1. Recent year average annual salmon and steelhead production within the Hood Canal summer chum ESU region.

Agency (Complex)	Stock Origin/ Lineage	Release Numbers (Recent avgs)	Release Class	Release Size (avg. FL)	Release Timing (avg. / range)	Juvenile Marine Migrational Timing	Freshwater Entry Timing (avg. adults)	Summ Chum Stream
(Hamma Hamma)	Native	150	Adults	620 mm	Mar-April	---	March-April	
“ ”	Native	5,000	2+ Yearlg.	165 mm	May	May-June	Dec 7 - Apr 14	Yes

e 11 Footnotes:

all chinook yearlings are no longer released from WDFW marine net-pens at Sund Rocks, Hoodsport Marina, and Pleasant Harbor Marina. These fish ma
y at unknown rates to adjacent summer chum streams.

oodsport-origin fall chinook underyearling smolts have been released into several summer chum streams in Hood Canal, including the Union River, Big
f Creek, Duckabush River, and the Hamma Hamma River. Hoodsport-lineage chinook have also been planted into three streams where self-sustaining
mer chum runs are no longer present: Dewatto River, Tahuya River, and Skokomish River. The Union, Tahuya, and Dewatto programs have been
ontinued.

oodsport-origin fall chinook unfed fry have been released from RSIs into regional summer chum streams including the Tahuya and Dewatto rivers. The l
programs have been discontinued.

ungeness chinook are planted as underyearling smolts, fingerlings and fry as part of a formal recovery program. The status of the summer chum stock tha
be affected by these releases is unknown.

he status of the summer chum stock that may be affected by these coho releases is unknown.

hese coho originate from indigenous stock planted as pre-smolts into Crocker Lake to acclimate and emigrate 2-5 months after release.

oho yearlings are released from marine area net-pens in Quilcene and Port Gamble bays. These fish may stray at unknown rates to regional summer chum
ms.

ungeness fall run pink salmon are produced as part of a formal recovery program.

nch Creek stock fall chum are released from RSIs into several regional summer chum streams, including the Union River and the Tahuya River.

Steelhead yearlings of Chambers Creek lineage are truck-planted into three regional streams, two of which have known summer chum populations.

Steelhead yearlings of Chambers Creek lineage are transferred into Dungeness Hatchery for two months of rearing prior to release. The status of the sum
n stock that may be affected by these releases is unknown.

Quilcene NFH average release range for 1992-96 for yearlings and 1994-96 for fingerlings.

Determination made from review of table of “existing stocks” and “known recently extirpated stocks” presented in the “Extinction Risk” section in Part O
ck Assessment” of the SCSCI (WDFW and PNPTT 2000).

ult summer chum may encounter the Quilcene net-pen structure, but the fish can freely pass the structure with no impedance of gration.

uent discharge effects

ed fish effects and concerns regarding hatchery effluent discharge are summarized in the above section addressing effects of mmer chum hatchery programs.

a) Juvenile and adult summer chum salmon

All hatchery facilities administered by USFWS, WDFW, and the PNPTT are operated to comply with NPDES permit effluent limitations (as appropriate) and best management practices that adequately limit the effects of hatchery effluent on downstream aquatic life, including salmon. Modest levels of fish production at the private and volunteer projects should also not adversely affect water quality to the detriment of summer chum. Freshwater hatchery programs operated by the Skokomish and Port Gamble S'Klallam tribes on Enetai Creek and Little Boston Creek are very modest in scale, requiring minimal amounts of water for operation. Total production at each hatchery is under the 20,000 pound annual level set by water quality regulatory agencies as the level necessitating a NPDES permit for operation. Neither hatchery is located on a summer chum salmon stream, and contact with, or adverse effects to, juvenile or adult summer chum salmon is unlikely.

Based on the best available information, the physical operation of unlisted salmon hatcheries in the action area is not expected to reduce the listed populations, their reproductive capacity, their distribution, or their critical habitat to the point of appreciably reducing their ability to survive and recover in the wild.

b. Broodstock Collection

Listed fish effects from broodstock collection are summarized in the above section addressing effects of summer chum hatchery programs. The concerns for the proposed unlisted salmon hatchery programs are effects, including injury and mortality, of broodstock collection programs targeting other salmon species on listed summer chum salmon, and degradation of their critical habitat through fish trap placement or operation.

Broodstock collection method effects

a) Juvenile summer chum salmon

USFWS Quilcene NFH coho salmon and fall chum salmon broodstock collection operations rely on volunteers to the hatchery. No natural summer chum spawning occurs upstream of the hatchery, and once entering the hatchery ponds, coho and fall chum are removed from downstream areas where summer chum juveniles might be present. No adverse effects to summer chum juveniles or designated critical habitat are anticipated.

The major salmon production hatcheries operated by WDFW in Hood Canal (Hoodsport, George Adams, and McKernan) are located in watersheds where summer chum salmon are not present. Broodstock collection operations for these hatcheries are therefore not expected to adversely affect juvenile summer chum salmon. Broodstock collection directed at indigenous pink salmon as part of a stock recovery program at WDFW's Dungeness Hatchery may adversely affect summer chum eggs through physical disturbances, if adult fish create redds near the weir location. The unknown status of summer chum in the river prevents quantification of potential effects on summer chum salmon or their critical habitat by the pink salmon broodstock operation. Trapping of coho salmon at Dungeness Hatchery does not rely on a fish weir, and summer chum juveniles should not be adversely affected.

The PNPTT's Enetai and Little Boston hatcheries are not located on summer chum streams, and no effects on juvenile summer chum will occur through broodstock collection actions at those locations. Broodstock used to supply coho salmon smolts for the tribal net-pen programs originate from Quilcene NFH, and no broodstock collection occurs at the net-pen sites.

b) Adult summer chum salmon

During the summer chum salmon migration period, Quilcene NFH is operated by USFWS for the primary purpose of collecting mainly hatchery-origin summer chum salmon that may recruit as volunteers to the hatchery. Trapping, handling , and care of summer chum is given priority over hatchery coho salmon returning to the hatchery at the same time. Fall chum adults collected at the hatchery return much later than summer chum, and no interaction between the broodstock actions directed at fall chum and adult summer chum is expected. No adverse effects on listed adult summer chum are anticipated to result from these broodstock collection programs.

WDFW's Hoodsport, George Adams and McKernan hatcheries use weirs to direct migrating adult hatchery salmon into collection ponds for use as broodstock. Although none of these weirs are located on a summer chum stream, WDFW policy requires that any stray summer chum adults encountered are to be released upstream of the weirs to spawn naturally. The pink salmon broodstock collection program at WDFW's Dungeness Hatchery may affect migrating adult summer chum through delay in migration or injury during trapping. As mentioned above, the unknown status of summer chum in the river prevents quantification of potential effects, but the pink salmon broodstock operation uses a weir spanning the lower river where summer chum will likely be present during their August-September migration period. WDFW has proposed risk minimization measures to reduce the likelihood of harm to any summer chum salmon incidentally encountered through weir operations in the action area (WDFW and PNPTT 2000).

Operation of fish weirs at Big Beef Creek for the primary purpose of managing reintroduced summer chum returns for artificial propagation and research should minimize the risk of adverse effects to listed fish. The collection of hatchery-origin fall chinook salmon as broodstock at the hatchery is managed to prevent adverse effects to summer chum commingled with chinook on return, with the capture, handling, and disposition of summer chum adults assuming priority for the operation. Broodstock collection methods employed for the LLTK's Hamma Hamma steelhead program will not adversely affect summer chum due to the late timing of these actions, well removed from the August-early October summer chum migration and spawning period.

As mentioned above, neither tribal freshwater hatchery considered in this Opinion is located on a summer chum stream. In addition, collection of fall chum broodstock at Enetai Hatchery occurs in late November and December, much later than the August-early October summer chum adult spawning period. No broodstock is collected at the tribal net-pen sites, and no adverse effects on summer chum adults are expected.

Removal of adults from the spawning population

a) Juvenile and adult summer chum salmon

The removal of adult unlisted salmonids from natural stream areas for use as broodstock by the proposed programs will not affect summer chum salmon. The programs produce species other than summer chum salmon, and their removal will not affect the demographics or genetic character of the listed summer chum populations.

Based on the best available information, and considering program locations and operational measures, unlisted salmon broodstock collection programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity, their distribution, or their designated critical habitat to the point of appreciably reducing their ability to survive and recover in the wild.

c. Genetic Effects

Genetic effects to natural fish populations associated with hatchery programs are summarized in the above section addressing genetic effects of summer chum hatchery programs. The concerns for the proposed unlisted salmon hatchery programs are genetic effects, including loss of genetic diversity and reduced fitness, on listed summer chum salmon.

Reduction in genetic variability among and within populations, and domestication effects

a) Juvenile and adult summer chum salmon

The production of other salmonid species through the proposed hatchery programs in the action area is not likely to adversely affect summer chum salmon through genetic effects. Interbreeding in the natural environment between summer chum salmon adults and hatchery salmon species, including chinook, pink, and coho salmon, and steelhead is highly unlikely. Interbreeding of these species in the wild is extremely rare, and ineffective when it does occur, due to inter-species differences including migration timing, mate selection, spawning habitat preferences, and the low viability and sterility of inter-specific crosses. No attempts at intentional interbreeding between these species will occur in the proposed hatchery programs. No adverse genetic effects to summer chum will result from hatchery programs directed at the propagation of these species.

Fall-run chum salmon produced in several of the proposed hatchery programs can interbreed with summer-run chum salmon, if they are present on the spawning grounds at the same time. Fall chum of Finch Creek lineage are produced through WDFW's Hoodsport, George Adams, and McKernan hatchery programs, and through volunteer group projects on small Hood Canal streams. The USFWS and tribal hatcheries also release late-timed fall-run chum salmon each year.

In the action area, summer chum adults enter freshwater to spawn between August and early October (see Appendix A) . The above WDFW programs use Finch Creek stock, an early- timed fall chum salmon stock which enters freshwater to spawn from early November through mid-December (early fall). The later timed, indigenous fall chum stock used in the Quilcene NFH and Enetai Hatchery programs enter freshwater to spawn between mid-November and early January. This later spawn timing for all fall-run stocks used by hatchery programs in the action area creates a temporal separation on the spawning grounds from the Hood Canal summer chum

stocks (WDF et al. 1994). Hatchery fall chum adults and summer chum adults will not be present on the spawning grounds at the same time. Inter-breeding, and therefore genetic effects to listed summer chum posed by fall-run chum salmon production in the Hood Canal region are unlikely.

Based on the best available information, and species produced in the programs, unlisted salmon broodstock collection programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild.

d. Disease

Listed fish effects that may be associated with fish disease transmittal and amplification as a result of hatchery practices are summarized in the above section addressing disease effects of summer chum hatchery programs. The concerns for the proposed unlisted salmon hatchery programs are disease effects, including injury and mortality, of programs producing unlisted salmon species in the action area on listed summer chum salmon.

Fish disease incidence and transmittal

The risk of acute or chronic mortality, or elevated susceptibility to predation, resulting from the potential transfer of fish diseases from hatchery-origin fish species to listed summer chum is evaluated here. The effects of this hazard are determined through consideration of operational practices applied to minimize the likelihood for disease epizootics at the proposed hatchery facilities and disease transfer to listed summer chum salmon.

a) Juvenile summer chum salmon

Routine monitoring at USFWS' Quilcene NFH for fish pathogens has commonly isolated the causative agents for furunculosis and bacterial kidney disease from returning hatchery adults (USFWS 1999a). Neither of these pathogens have been isolated from hatchery-reared juveniles. Monitoring of '99 brood summer chum spawned at Quilcene NFH indicated the presence of infectious hematopoietic necrosis virus (IHN), a regulated pathogen under the co-managers' policy. As a result of this finding, all egg lots having the potential to have originated from an infected spawner were quarantined. All other monitoring of the incidence of regulated pathogens in adults used as broodstock for the programs has shown no incidence of disease.

The risk of fish disease transfer from salmon and steelhead propagated through the hatchery programs in the action area is low. The major hatcheries comply with the co-managers' fish health policy (NWIFC and WDFW 1998). All fish health monitoring, disease control and sanitation procedures specified in the policy are followed in spawning, fish rearing, and fish release activities conducted at the hatcheries.

To reduce the likelihood for the amplification of fish disease in the hatchery, the incidence of viral pathogens in all salmon broodstocks is determined by sampling fish at spawning in accordance with procedures set forth in the co-managers' Fish Health Policy (NWIFC and WDFW 1998). Green eggs brought in the facilities for incubation are water hardened in an approved iodophore solution to minimize the risk of vertical (parent to progeny) transfer of fish

disease. All eyed eggs transferred out of the hatcheries are disinfected with an iodophore solution to reduce the likelihood for horizontal (fish to fish) transfer of disease. The risk of disease transfer from fish production at Hoodsport, George Adams, and McKernan hatcheries is further reduced by the lack of summer chum populations in the streams where the hatcheries are located. Compliance with NPDES permit provisions at the hatcheries also minimizes adverse water quality impacts that could lead to increased natural-origin fish susceptibility to disease outbreaks.

WDFW is responsible for providing fish health monitoring for private and volunteer group fall chinook and fall chum salmon hatchery programs in the region. Many of these programs are located on summer chum streams. Fish health monitoring has been sporadic for these programs within the action area, due to a lack of state funding and an inadequate number of available state fish health personnel. This condition has led to a general lack of monitoring and recording of fish health condition during juvenile fish rearing and prior to release across many of the volunteer group programs. Rearing of fish in conflict with known fish disease amplification limitation measures has also been a consequence. Monitoring of hatchery broodstock and juvenile fish health by fish health professionals during operation, examination and certification of hatchery fish health by a fish health professional as free of regulated pathogens prior to release; and documentation of all fish transfers and releases, in compliance with transfer policies specified in the co-managers' fish health policy are essential to insure that the risks of disease transfer to natural summer chum are minimized.

The PNPTT freshwater hatchery programs are not likely to adversely affect juvenile summer chum salmon through fish disease transmission. Neither Enetai and Little Boston hatchery is located on a summer chum salmon stream, and both hatcheries comply with co-managers' fish health policy procedures (NWIFC and WDFW 1998), making the transmission of fish disease to summer chum unlikely. The Quilcene Bay and Port Gamble Bay net-pens operated by the tribes receive coho salmon that are progeny of Quilcene NFH adult returns. The fish are reared to smolt size at either Quilcene NFH or WDFW's George Adams Hatchery. The coho are certified as free from regulated pathogens by USFWS and WDFW fish health professionals prior to their transfer to the pens. Fish in the pens are reared and released in accordance with co-manager fish health policy disease monitoring and control procedures. No adverse effects to natural summer chum juveniles are expected.

b) Adult summer chum salmon

As noted above, the risk of disease transfer to summer chum, including adult fish, is minimal for several of the major WDFW hatcheries in the region due to the lack of summer chum populations in the streams where the hatcheries are located. Compliance with co-manager fish health policy procedures minimize the risk of fish disease transfer for these, and other USFWS and WDFW-managed hatcheries. These procedures include collection of ovarian fluid, kidney, and spleen samples from a representative sample of the total number of each species spawned for evaluation by USFWS or WDFW fish health specialists for disease certification purposes. The hatcheries are also operated to comply with NPDES permit provisions to minimize the likelihood

for water quality impacts from hatchery effluent that may lead to increased natural-origin fish susceptibility to disease outbreaks.

The lack of summer chum populations in Enetai and Little Boston creeks, and compliance with co-manager fish health policy (NWIFC and WDFW 1998) fish disease monitoring, control, and hatchery sanitation procedures minimize the risk of disease transfer to adult summer chum from the tribal hatchery operations.

To address hatchery salmonid to natural-origin fish disease transmission concerns, the USFWS and the co-managers implement measures insuring that fish health is monitored and that hatchery fish are reared and released in good condition, thus minimizing disease risks to natural fish (e.g., NWIFC and WDFW 1998). WDFW's Fish Health Manual sets forth policies and procedures for the production of quality, healthy fish at the state-managed and administered hatcheries in the action area (WDFW 1996). The WDFW manual also serves as a guide for training Fish Hatchery Specialists operating the hatcheries in appropriate fish culture and fish health practices. Compliance with NPDES permit provisions at hatcheries also acts to minimize the likelihood for disease epizootics and water quality impacts that may lead to increased natural-origin fish susceptibility to disease outbreaks.

Compliance with the co-managers' fish health policy and the application of appropriate fish disease monitoring and control and hatchery sanitation measures by the USFWS and the con-managers should adequately minimize the risk of adverse effects to summer chum through fish disease transfer. Extension of compliance with the fish health policy to all non-governmental co-operative hatchery programs, and monitoring of their fish production practices and releases for fish health purposes, is necessary to further minimize the risk of disease effects on listed summer chum salmon. Compliance with the policy will include monitoring of hatchery broodstock and juvenile fish health by fish health professionals during operation; examination and certification of hatchery fish health by a fish health professional as free of regulated pathogens prior to release; and documentation of all fish transfers and releases, in compliance with transfer policies specified in the co-managers' fish health policy.

Based on the best available information, including disease monitoring and control procedures applied in the hatcheries, and the expectation for uniform compliance with fish health policies and standardly applied fish health maintenance measures, unlisted salmon hatchery programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild.

e. Competition, including Density-Dependent Effects

Food or habitat resource competition risks to natural-origin fish that may be posed by hatchery-origin fish are summarized in the above section addressing the effects of summer chum hatchery programs. The concerns for the unlisted salmon hatchery programs evaluated in this section are competitive effects, including injury and mortality, on listed summer chum salmon resulting from hatchery-origin juvenile and adult salmon produced in the action area.

1) Specific competition/density-dependent effects

a) Juvenile summer chum salmon

From the discussion of general effects presented in Section V.A.5., there is a potential for adverse competitive effects for some of the proposed programs. A indicated in Table 3, the likelihood is low that competition in freshwater resulting from releases of juvenile hatchery-origin pink, chum, sockeye, coho, and chinook salmon, and steelhead, will have a significant, negative impact on the productivity of natural-origin chum salmon. Summer chum salmon juveniles in the action area spend little if any time rearing in freshwater areas, emigrating soon after swim-up to marine waters (Koski 1975; Tynan 1997). Opportunities for freshwater competition between unlisted juvenile hatchery salmon and juvenile listed summer chum are therefore lacking. Adult hatchery-origin fish that return to spawn in freshwater areas where summer chum salmon redds are located may injure or kill incubating listed summer chum eggs or alevins through redd superimposition. This form of habitat resource competition is a concern for unlisted fall chinook salmon and early-returning coho salmon that enter summer chum streams during August, September or October to spawn.

Juvenile hatchery-origin pink and chum salmon are thought to pose a high risk of adverse competitive impacts when interacting with natural-origin juvenile chum salmon during the early marine life history stage (Table 4, from SIWG 1984). Due to a lack of data, other juvenile salmonid species produced by hatcheries have an unknown impact through competition on natural-origin chum salmon in nearshore marine waters. Hatchery-origin fall chum and pink salmon have a potential to compete with summer chum fry in marine waters for food in areas where they intermingle. Although hatchery fall chum and pink salmon fry releases may overlap with natural-origin summer chum in the estuary temporally, the degree to which the hatchery fish and natural-origin summer chum interact is affected by the estuarine realm used by the groups during seaward emigration. From Appendix A, the smaller, natural-origin summer chum fry likely migrate in shallow waters along the shoreline, until the fish reach a larger size (45-60 mm) that decreases their susceptibility to predation, enabling off-shore movement. Chum and pink salmon fry released from hatcheries after rearing to a size of 50 mm and larger tend to be found in pelagic areas during migration, separating them spatially from smaller emigrating natural-origin summer chum fry. Smaller fall chum and pink salmon released from hatcheries without rearing during the summer chum emigration period are of greater concern, because of their greater propensity to use the same nearshore feeding and migratory areas within the estuary as natural-origin summer chum fry. Unfed fry releases may therefore have a greater potential for interaction, posing an increased risk of adverse competitive effects.

Researchers have postulated that food resources preferred by chum salmon may be limited during the summer chum emigration period (Simenstad et al.1981). Any abundance level of hatchery fall chum or pink salmon present in the estuary during the summer chum emigration period may pose risks to summer chum. However, as noted previously, WDFW (1997) indicated the speculative nature of judgements regarding the competitive effects between hatchery fall chum and summer chum fry, either positive or negative. However, to be conservative, hatchery programs that are likely to lead to high spatial and temporal juvenile hatchery fish overlap with summer chum fry during emigration in marine areas are judged likely to pose a high risk of

adverse competitive effects. In making this assessment for juvenile fish, it is assumed that there is some as yet undefined, but critical, food resource carrying capacity in Hood Canal that limits chum and pink salmon fry population survival during the estimated summer chum emigration period (see Appendix A). The risk of adverse competitive effects is also considered high in instances where the fish release timing for a particular program is unknown (e.g., unmonitored RSI release programs).

The co-managers identified the need to minimize ecological risks by avoiding the predominate summer chum fry egression and early marine arrival periods through adjustments in hatchery fish release practices (WDFW and PNPTT 2000). The co-managers assigned a high risk of adverse effects for releases of fall chum and pink salmon from individual hatcheries during the main portion of the summer chum emigration period in Hood Canal. Based on average adult spawn timing, average water temperature regimes in summer chum streams, and water temperature-based summer chum egg and fry developmental data, in an average year, 90 % of the Hood Canal summer chum fry population is estimated to have emigrated into marine waters prior to April 1 WDFW and PNPTT 2000). Summer chum fry emigrating during February, March, and April migrate seaward from Hood Canal quite rapidly, leaving little opportunity for interaction for later arriving juvenile salmon in the estuary (Appendix A; summarized in Tynan 1997). Based on this estimated emigration timing and behavior, hatchery fall chum and pink salmon fry releases, and releases of other hatchery-origin juvenile fish species after April 1, have an increased likelihood for avoiding interaction, and competition with summer chum juveniles in marine migration areas. Programs that delay unlisted salmon releases until after April 1 are therefore considered at low risk for causing significant competitive effects to summer chum juveniles. Hatchery programs that delay juvenile salmon releases until after April 1 may affect the latest emigrating listed summer chum fry, but are not likely to adversely affect the majority of the emigrating natural fry populations.

Considering the hatchery programs evaluated in this section, fall chum salmon juveniles produced by USFWS at Quilcene NFH are a late-timed, native stock that are released after April 1 each year. Interactions between the hatchery fall chum and earlier-migrating summer chum are not likely, and the program is not expected to result in adverse competitive effects to summer chum fry in marine waters.

To respond to the concern that hatchery fall chum juveniles may adversely affect summer chum fry through competition (as per SCSCI recommendations), WDFW adjusted its hatchery programs so that the vast majority of fall chum juveniles are now released from the three major WDFW-managed hatcheries in southwest Hood Canal (Hoodsport, George Adams, and McKernan) after April 1. This action limits the potential for interaction, and therefore potential competition for food, with summer chum fry during the early marine life stage. A portion of the juvenile fall chum production at McKernan Hatchery, and most WDFW pink salmon production from Hoodsport Hatchery, are still released in mid- to late March in most years. WDFW is adjusting these hatchery programs through water use and fish production programming changes to release all fall chum and pink salmon groups produced at its hatcheries in the action area until after April 1 (M. Kimbel, WDFW, pers. comm.). In addition, several WDFW-administered

volunteer cooperative group programs release unfed and fed fall chum fry in the late winter. The co-managers have required these cooperative programs to delay fall chum release until after April 1 through the SCSCI (WDFW and PNPTT 2000).

Pink salmon fry from WDFW's Dungeness Hatchery are released prior to April 1 as part of a formal stock recovery program. This program is considered essential for the recovery of the critically depressed indigenous pink salmon population by the co-managers. Release numbers from the program are expected to be modest (less than 100,000 fry per year), given the low numbers of adults returning to the river that are available for collection as broodstock. Also, the fish are released into the Dungeness River, and are expected to disperse into Strait of Juan de Fuca waters shortly thereafter. The potential for competition with emigrating summer chum fry is therefore likely to be low for releases from this conservation hatchery program. NMFS finds that the benefits of the program to the recovery of the critically depressed Dungeness River pink salmon population outweigh the risks posed by the program to summer chum salmon.

Superimposition of redds by later salmon spawners removes previously deposited eggs from the gravel, and has been identified as an important source of chum salmon mortality in some areas (Bakkala 1970). Of particular concern is that many summer chum streams in the region record lowest flows during the summer chum spawning period (WDFW and PNPTT 2000). Low flows tend to constrain spawning of all species to center channel, lower river areas, especially in smaller creeks. In such instances, the effects of non-indigenous fish spawning in areas where summer chum redds are present is likely to adversely impact summer chum egg and fry survival. Natural-origin summer chum spawners in streams with greater channel widths and flows during the summer chum spawning period (e.g., certain west-side Hood Canal Rivers and the Dungeness River) may be less affected by non-indigenous salmon spawners, as fish may be able to disperse over larger areas. Hatchery releases of indigenous salmonid stocks, and adult returns resulting from them, may pose a decreased risk of negative effects through assumption of some measure of co-adaptation that has led to resource partitioning between the "native stock-origin" hatchery fish and summer chum. It is assumed that the indigenous salmonid species within a watershed have evolved mechanisms for segregating their use of limited resources that act to prevent or reduce interspecific competition.

Coho and fall chum salmon adults resulting from USFWS Quilcene NFH production are indigenous to the Big Quilcene River. Quilcene coho salmon adult migration timing overlaps with summer adult spawn timing, but the vast majority of coho home directly without delay to Quilcene NFH upon entering freshwater (L. Telles, USFWS, pers. comm. July 1999). The majority of the hatchery coho are removed from the river upon reaching the hatchery. Coho salmon originating from the hatchery do not tend to use the lower Big Quilcene River for spawning, and adverse effects to summer chum redds in the lower river through redd superimposition are not anticipated. Fall chum adults return in November and December to spawn in the Big Quilcene River. River flows are higher during this latter period, allowing the fall chum to use stream areas not available to summer chum salmon for spawning. The later spawn timing for fall chum salmon also decreases the likelihood for harm through superimposition to summer chum juveniles, due to their advanced developmental stage (alevins

rather than eggs) at the time of fall chum spawning. Quilcene NFH-origin fall chum adults are unlikely to adversely affect summer chum eggs deposited in September and early October through redd superimposition. Hamma Hamma Hatchery-origin chinook salmon adults produced through the Federally-funded WDFW-non-governmental cooperative program enter freshwater to spawn at the same time as summer chum salmon. Returning adult chinook in the Hamma Hamma River have the opportunity to disperse over a broad stream area, and spawning area partitioning between the chinook and summer chum salmon adults may be assumed. Redd superimposition risks to summer chum posed by this program are likely low.

Non-indigenous hatchery-origin adult fall chinook (Green River lineage) and fall chum (Finch Creek lineage) salmon returning to several summer chum streams in the action area as a result of WDFW-non-governmental cooperative program hatchery releases may adversely affect summer chum juveniles through redd superimposition. Fall chinook yearlings that have in the past been released from marine net-pen operations in the region (the Sund Rock, Hoodsport Marina, and Pleasant Harbor Marina net-pens) may stray into summer chum streams, posing a moderate risk of adverse effects through redd superimposition (WDFW and PNPTT 2000). The co-managers have discontinued the fall chinook net-pen programs to minimize redd superimposition risks to summer chum salmon (WDFW and PNPTT 2000).

Non-federally funded WDFW- non-governmental cooperative group fall chinook hatchery programs on the Union, Tahuya, and Dewatto rivers have been identified as of particular concern with regards to redd superimposition risks to summer chum salmon. NMFS and WDFW had determined that none of these eastside Hood Canal rivers have supported indigenous, self-sustaining chinook populations, and that returns have resulted from direct hatchery chinook outplants or straying hatchery fish (B. Waknitz, NMFS pers. comm.; T. Tynan, J. Ames, and T. Flint, WDFW, pers. comm.). Non-indigenous-origin fall chinook adults produced through these programs have been determined to pose a high risk of adverse competitive and behavioral modification impacts to native summer chum spawners (WDFW and PNPTT 2000). Fall chinook salmon adults produced through the programs have been observed to enter the rivers to spawn at the same time as summer chum. Due to the low flows available in September and early October, non-indigenous hatchery-origin chinook salmon adults produced by the cooperative programs have been observed to spawn in the same locations as the native summer chum spawners (spawning ground survey information for RM 0 - 2.1 from R. Egan, WDFW, pers. comm. and T. Johnson, WDFW, pers. comm.). The presence of spawning fall chinook in summer chum spawning areas enhances risks of spawning gravel competition and redd superimposition to listed summer chum. The co-managers have discontinued the freshwater fall chinook hatchery programs in the eastside Hood Canal summer chum streams, to minimize redd superimposition risks to summer chum salmon (WDFW and PNPTT 2000). NMFS believes that the termination of these fall chinook salmon programs is necessary so as not to appreciably reduce the likelihood for survival and recovery of listed summer chum salmon in the wild. Risks to summer chum posed by non-native fall chum salmon fry releases through the freshwater programs in the Union and Tahuya watersheds are unknown. The fall chum stock used in the programs originates from Finch Creek, and is an earlier spawn timing than native fall chum stocks in the Hood Canal streams where the hatchery fish are planted. Redd superimposition

risks posed by the earlier-spawning hatchery fall chum stocks are elevated compared with the native fall chum stocks, because, due to their earlier stage of development in the gravel, summer chum eggs may suffer greater mortality. The co-managers have reduced WDFW-non-governmental cooperative group hatchery fall chum salmon production in the Hood Canal summer chum watersheds to low levels to reduce risks to listed summer chum salmon so that the programs will not significantly affect their survival (WDFW and PNPTT 2000; T. Johnson, WDFW, pers. comm.).

Non-indigenous adult fall chinook returns from the WDFW-non-governmental group cooperative program on Big Beef Creek are required by the co-managers to be removed from the stream after capture at the hatchery weirs, preventing the fish from spawning in either Big Beef Creek or in the spawning channel (WDFW and PNPTT 2000). This measure prevents spawning location competition and redd superimposition effects on summer chum salmon in the process of being reintroduced to the creek. This program is considered to be of low risk to summer chum, if the operators continue the practice of removing hatchery fall chinook from the creek as the hatchery adult chinook return.

Chinook salmon adults resulting from WDFW's Dungeness Hatchery releases contribute to natural spawning as part of an indigenous stock recovery program. As noted above for the pink salmon program, adult chinook returns from the Dungeness Hatchery program are essential for the recovery of a critically depressed indigenous salmon population. In view of the importance of this program, and assuming spawning resource partitioning between the two indigenous species in river areas, risks posed by adult Dungeness Hatchery chinook to summer chum redds or eggs in the Dungeness River are considered low and acceptable.

Fall chum salmon juveniles produced at the Skokomish Tribe's Enetai Hatchery are a late-timed Wolcott Slough-origin stock that are released as fed fry after April 1 each year, and as unfed fry in March and April. Release of unfed fry at Enetai Hatchery will be terminated if it is not possible to release the fry after April 1 (WDFW and PNPTT 2000). Fall chum released from the Port Gamble Tribe's Little Boston Hatchery are of an earlier timed stock (Finch Creek lineage), but are released as fed fry after April 1. Significant interactions between the hatchery fall chum released as fed fry and migrating summer chum fry are not likely, and the programs are not expected to result in adverse competitive effects to summer chum fry. Delay or termination of unfed fry releases at Enetai Hatchery will also result in a low risk of adverse competitive effects with summer chum fry. Fall chum salmon adults resulting from production at the hatcheries return to streams that lack summer chum populations, and no adverse effects to summer chum through redd superimposition are expected. Quilcene-stock coho salmon adults resulting from PNPTT Quilcene Bay and Port Gamble Bay net-pen releases over-lap with summer chum in spawning ground migration timing. Quilcene Net-pen coho adults home to Quilcene NFH, and adverse effects on summer chum juveniles from these fish are unlikely (see above). The majority of returning Port Gamble Bay coho salmon are intercepted in tribal net fisheries in Port Gamble Bay. Coho not harvested in these fisheries have been shown to home to, or enter, Hood Canal tributaries south of the net-pen location, including the Big Quilcene River and other summer chum streams (NRC 1997). Given differences in spawning habitat preferences between

the two species and homing of coho reared at Quilcene NFH directly to the hatchery, the likelihood for interaction, and adverse effects, to summer chum juveniles is low.

b) Adult summer chum salmon

Hatchery-origin adult salmonids, including non-indigenous stocks of fall chinook, fall chum, or pink salmon that may home to, or stray into, summer chum production streams during the summer chum spawning or egg incubation period may pose an elevated competitive and behavioral modification risk to natural-origin summer chum productivity. These returning or straying fish may compete for mates or spawning locations, or adversely affect summer chum survival through redd superimposition (see above discussion).

Of the above species, fall chum incubated, reared, and released into streams not harboring summer chum populations are the least likely to stray from their home stream, and likely pose low risks of competition and behavioral modification hazards. Several sources indicate that chum salmon homing to hatchery release sites is quite strong. Salo (1991), reporting on a 1952 study of tagged fall chum released from, and returning to, Minter Creek Hatchery in south Puget Sound, noted no strays into adjacent streams in two seasons of monitoring. Studies of fall chum released from Wolcott Slough by USFWS showed the same result, with no strays reported in adjacent streams (Salo 1991, citing Wolcott 1978). Studies by Fuss and Hopley (1991) corroborated the above work indicating the high fidelity of chum salmon to their stream of origin, finding that over five consecutive brood years, an extremely small percentage of returning adult coded wire tagged fall chum released from Hoodsport Hatchery strayed to streams adjacent to the release site. Out of 6,600 tagged fish recovered over the five brood years studied, only 4 were recovered in Hood Canal streams outside of the hatchery. None of the tagged fish released at Hoodsport Hatchery during this study were recovered at other adjacent southwest Hood Canal hatcheries producing fall chum salmon (Enetai, McKernan, and George Adams).

The risk of adverse competitive effects is considered to be high for hatchery-origin adult fall chinook, fall chum, or pink salmon that are not part of a formal recovery program that, lacking avenues to remove the majority of returning fish, return or stray into summer chum spawning areas during the summer chum adult migration or spawning period. Where spatial and temporal overlap between hatchery-origin adult fish and summer chum is minimal, or tempered by hatchery management actions, the risk of adverse effects through competition is considered to be insignificant. Low risk outcomes include instances where little overlap on the spawning grounds or in the estuary between unlisted hatchery-origin salmon and summer chum adults is expected.

For the USFWS-funded programs, coho salmon adults produced through the Quilcene NFH program, and chinook salmon produced through the WDFW-non-governmental cooperative Hamma Hamma program, enter freshwater at a time when summer chum adults may be present. Because Quilcene NFH-origin coho salmon have a tendency to rapidly migrate upstream to the hatchery holding ponds, without delaying in the lower river, adverse effects to summer chum adults through competition for spawning gravel are not likely. Hamma Hamma Hatchery-origin

chinook salmon adults have the opportunity to disperse over a broad stream area, and spawning area partitioning between the chinook and summer chum salmon adults may be assumed.

WDFW hatchery programs identified above producing non-indigenous fall chinook adults that may return to, or stray into, summer chum streams without avenues for removing them are considered a high risk to summer chum adults through competition. As noted, fall chinook salmon release programs falling into this category (the yearling net-pen, and the Union, Tahuya, and Dewatto fall chinook fingerling programs) have been terminated by the co-managers (SCSCI 2000). Termination of these programs removes the risk of adverse effects to indigenous summer chum spawners in the ESU, and in particular, in the Union River. The co-managers' decision to terminate the programs also will minimize the risk of adverse effects to the few summer chum remaining in the Tahuya and Dewatto rivers, and to summer chum as they are reintroduced to these rivers in future years.

Required removal of all non-indigenous hatchery-origin fall chinook adult returns to Big Beef Creek through the hatchery weirs should adequately address the risk of adverse competitive effects to summer chum adults (WDFW and PNPTT 2000). The continuation of the practice of not allowing non-indigenous fall chinook to spawn naturally upstream using existing weirs is proposed (WDFW and PNPTT 2000).

Adult fish returning as a result of the WDFW-non-governmental co-operative group Duckabush chinook program, and WDFW's Dungeness Hatchery indigenous chinook and pink salmon supplementation programs, may interact with summer chum at unknown levels on the spawning grounds. Resource partitioning that is likely between the stocks in these larger watersheds during spawning minimizes the likelihood for significant adverse effects to summer chum salmon.

Coho salmon adults produced through the Port Gamble Bay net-pen program may pose risks to summer chum adults if they stray into and spawn within the same areas as summer chum in southern tributaries. These coho are of early-returning stock, and may enter summer chum streams at the same time as summer chum, posing an increased risk of adverse competitive effects through redd superimposition or competition for spawning sites. In past years, fish reared to smolt size at Quilcene NFH were found to home back to a large degree to that hatchery facility, and relatively few Port Gamble Net-pen fish were recovered in other east and westside tributaries of Hood Canal (NRC 1997). The reliance of the present net-pen program on transfers of Quilcene stock coho as smolts from George Adams Hatchery may lead to a different homing response, and increased straying. However, as noted above, differences in spawning habitat preferences between the two species make the likelihood for interaction, and the potential for adverse effects to summer chum low.

Based on the best available information, including consideration of risk minimization measures implemented to reduce the risk of juvenile salmon competition in marine areas, and assuming the co-managers' continued termination of hatchery programs determined through the SCSCI to pose a high risk of adverse competitive effects to listed summer chum salmon, unlisted salmon

hatchery programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild through competition effects.

f. Predation

The generic effects of hatchery salmon programs in elevating predation risks to natural-origin fish are summarized in the previous section addressing summer chum salmon hatchery program effects. Issues of concern regarding the unlisted hatchery programs evaluated in this section include risks to listed summer chum, including injury and mortality, attributable to direct predation by hatchery fish (direct consumption), and indirect predation (increases in predation by other predator species due to enhanced attraction) resulting from hatchery salmonid releases within the action area.

Specific predation effects

a) Juvenile summer chum salmon

From Tables 5 and 6, there is a high risk of a significant negative impact on natural-origin chum salmon due to predation by hatchery-origin chinook, coho, and steelhead in freshwater and nearshore estuarine areas where the species co-occur. There is a low risk of predation impacts to natural-origin chum for hatchery pink and chum release groups where they interact in freshwater and estuarine migrational areas.

As noted in the background section, salmonid predators are generally thought to prey on fish approximately 1/3 or less their length (USFWS 1994). Hargreaves and LeBrasseur (1986) reported that coho salmon smolts ranging in size from 100-120 mm FL selected for smaller chum fry (sizes selected 43-52 mm FL) from an available chum fry population including larger fish (available size range 43-63 mm FL). Ruggerone (1989; 1992) also found that coho smolts (size range 70-150 mm FL) selected for the smallest sockeye fry (28-34 mm FL) within a available prey population that included larger fish (28-44 mm FL). Summer chum in the region emerge at an approximate size of 1200-1300 fpp, or 35-39 mm FL (Bakkala 1970; Salo 1991; Tynan 1997; Fuss 1997; S. Schroder, WDFW unpublished data for Big Beef Creek 1999). Applying the “1/3 size criteria” to the minimum chum fry size from the above range (35 mm) to assess risk, hatchery fish released at a size equal to or larger than 106 mm fl, or attaining that size after release as fry through freshwater rearing, during the summer chum freshwater and marine emigration period may pose an elevated, direct predation risk to emigrating summer chum fry.

Hatchery pink salmon and fall chum salmon released as fry during the summer chum emigration period may pose an elevated, indirect predation risk. Alternatively, large concentrations of hatchery pink and fall chum fry migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring natural-origin summer chum. Hargreaves and LeBrasseur (1985) demonstrated that coho salmon prey selectively on pink salmon, even when intermingled chum salmon are both significantly smaller and more abundant than pink salmon. Thus, hatchery pink salmon fry releases during the summer chum fry emigration period may attract and occupy potential chum salmon predators.

Due to their location in the lower portions of regional watersheds and relatively early time of emergence (late February through April), natural-origin summer chum fry will not generally be vulnerable to predation by hatchery salmon smolts. Hatchery yearling coho, steelhead, and chinook smolts that, due to their relatively large size at release, have the greatest potential to impact juvenile natural-origin fish through predation are liberated into mainstem river areas beginning in late April or early May, separating them spatially and temporally to a significant degree from emerging and migrating summer chum fry (see Table 11). Hatchery coho and steelhead planted into summer chum watersheds as fry or fingerlings may have an elevated potential to prey on emerging summer chum fry the subsequent year as yearlings if they are rearing in lower stream areas. Release practices implemented to provide spatial and temporal separation between hatchery fall chinook salmon, coho salmon, and steelhead smolts, and summer chum fry, minimize predation risks. The critically depressed status of summer chum calls for a conservative approach to hatchery fish release practices and the assessment of their effects. Further studies are needed in nearshore areas to fully evaluate the risk of predation to summer chum emigrants posed by resident chinook and coho resulting from hatchery programs within the action area.

For those hatchery programs in the action area releasing salmon at a size greater than 106 mm fl, a delay in allowable release time through April 15 is implemented by the co-managers to allow some progression in the migration of summer chum fry seaward and out of the estuary. Risks of predation are determined to be "low" through the SCSCI for salmonid releases made after April 15 for "large" smolts (> 106 mm FL) that may pose a direct predation risk. The risk of adverse effects from hatchery fish predation is considered high for hatchery-origin juvenile salmonids of this size that are still released prior to April 15. A release date of April 15 is applied to take into account the need for emigrating summer chum fry populations to clear, to a significant extent, the Hood Canal estuary, as estimated from migration timing data (see Appendix A). The co-managers assess indirect predation risks through enhanced predator attraction as "high" for pre-April 1 releases of fall chum or pink fry near (within 1000 yds of) a summer chum stream, and for fry released directly into a summer chum stream prior to April 1 (WDFW and PNPTT 2000). Risks are also considered low for conspecific fish species releases made after April 1 in or near summer chum streams that might pose indirect predation effects. The above approach for decreasing the likelihood for interaction between unlisted hatchery-origin salmon juveniles that may potentially prey on summer chum fry, and emigrating natural-origin summer chum fry is expected to adequately minimize listed summer chum predation risks.

USFWS coho salmon fingerling releases from Quilcene NFH into the Big Quilcene River may lead to direct predation of summer chum fry when the coho are present in lower river reaches as smolts during the summer chum fry emigration period the subsequent year. USFWS proposes to curtail releases of coho fingerlings into the river, instead using adult coho salmon passed upstream of the hatchery to seed available upstream habitat naturally (Zajac 2000). Yearling coho smolt and fall chum fry releases from the hatchery presently occur after April 15, and no direct or indirect predation effects from these species are expected.

WDFW-managed programs posing a risk of adverse predation effects to summer chum juveniles include: the Snow Creek natural-origin coho salmon fry and fingerling release project (direct predation risks); the pink salmon fry release program at Dungeness Hatchery (potential indirect predation risks); and the volunteer cooperative hatchery programs producing fall chum salmon on the Union and Tahuya rivers (indirect predation risks). Coho juvenile releases into Snow Creek may lead to the predation of Snow/Salmon stock summer chum fry when the coho are present in the creek as smolts the following year during summer chum emigration. Because the degree of risk is unknown, and because the project is part of a stock recovery program, monitoring should be conducted to identify coho survival rates, distribution within the stream, and actual predation effects on summer chum fry. Pink salmon fry releases from Dungeness Hatchery are made prior to April 1 into an identified summer chum stream., potentially leading to indirect predation effects through predator attraction. NMFS views the risk of adverse predation effects of this program on summer chum fry as acceptable in recognition of the critically depressed abundance status of the supplemented pink salmon population and the urgent need to recover the pink salmon population to a viable abundance level. Fall chum salmon fry releases from the Tahuya and Union volunteer group RSI programs also occur prior to April 1 Indirect predation risks resulting from these releases are proposed to be reduced by delaying fall chum releases until after April 1, or through termination of these programs (WDFW and PNPTT 2000).

PNPTT freshwater hatchery and net-pen programs are unlikely to pose significant predation risks to summer chum juveniles. Net-pen coho smolts and fed fall chum fry are released after April 15 each year, significantly limiting the likelihood for interaction with summer chum fry. Delay in release until after April 1, or termination of unfed fry releases from Enetai Hatchery as proposed by the Skokomish Tribe (WDFW and PNPTT 2000) will further minimize risks to natural summer chum of indirect predation.

b) Adult summer chum salmon

Given the size of unlisted juvenile hatchery fish released and the similar sizes of the species at adulthood, the programs are not likely to affect summer chum salmon adults through predation.

Based on the best available information, including consideration of risk minimization measures implemented to reduce the risk of juvenile hatchery salmon predation, unlisted salmon hatchery programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild through predation effects.

g. Residualism

General hatchery salmon residualism effects on natural fish populations are summarized in the above section addressing the effects of summer chum hatchery programs. The concerns for the proposed unlisted salmon hatchery programs evaluated in this section are the potential effects, including injury and mortality, of residualizing hatchery fish on listed summer chum salmon.

Specific risks of residualism effects

a) Juvenile and adult summer chum salmon

As noted in the above section addressing predation effects, SIWG (1984) reported that there is a high risk of a significant negative impact on natural-origin juvenile chum salmon due to predation by hatchery-origin chinook, coho, and steelhead in freshwater areas where the species co-occur. If steelhead released after April 15 into streams within the action area residualize and do not migrate, they have the potential to prey on summer chum fry if the steelhead survive and remain in summer chum emigration areas until the following year. From Section V.A.7., coho salmon released as yearling smolts do not generally have the same potential to residualize as steelhead. Although most chinook salmon stocks in Puget Sound are ocean-rearing stocks, WDFW trapping data on the Dungeness River has indicated that chinook fry or fingerlings released into the river in the summer months may remain in freshwater, and migrate the following spring as yearlings. Ocean-type chinook salmon generally begin migration towards salt water soon after emergence, and it is unknown whether a significant percentage of the total annual WDFW Dungeness Hatchery chinook fry and fingerling release adopt a yearling life history strategy that might pose risks to summer chum fry in the Dungeness River.

No steelhead, the main species of concern regarding residualism effects to summer chum fry, are produced through the USFWS Quilcene NFH program. Coho salmon smolts produced at the hatchery have a low risk of residualizing in the river, and adverse effects to summer chum fry are not likely. The Federally funded WDFW-non-governmental group cooperative program on the Hamma Hamma River releases indigenous origin steelhead smolts. The Hamma Hamma programs will also release hatchery-produced adult steelhead into the river.

Releases of steelhead smolts also occur through WDFW hatchery programs on the Skokomish, Dungeness, and Duckabush rivers. With the exception of the Skokomish River, where summer chum have been extirpated, these rivers harbor summer chum populations that may be affected by steelhead that residualize from these releases.

The practice of releasing migration-ready hatchery steelhead smolts through the programs in the action area minimizes the risk of residualism, and therefore interaction with summer chum fry in the subsequent season. Physiological measures of the degree of smoltification within the hatchery populations, including allowable fork length coefficient of variation maximums (CV less than 10 %) and average condition factor at release targets (0.9 - 1.0), are used by WDFW to indicate when fish should be allowed to be liberated. Steelhead released into the Dungeness River are acclimated at the hatchery through rearing. The potential for residualism by steelhead in the region may be reduced by using a combination of acclimation, volitional release strategies,

and active pond management whereby steelhead not meeting smolt size criteria are not released. WDFW hatcheries use a combination of these strategies for reducing steelhead residualization.

Although questions remain regarding the proportion of hatchery steelhead that residualize after liberation, the issue of whether these steelhead survive a full year in freshwater after release also bears upon the degree of risk to summer chum salmon fry. Hatchery-origin steelhead smolts in Hood Canal have a very low smolt-to-adult survival rate (WDFW Fish Program and PNPTT data, 1997), and it is unlikely that the programs pose a significant risk of adverse effects to summer chum through residualism in the rivers where they are planted.

No steelhead are produced through any of the tribal programs in the region. Coho salmon smolts are released from the Quilcene Bay and Port Gamble Bay net-pens into marine waters, and there is no risk of residualization in their river of origin. Delayed release coho may remain in Puget Sound marine waters after release, however, and have a potential to prey on summer chum fry if they are present in nearshore marine waters used by emigrating fry the subsequent year. The actual risk of predation by residualizing coho salmon in marine waters is unknown. Although risks of residualizing hatchery fish in freshwater are low, research is needed to indicate whether residualizing hatchery coho salmon in Puget Sound marine waters pose an elevated risk of predation to emigrating summer chum salmon fry.

Unlisted salmon hatchery programs in the action area are not expected to reduce the listed summer chum populations, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild as a result of residualism.

h. Fisheries Effects from Program Releases

The issue of fisheries effects resulting from hatchery program adult salmon production was introduced in the above section describing summer chum salmon hatchery program effects. The concern regarding the programs evaluated in this section is that an increased incentive for hatchery-origin salmon-directed fisheries as a result of adult salmon produced by the programs may lead to elevated fishery-related injury and mortality to commingled summer chum salmon adults.

Specific fisheries effects

a) Juvenile and adult summer chum salmon

The effects of fisheries directed at other anadromous salmonid species produced by hatcheries in the action area on listed summer chum salmon have been evaluated by NMFS in separate section 7 consultations (NMFS 1999b; 2000c). “No jeopardy” conclusions pertaining to those fisheries were determined through those consultations. This Opinion defers to the previous NMFS consultations (NMFS 1999b; 2000c) regarding “no jeopardy” findings for the harvest actions. Information in this section regarding fisheries effects is provided to indicate whether the hatchery actions are integrated with appropriate harvest responses.

Under the SCSCI, and based on the NMFS consultation, there are no fisheries in the action area directed at summer chum salmon. In addition, other fisheries directed at other salmon species,

including hatchery-origin adult salmon produced by the programs evaluated in this section, are managed to limit any incidental harvest effects on summer chum to levels that will not jeopardize their continued existence or destroy or adversely modify their critical habitat (NMFS 1999b; 2000c).

As noted in the "Environmental Baseline" section of this Opinion, the co-managers' harvest management strategy uses a conservative, four-way control mechanism to preserve and protect adult summer chum from adverse fisheries effects. The "Baseline Conservation Regime" has been developed to guide the management of fisheries affecting summer chum. The regime is implemented through time and area closures, summer chum salmon release requirements, and gear restrictions. The expected summer chum population exploitation rate in fisheries within the action area under this regime is 2.1% (range 0.5% to 3.5%) in the Hood Canal region and 0% in the Strait of Juan de Fuca region (WDFW and PNPTT 2000).

NMFS has determined, in separate section 7 consultations, that marine and freshwater fisheries directed at other anadromous salmonid species, including those harvesting fish produced by hatcheries within the action area, are not likely to jeopardize the continued existence of the Hood Canal summer chum salmon ESU (NMFS 1999b; 2000c). The hatchery programs evaluated in this section do not produce unlisted salmon that lead to the implementation of fisheries posing risks to listed summer chum salmon. As per the findings of the NMFS harvest consultations, the hatchery programs are adequately integrated with conservative SCSCI harvest management actions to protect listed summer chum in the action area, so as to not appreciably reduce the likelihood for their survival and recovery in the wild.

i. Masking

The potential for fish produced by hatcheries to mask the status of natural-origin adult salmon populations of the same species is the issue of concern. Drawing from Section V.A.9., of specific concern in this section is the potential inability to differentiate unlisted salmon adults produced through the hatchery programs from natural-origin summer chum salmon, and consequent effects on natural-origin summer chum salmon stock status and hatchery summer chum salmon program effectiveness determinations.

No effects associated with masking of natural summer chum population status will occur through the proposed unlisted salmon hatchery programs, due to species and adult spawning ground entry timing differences for fish produced through the proposed programs. No summer chum salmon are produced by the programs evaluated in this section. Hatchery-origin chinook, pink, and coho salmon adults that return to the action area during the summer chum migration and spawning period are unlikely to be confused with listed summer chum salmon adults.

j. Monitoring and Evaluation

The general effects of hatchery program monitoring and evaluation and research programs on natural-origin fish are summarized in the above section describing summer chum hatchery program effects. Of concern for the hatchery programs evaluated in this section of the Opinion are the effects of monitoring and evaluation and research on listed summer chum salmon, including injury and mortality, resulting from their incidental contact during these activities.

Monitoring and evaluation program objectives and effects

a) Juvenile and adult summer chum salmon

Monitoring and evaluation are proposed for most of the artificial production programs addressed in this section of the Opinion. Generally, monitoring and evaluation is conducted to determine if the hatchery is meeting its performance goals. As proposed for many of the programs, and as an outcome of this Opinion, monitoring and evaluation is also necessary to determine if management actions are adequate to reduce or minimize adverse hatchery impacts to listed fish.

Most monitoring and evaluation actions conducted to identify hatchery performance and to minimize risks to listed fish will occur within the hatcheries, where impacts to listed summer chum are not likely. Monitoring and evaluation actions directly attached to the hatchery programs that may potentially affect listed summer chum fish in the natural production areas are confined to spawning ground surveys. These surveys are routinely conducted by WDFW and USFWS salmon stock assessment personnel to document natural escapement levels in the region. Mark recovery may also be part of the stream survey actions to collect information regarding escapement contribution and stray rates of hatchery-origin salmonids. Spawning ground surveys can potentially lead to elevated risks to fish, though harassment, or mortality to summer chum eggs if redds are inadvertently contacted and harmed. The actual effects of these potential hazards to listed summer chum are unknown. To reduce the likelihood for adverse effects, the co-managers use trained technical staff to conduct stream surveys. Surveyors avoid contact with redds and minimize disturbance to spawning fish by staying out of the stream channels to the extent feasible (WDFW and PNPTT 2000). No other monitoring and evaluation actions that may potentially affect listed summer chum have been proposed.

Adequate measures designed to minimize the potential for injury and mortality of listed summer chum salmon are implemented for the stream survey programs associated with the unlisted salmon hatchery programs. The spawning ground surveys will provide information that will enhance the ability to make more effective and responsible decisions regarding unlisted hatchery salmon production to aid listed summer chum salmon. Also, the survey activities are distributed throughout the Hood Canal summer chum salmon ESU's freshwater range and within streams where summer chum are not present, thereby further diminishing the impacts of any take. For these reasons, monitoring and evaluation, and research-related takes, are not expected to reduce the Hood Canal summer chum population, their reproductive capacity or distribution to the point of appreciably reducing their ability to survive and recover in the wild.

k. Summary of Effects of Artificial Propagation Programs Producing Other Salmonid Species

a) Operation of hatchery facilities - Risks posed to summer chum salmon by the physical operation of hatcheries in the action area should be adequately reduced through existing water withdrawal structures and practices, and through compliance with applicable, effluent discharge permits so as to not appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild.

b) Broodstock collection - The risk of effects on summer chum juveniles and adults through broodstock collection activities directed at other salmon species, if any, are expected to be adequately minimized by operating all fish weirs and collection programs for the primary purpose of protecting summer chum adults and redds, minimizing fish holding time in traps, careful handling and release of any summer chum salmon inadvertently captured, and continuous monitoring of fish trapping operations by trained personnel. Unlisted salmon broodstock collection programs are not likely to appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild.

c) Genetics - No genetic effects from the proposed actions are likely. Fall chum salmon produced through the programs are later in spawning ground entry timing than summer chum, and inter-breeding between the two races is unlikely.

d) Disease - Risks of disease amplification and transfer from hatchery fish to natural summer chum are limited through full compliance with co-managers' fish health policy fish health monitoring, disease control, and hatchery sanitation protocols (NWIFC and WDFW 1998) and application of standard fish health maintenance and hatchery sanitation procedures. The unlisted salmon hatchery programs are nor likely to appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild as a result of fish disease transmittal.

e) Competition/density-dependent effects - Risks of adverse ecological effects on listed summer chum salmon should also be adequately minimized through the implementation of proposed measures that limit interaction between hatchery salmonids and summer chum in freshwater migration and spawning areas, and in marine area migration and rearing areas. The Federal and non-Federal agencies limit interactions through the release of all hatchery fish species and life stages that may impose risks of adverse competition effects at times, and in areas, where the likelihood for contact with summer chum is low. Adjustments or reductions in those hatchery programs presently releasing hatchery fish that are likely to adversely affect listed summer chum salmon through competition have been implemented. Given these actions, the unlisted salmon hatchery programs are unlikely to appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild as a result of competition by hatchery-origin salmon.

f) Predation - Implementation of proposed measures by the agencies that limit interaction between hatchery salmonids and summer chum in freshwater migration areas, and in marine area migration and rearing areas should adequately minimize predation risks so as to not appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild.

g) Residualism - The risks of residual steelhead effects on summer chum are adequately reduced through application of release practices designed to maximize the number of migration-ready smolts liberated. No effects to summer chum salmon in the action area are expected for this potential hatchery hazard.

h) Masking - Masking of summer chum salmon population status is not likely to occur through the unlisted salmon hatchery programs due to species and return timing differences.

i) Fisheries - Fisheries in the action area are judged as posing no jeopardy to listed summer chum salmon in previous NMFS consultations (NMFS 1999b; 2000c). Adverse fisheries effects to listed summer chum salmon resulting from unlisted hatchery salmon production are not likely.

j) Monitoring and evaluation - Monitoring and evaluation programs conducted through the hatchery programs are mainly directed at unlisted adult and juvenile fish held or reared in the hatchery, and no effects on listed summer chum will occur. Spawning ground surveys conducted as part of the unlisted hatchery programs apply practices that adequately minimize risks to listed summer chum salmon adults. These surveys are unlikely to appreciably reduce the ability of the listed summer chum salmon ESU to survive and recover in the wild.

l. Consistency of the Proposed Actions with the Summer Chum Salmon Conservation Initiative (SCSCI)

Section 3.3 of the co-managers' SCSCI (WDFW and PNPTT 2000) defines artificial propagation measures in the action area that are necessary to minimize the risk of adverse ecological effects to listed summer chum salmon. The actions proposed by the action agencies that are reviewed in this Opinion are consistent with risk aversion measures directed at summer chum protection that are presented in the SCSCI.

V. Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they will require separate consultation pursuant to section 7 of the ESA. For the purposes of this analysis, the action area encompasses all river reaches accessible to listed summer chum (including estuarine areas and tributaries) draining into Hood Canal, as well as Olympic Peninsula rivers between and including Hood Canal and Dungeness Bay, Washington. Also included are estuarine and marine areas

of Hood Canal, Admiralty Inlet, and the Strait of Juan de Fuca to the international boundary, and as far west as a straight line extending north from Dungeness Bay. Under the section 4(d) rule specifying take prohibitions pertaining to listed salmonid stocks in the region (65 FR 42422 - July 10, 2000), future state, tribal, local, or private actions that may affect ESA-listed threatened salmonids in the action area would require authorization under either the new 4(d) rule, or under section 10 of the ESA. These future actions would be evaluated by NMFS for compliance with the 4(d) rule and/or under section 7 consultations, and therefore are not considered cumulative to the proposed action.

VI. Conclusions

NMFS' approach for determining whether the proposed actions are likely to jeopardize the continued existence of ESA-listed salmonids or destroy or adversely modify designated critical habitat is based on an analysis of the existing or potential risk of hazards posed by the actions. NMFS has considered the above risk assessment sections, compliance of the proposed actions with the o-manager's SCSCI (WDFW and PNPTT 2000), and the likelihood for survival and recovery of the listed salmon ESUs under the environmental baseline in making its jeopardy determination.

After reviewing the current status of listed Hood Canal summer chum salmon and Puget Sound chinook salmon, the environmental baseline for the action area, the effects of the proposed Federal and interrelated and interdependent non-Federal summer chum salmon artificial propagation programs in the action area, and cumulative effects, it is NMFS' biological opinion that the proposed Federally funded summer chum salmon supplementation and reintroduction programs in the Hood Canal and Strait of Juan de Fuca regions are not likely to jeopardize the continued existence of the listed Hood Canal summer chum salmon ESU and the Puget Sound chinook salmon ESU or result in the destruction or adverse modification of their designated critical habitat. Furthermore, the supplementation and reintroduction programs reviewed and covered in this Opinion have been effective in increasing production of summer chum fry above levels feasible through natural production, and should provide a survival benefit to Hood Canal summer chum salmon. The collection of Hood Canal summer chum salmon adults required as broodstock for the supplementation and reintroduction programs is expected to help reduce the short-term risk of extinction of the ESU and speed recovery. Monitoring and evaluation proposed for the programs will help insure that risks to the listed ESUs are adequately minimized and within the levels of take authorized.

NMFS concurs with WDFW, the PNPTT, and USFWS that the status of the summer chum populations within the Hood Canal and eastern Strait of Juan de Fuca regions has declined to such low levels that the risk of extinction to portions of the ESU on the short term is high. In combination with other management actions aimed at addressing factors for decline, supplementation and reintroduction may be effectively applied to reduce the short term risk of extinction to existing natural-origin populations, and help restore natural summer chum

production to healthy levels within the ESU. The Federally funded artificial production programs reviewed in this Opinion will provide a short-term boost in productivity, conserve distinct population structure within the regions, assist in the reintroduction of summer chum into vacant habitat that appears unlikely to be re-colonized within a reasonable time frame, and help prevent the extinction of the ESU. The proposed programs are conducted consistent with the concepts contained in the NMFS VSP document (McElhany et al. 2000). The programs are operated to preserve the abundance, productivity, population spatial structure, and diversity of the listed summer chum ESU. If successful, the supplementation and reintroduction programs should help improve the status of the individual summer chum stocks into viable population threshold ranges.

NMFS believes that the risk of summer chum salmon extinction, and risks associated with demographic effects, including extirpation of discrete stocks within the ESU and population bottlenecks, exceed the potential risks of adverse effects from inbreeding, loss of genetic variability and domestication that may result from artificial propagation. The risk of adverse genetic effects to natural summer chum populations can be minimized through the 12 year limit on the duration of the supplementation programs, and hatchery operation, broodstock collection, and monitoring and evaluation protocols proposed for all programs. The risks to the summer chum stocks used for the supplementation and reintroduction programs are further diminished by measures that address activities within the hatchery environment, including hatchery operation, broodstock collection, fish mating, rearing, release, and monitoring and evaluation protocols. The programs should therefore be effective in adequately protecting existing natural summer chum populations from adverse genetic and ecological effects, and reducing the risk of extinction to the ESU, while potential factors for decline are being addressed.

Impacts to listed Puget Sound chinook salmon may occur as a result of the proposed actions. Listed Puget Sound chinook may be handled during broodstock collection activities in the Hamma Hamma and Union rivers, and straying chinook may be encountered at other summer chum trapping operations. Low numbers of listed chinook are likely to be encountered in the watersheds where the summer chum trapping programs will occur, and risk minimization measures that are applied to insure that any incidentally encountered chinook are not harmed, indicate that risks to listed chinook are low. Because summer chum salmon are the focus of the proposed supplementation and reintroduction programs, and considering fish propagation protocols proposed, adverse ecological or genetic effects on listed chinook as a result of the programs are unlikely. The summer chum salmon hatchery programs are not expected to appreciably reduce the likelihood for survival and recovery of listed Puget Sound chinook.

In conclusion, NMFS believes that the proposed Federal summer chum salmon supplementation and reintroduction covered by this Opinion will benefit recovery of the listed Hood Canal summer chum salmon ESU. Some facets of the proposed programs do have the potential to adversely affect the listed summer chum and chinook salmon populations, but NMFS believes that measures taken by the action agencies will adequately minimize the risks. The current status of the summer chum salmon populations within the ESU proposed for supplementation is such

that, without the proposed artificial production programs, extirpation of one or more of the stocks comprising the ESU is likely.

NMFS has also determined, based on evaluation of the best available science and information, the environmental baseline for the action area, the effects of the Federally funded and interrelated and interdependent non-Federally funded artificial propagation programs in the action area, and the cumulative effects, that the proposed Federally funded artificial propagation programs that produce other salmonid species in the action area are not likely to jeopardize the continued existence of the listed Hood Canal summer chum salmon ESU or result in the destruction or adverse modification of their designated critical habitat.

Increased risks of adverse impacts to listed Hood Canal summer chum salmon may result from the proposed artificial propagation of other anadromous salmonid species in the action area. Listed summer chum may be handled incidentally during pink salmon-directed broodstock collection activities in the Dungeness River, and straying summer chum may be encountered at other chinook, coho, and pink salmon trapping operations. The level of incidental take of listed summer chum that may occur during broodstock collection directed at other species is likely to be low, and insignificant relative to the total annual adult summer chum population return. Given measures proposed by the action agencies to limit effects of the hatchery operations on summer chum, including production and release practices directed at limiting interactions between hatchery fish and summer chum in the action area, adverse ecological or genetic effects on listed summer chum as a result of the programs are unlikely. The impacts from these programs are not expected to jeopardize the continued existence and recovery of listed Hood Canal summer chum salmon.

VII. Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or develop information. NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented.

1. USFWS and BIA should coordinate with WDFW to plan and implement research to assess spatial and temporal overlap, and food resource competition, between hatchery-origin chum salmon juveniles and listed natural summer chum salmon fry in Hood Canal estuarine areas used for early rearing and seaward emigration. The results of this research will improve scientific understanding regarding the potential effects of hatchery chum salmon production on summer chum salmon early marine survival.

2. USFWS and BIA should coordinate with WDFW to plan and implement studies to assess the current ecological carrying capacity of freshwater and nearshore marine

habitats critical for summer chum survival. The results of these studies would help improve scientific understanding of the effects of hatchery salmon production in the action area, and appropriate levels of juvenile hatchery fish production.

3. USFWS and BIA should coordinate with WDFW to plan and implement studies that evaluate the expected time required to secure the recovery of degraded freshwater habitat areas critical to summer chum salmon productivity. Information gathered from such studies could be used to determine if allowable durations of summer chum salmon supplementation and reintroduction programs defined in the SCSCI and in this Opinion (three chum salmon generations or 12 years) are realistic and in need of reconsideration.

VIII. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary; and must be undertaken by the action agencies so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The action agencies have a continuing duty to regulate the activity covered in this incidental take statement. If the action agencies 1) fail to assume and implement the terms and conditions or 2) fail to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agencies must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR 402.14(i)(3)).

A. Amount or Extent of Take

When operated at “goal” levels proposed by the USFWS and the co-managers, the proposed summer chum salmon supplementation and reintroduction programs will lead to the capture, handling, and spawning of up to 1,882 adult summer chum and the artificial propagation and potential release of approximately 2,035,000 juvenile summer chum each year. There is the potential for take of listed natural summer chum and chinook salmon during summer chum

broodstock collection, and as a result of hatchery summer chum fry releases and subsequent adult returns. Listed natural summer chum adults above programmed collection levels, and listed chinook salmon (in particular, at one location: the Hamma Hamma project), may be captured handled, and released during summer chum trapping operations. The number of listed summer chum salmon adults that may be encountered is difficult to quantify, and dependent on the type and location within the watershed of the individual trapping operation, and total annual return numbers to each watershed where broodstock collection operations are conducted. Because of the location of weirs used to trap broodstock, the Lilliwaup, Salmon Creek, and Jimmycomelately programs may capture and handle nearly 100 % of the total summer chum returns. Incidental take levels may increase as adult returns of listed summer chum increase in the future, in response to ESU-wide recovery actions. Up to 50 listed chinook adults may be encountered during summer chum broodstock collection in the Hamma Hamma River. Although the number of listed chinook adults that may be taken in the other summer chum-directed broodstock trapping programs is unquantifiable, it is likely to be low (< 5 fish), and dependent on straying levels of listed adult chinook to the watersheds from other areas where self-sustaining chinook salmon populations are present. Measures applied to safeguard fish during capture, handling and release will minimize injury and mortality of incidentally captured, listed adult salmon.

The incidental take of listed natural Hood Canal ESU summer chum and Puget Sound chinook salmon during summer chum broodstock collection is not expected to jeopardize the continued existence of the ESUs. The incidental capture, handling, and release of natural summer chum adults not required as broodstock for the summer chum supplementation and reintroduction programs is authorized for the proposed programs. The incidental capture handling, and release of up to 50 fall chinook adults through the Hamma Hamma program, and additional low numbers of straying adult chinook through the other programs, is also authorized.

Hatchery summer chum fry releases and subsequent adult returns may lead to the incidental take of listed natural summer chum and chinook salmon through the imposition of ecological effects (affecting both listed species) or genetic effects (affecting natural summer chum). In addition, the proposed hatchery juvenile chinook, coho, pink, and fall chum salmon, and steelhead release programs have a potential to result in the incidental take of listed summer chum salmon in the Hood Canal and eastern Strait of Juan de Fuca regions. Incidental take levels associated with these programs are difficult to define. The inherent biological attributes of aquatic species such as salmon and steelhead, the dimensions and variability of the freshwater and estuarine habitats included within the action area, and the operational complexities of artificial propagation actions impairs NMFS' present ability to determine, or quantify, ESA-listed fish incidental take levels attributable to artificial propagation activities evaluated in this Opinion. NMFS has relied on a qualitative analysis to evaluate the effects of the actions on listed fish in the absence of quantifiable estimates of incidental take. In the absence of quantified estimates that might be used to limit the effects of the proposed programs, NMFS will require monitoring of broodstock collection activities, fish release numbers, and fish release locations, and evaluation of the results of hatchery research programs directed towards identification of ecological and genetic impacts,

to assure that the incidental takes, and the potential effects to ESA-listed species associated with such takes, are minimized.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts, and sets forth terms and conditions with which the action agencies must comply in order to implement the reasonable and prudent measures.

B. All Agencies Reasonable and Prudent Measures

The following reasonable and prudent measures are provided to minimize levels, and the effects of, incidental take that are likely to be associated with all of the proposed artificial propagation programs:

1. All agencies shall manage their programs to reduce potential negative impacts to listed Hood Canal ESU summer chum and Puget Sound ESU chinook salmon that may result from the operation of their respective artificial propagation facilities in the Hood Canal and eastern Strait of Juan de Fuca regions.

2. All agencies shall manage their respective summer chum supplementation and reintroduction programs, and other hatchery programs in the action area, to not exceed maximum adult broodstock collection and/or juvenile salmonid release levels proposed for the programs, and evaluated in this Opinion.

3. All agencies shall collectively monitor and evaluate the artificial propagation programs in the Hood Canal and eastern Strait of Juan de Fuca regions.

4. All agencies shall, *during the trapping of adult summer chum salmon for broodstock,* minimize the incidental take of listed summer chum salmon (above desired broodstock collection levels) and chinook salmon. All agencies shall, during the trapping of *other adult salmon species* for broodstock, minimize the incidental take of summer chum salmon.

5. All agencies shall coordinate all hatchery programs used to recover summer chum salmon stocks and to produce other salmonid species in the Hood Canal and eastern Strait of Juan de Fuca regions with the other fisheries co-managers.

C. All Agencies Terms and Conditions

To carry out these reasonable and prudent measures, the following terms and conditions shall be implemented by the action agencies and the private and cooperative volunteer cooperators administered by those agencies:

Summer Chum Supplementation and Reintroduction Programs

1a. To minimize the likelihood for deleterious genetic changes in natural summer chum populations that are the focus of the supplementation and reintroduction programs, the duration of regional supplementation programs shall be limited to a maximum of 12 years,

or three chum salmon generations. A three generation (12 year) limit for the duration of each program is intended to address the concern that repeated enhancement of the same population segment will result in a decrease in effective population size. It also limits to a few generations, the exposure of natural fish to potentially deleterious selective effects of hatchery conditions, minimizing the likelihood for divergence between hatchery and natural-origin fish within a supplemented stock.

1b. To minimize the likelihood for catastrophic loss of summer chum while under artificial propagation, all summer chum shall be reared in facilities that apply measures ensuring the safety of eggs, fry, and adults. These measures must include: on-site residence or consistent site monitoring by personnel trained in facility operation, fish propagation, and fish health maintenance procedures to allow rapid response to power or facility failures; use of low water alarms to monitor water supplies for summer chum holding, incubation, and rearing; ready availability of back-up water supplies or generators to respond to power loss; continuous monitoring of sites during freshets or flood events; or, use of stable, high quality gravity fed water supplies, where available, for incubation of eyed eggs and rearing of fry.

1c. The action agencies shall insure that water intakes into all hatchery facilities used for the supplementation and reintroduction programs are properly screened using NMFS screening criteria (NMFS 1995; 1996) to prevent injury or mortality to listed summer chum and chinook. All action agencies shall inspect water intake structures at their summer chum salmon hatchery facilities to determine if listed salmon are being drawn into the facility.

1d. All action agencies shall follow, as minimum standards, the guidelines of the *Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State* (NWIFC and WDFW 1998) to insure application of fish disease control protocols that are protective of hatchery and listed natural salmon populations.

1e. The action agencies shall minimize the risk of loss of genetic variability between populations that may result from the proposed summer chum programs through application of the following measures:

1) Supplementation programs for streams selected under this plan will propagate and release only the indigenous population.
2) The transfers of each donor stock for reintroduction will be limited to only one target watershed outside of the freshwater spawning range of the donor stock to avoid the situation that one or few stocks within the ESU predominate.
3) Supplemented and reintroduced populations will be acclimated to the watershed desired for out-planting to insure that the summer chum retain a high fidelity to the targeted stream.
4) For reintroduced populations, where logistically and technically feasible, local adaptation should be fostered by using returning spawners rather than the original donor population as broodstock if the reintroduction program is still in progress.
5) Un-supplemented populations will be recognized to help preserve existing total abundance and diversity.

1f. The action agencies shall minimize the risk of loss of genetic variability within populations that may result from the proposed summer chum programs through application of the following measures:

1) Adults for broodstock will be collected so that they represent, to the extent feasible, an unbiased sample of the naturally spawning donor population with respect to run timing, size, age, sex ratio, and any other traits identified as important for long term fitness. Special emphasis will be placed on ensuring that the age group structure and sex ratio of collections are as similar as possible to those of adult returns of the founding population for the given period of the run.
2) Returning adults produced by a supplementation program will be used, with natural-origin summer chum, as broodstock over the duration of the supplementation programs.
3) Spawning protocols, including collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of at least 1:1 male-female mating schemes, and avoidance of intentional selection for any life history or morphological trait, will be applied that help insure that hatchery broodstocks are representative of natural-origin stock diversity. Spawning protocols will equalize as much as possible the contributions of parents to the next breeding generation.
4) Broodstock collection objectives for all programs must be based on donor population size to help retain genetic diversity of the hatchery and founding populations. Minimum broodstock collection levels must allow for the hatchery spawning of the number of adults needed to minimize loss of some alleles and the fixation of others. Maximum collection levels must be applied to allow for at least 50 % of escaping fish to spawn naturally each year (populations > 200 fish). For populations under 100 fish, no maximum broodstock collection level will be required as an emergency measure. All action agencies shall therefore apply the following schedule for collecting summer chum broodstock:

Donor Population Size (Number of individual fish)	**Allowable Broodstock Collection Levels**	
	Minimum	**Maximum**
< 100	25 pairs	none
100 - 200	25 pairs	50 pairs
> 200	50 pairs	50 % of total return

5) Hatchery methods applied to propagate summer chum shall mimic the natural environment to the extent feasible. Hatchery rearing will be limited to a maximum of 75 days post swim-up, to minimize the level of intervention into the natural summer chum life cycle, minimizing the potential for domestication selection.

1g. The action agencies shall employ broodstock collection methods that maintain the ecological and genetic characteristics of the natural summer chum populations to the extent feasible. The objective will be to collect and spawn broodstock that are fully representative

of the genetic and ecological characteristics of the target population (supplementation programs) or that show the greatest possible similarity in genetic lineage, life history patterns, and ecology of the originating environment (reintroduction programs). Fish collection methods applied must insure that broodstock are collected in an unbiased manner.

1h. The action agencies shall employ egg and fry incubation procedures that maintain the ecological characteristics of the natural summer chum populations to the extent feasible, while maximizing survival rates during propagation. Eggs and alevins should be incubated under density, substrate, light, temperature, and oxygen conditions that simulate, or improve upon natural intergravel survival.

1i. The action agencies shall employ fish rearing procedures that maintain the ecological characteristics of the natural summer chum populations to the extent feasible, while maximizing survival rates during propagation. To meet this objective, rearing environments and procedures applied should attempt to simulate attributes of natural conditions that may promote the development of fitness-related behaviors. Attributes addressed should include rearing water quality (including temperature regime), hydraulic characteristics of rearing areas, feeding conditions, feeding behavior, and health and nutritional status up to the point of release. Desirable production strategies for maintaining similarity to the natural-origin population may include rearing all fish of a population under the same conditions and mixing families randomly so that unintentional differences in rearing conditions will affect all families equally.

1j. The action agencies shall employ fish release procedures that maintain the ecological characteristics of the natural summer chum populations, while concurrently maximizing survival rates, to the extent feasible. Release procedures should mimic natural migrational characteristics for the life stage at release, including release location, nocturnal timing, and seasonal timing. Fish should be released as fed fry at an average individual size of 1.0 gram, promoting high smolt to adult survival rates, reducing the likelihood for ecological interactions with co-occurring natural-origin summer chum, and fostering rapid seaward migration. Summer chum fry should be released within the period when naturally-produced fish are known to be present as migrants in the estuary. Releases should be made as close to the estuary as is feasible to mimic lower river migrational distances experienced by natural fish. Releases should be timed to occur after dusk, but before mid-night to mimic the natural stream emigration period exhibited by natural chum fry. All summer chum fry populations should be mass-released, leading to the arrival of large, instantaneous volumes of fish in the estuary, as a strategy to reduce potential predation effects.

2a. The agencies shall limit the total number of broodstock removed within the action area through the proposed supplementation and reintroduction programs to a maximum of 1,882 adult fish, distributed as defined in “Specific Agency Terms and Conditions” identified below and as specified in the “Cumulative Effects” section.

2b. The agencies shall limit the total number of summer chum salmon juveniles released from the supplementation and reintroduction programs to a maximum of 2,035,000 fry, distributed within the Federally funded programs as defined in "Specific Agency Terms and Conditions" identified below.

2c. Annual adult broodstock collection and juvenile fish release numbers associated with each supplementation or reintroduction program shall be targeted within +/- 10 % of "goal" levels evaluated in this Opinion. In the event that circumstances such as unanticipated, high adult returns to a hatchery, higher than expected fecundity, or high egg to fry survival rates lead to the possession of fish in excess of program needs, all action agencies will comply with the following procedures:

1) Fish collected at weirs, or captured through other broodstock collection procedures, in excess of 10 % of daily, weekly, or bi-weekly, or total program goals shall be returned to the natural environment at the point of capture. The sex ratio of fish returned must be equivalent to the ratio observed at the time of escapement, collection, or capture.
2) If enabled by identification of hatchery fish through mass marking, measures may be applied to cull surplus hatchery-origin fish returning to a watershed in excess of program needs.
3) In the event that the total number of eyed eggs or juvenile fish in hand are in excess of production goals (>110 % of the target production number), surplus fish shall be removed from the population in a random manner and destroyed.
4) Surplus fish will be randomly removed in a manner that accounts for the need to retain a population that is representative and proportionate with the timing and spawning dates of adult returns contributing to egg takes.

3a. To assist in the determination of the effects of hatchery-origin summer chum on natural summer chum stocks, and the contribution of the supplementation and reintroduction programs to total returning populations, all summer chum released from the hatcheries shall be marked to allow for their differentiation from natural-origin summer chum. Marking may be internal or external.

3b. The action agencies shall conduct monitoring and evaluation programs described in HGMPs submitted for each supplementation or reintroduction program, and as specified in the SCSCI. This measure will help insure that program production and performance objectives are met and that the effects of the actions on listed salmon are adequately monitored.

3c. The action agencies shall monitor hatchery effluent to insure compliance with National Pollutant Discharge Elimination System permit limitations, where appropriate. Monitoring should help insure that effects on water quality in receiving waters are minimized, thus minimizing impacts to listed salmon.

4. The action agencies shall trap, handle and release all summer chum adults surplus to broodstock collection needs, and any listed natural fall chinook incidentally captured in summer chum directed broodstock collection operations, in a manner that minimizes injury and mortality. Trapped fish should be held in trap live boxes for no longer than 12 hours.

All fish destined for release must be carefully removed from traps, handled, and released immediately.

5a. The action agencies shall jointly conduct spawning ground surveys in the watersheds targeted for supplementation and reintroduction for stock assessment purposes. Data collected shall include total spawner escapement, the estimated number of naturally spawning summer chum salmon, and meristic, morphometric, and genetic information.

5b. All action agencies shall provide a separate annual report that summarizes numbers, individual fish sizes, pounds, dates, tag/mark information, and locations of hatchery summer chum releases, and adult broodstock return and removal information from each hatchery. Adult return information should include the estimated number of hatchery fish on the spawning grounds and number and, if data are available, the location of adults that were recovered outside the release areas. Results from monitoring and evaluation of ecological and genetic interactions should be included in the annual report. This report shall be submitted by January 31, of each year to the Hatchery/Inland Fisheries Branch, NMFS, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232-2737.

Hatchery Programs Producing Other Species Within the Action Area

1a. To minimize the risk of harm to summer chum salmon as a result of the physical operation of hatcheries in the action area, the following measures are required:
   1) All action agencies shall insure that water intakes into all hatchery facilities are properly screened using NMFS screening criteria to prevent injury or mortality to listed summer chum salmon. All action agencies shall inspect water intake structures at their facilities to determine if listed summer chum salmon are being drawn into the facility.
   2) All action agencies shall monitor hatchery effluent to insure compliance with National Pollutant Discharge Elimination System permit limitations, where appropriate. Monitoring should help ensure that effects on water quality in receiving waters are minimized, thus minimizing impacts to listed summer chum salmon.
   3) All hatchery operations shall ensure that surface water withdrawals do not lead to the dewatering of adjacent summer chum migration or spawning areas.

1b. To minimize the risk of harm to listed summer chum during broodstock collection activities directed at other salmonid species, all action agencies shall apply the following measures:
   1) All weirs used to capture non-ESA-listed anadromous salmonid adults will be designed and operated with a primary intent of passing incidentally captured summer chum upstream with minimal harm or delay in migration. Handling of summer chum will be minimized to the extent feasible to meet this measure.
   2) All weirs will be operated by individuals trained in proper and safe fish handling procedures that will be protective of any summer chum adults encountered.
   3) All fish weirs where summer chum may be captured incidentally will be monitored continuously to insure that captured fish are held under safe conditions, including maintenance of adequate flow in fish holding boxes and protection from poaching.

4) Summer chum captured incidentally in fish weir or broodstocking operations shall be held for no longer than 12 hours prior to release upstream to minimize delay in migration
5) All fish weirs will be placed and removed in a manner that does not lead to adverse changes in summer chum spawning areas, spawning distributions, or to summer chum redds upstream or downstream of the weir location.
6) All fish weirs and hatchery operations, including annual fish removal, egg take, and juvenile production criteria set forth for the weir or hatchery in the co-managers annual Future Brood Document, should be consistent with the provisions of this plan.

1c. All agencies shall reduce the risk of hatchery fish predation on listed summer chum salmon by applying practices that reduce the likelihood for interaction between hatchery fish and natural-origin summer chum using spatial and temporal separation measures. The following fish size, fish release timing, and fish release location measures shall be applied to reduce predation risks:
1) All steelhead, coho, and chinook smolt releases from regional hatcheries, truck-plants, or marine area net-pens will occur no earlier than April 15 to allow for the clearance of juvenile natural-origin summer chum from freshwater and Hood Canal estuarine areas, minimizing the likelihood of interaction between the hatchery fish and summer chum. A uniform-sized population shall be released to help insure that the majority of fish meet target smolt size criteria, minimizing the likelihood for migration delay or residualization resulting from the release of undersize fish.
2) Releases of coho, chinook, or steelhead fry, fingerlings, or sub-yearlings into summer chum streams that are not part of a formal recovery program, and that will have a high likelihood of residualizing or being present as yearling fish in freshwater during the summer chum egression period, shall be avoided.
3) All salmonids released from regional hatcheries or transferred from out-of-watershed facilities for planting into summer chum streams will be volitionally-migrating smolts that are acclimated to the stream of release to reduce the risk of residualization, and straying as returning adults, respectively.
4) Hatchery-lineage fall chum and pink salmon fed and unfed fry populations shall be released after April 1 each year to reduce the risk of predator attraction to summer chum fry in estuarine areas where they may aggregate with hatchery fish. Releases that are part of a formal recovery program are exempt from this measure.
5) Resident trout shall only be released into lakes, ponds, or stream sections within the Hood Canal summer chum ESU region that are land-locked or have screened outlets, or where access to anadromous waters is unlikely.

1d. All action agencies shall apply the following measures to minimize the risk of adverse effects to listed summer chum that may be imposed through competition by hatchery fish. Risk minimization measures applied will focus on timing and area of release criteria for hatchery juveniles, and return area and removal criteria for non-indigenous hatchery adults, to minimize adverse competition and behavioral modification effects that may result from the release, and adult return, of hatchery fish.

1) No fed fall chum salmon fry or Hoodsport Hatchery pink salmon fry shall be released from individual hatcheries prior to April 1 each year to minimize the risk of food resource competition with emigrating summer chum fry in estuarine areas and to reduce the risk of adverse behavioral modifications, including changes in summer chum fry feeding behavior, predator avoidance, and preferred migration areas.
2) No *unfed* fall chum or pink salmon fry shall be released from hatcheries within the action area prior to April 1 to reduce the risk of food resource competition from hatchery fish that may use the same estuarine habitat as natural-origin summer chum fry.
3) No fall chum or pink salmon fry originating as progeny of George Adams, Hoodsport, or McKernan hatchery returns shall be released into watersheds currently harboring self-sustaining summer chum populations where there is no ability to remove 100 % of returning spawners, or where it is not advisable to do so (i.e., where removal would impose further risks to summer chum by trapping fish). This measure is necessary to reduce the risk of spawning ground space competition, redd superimposition, and behavioral modification posed by early-returning hatchery-origin adults, and to reduce the risk of genetic introgression by early-returning fall chum.
4) Unless part of a formal stock recovery program, no fall chinook salmon shall be released into eastside Hood Canal or Strait of Juan de Fuca summer chum streams in instances where there is no ability to capture 100 % of adults upon freshwater return, or where it is not advisable to do so (i.e. where removal would impose further risks to summer chum by trapping fish). This provision is necessary to reduce the risk of spawning ground space competition, redd superimposition, and behavioral modification to summer chum.
5) Fall chinook, fall chum, and pink salmon released into streams with no existing summer chum populations shall be fully acclimated to the stream of release to minimize the risk of adult straying to summer chum streams.
6) Hatchery under-yearling chinook, fall chum, or pink salmon that are indigenous to a summer chum watershed and are part of a stock maintenance or formal recovery program shall be released after April 1 to minimize overlap with the estimated summer chum fry emigration period.
7) Net-pen coho salmon shall be acclimated to a local freshwater hatchery to minimize the risk of straying to summer chum streams

1e. To ensure compliance with accepted fish health monitoring, fish disease control, and hatchery sanitation procedures, all action agencies shall apply the following measures:
1) All action agencies shall implement *Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State* (NWIFC and WDFW 1998) guidelines to insure application of fish disease control protocols that are protective of listed summer chum salmon populations.
2) Hatchery broodstock and juvenile fish health will be monitored by a fish health professional during operation of all broodstock capture and juvenile fish incubation and rearing programs.

3) The condition and health of all anadromous salmonids reared by a facility will be certified by a fish health professional prior to release.
4) All fish shall be released in a healthy condition into regional waters.

2. The action agencies shall manage hatchery programs to not exceed juvenile salmon and steelhead release levels described in HGMPs and the SCSCI for the programs, and evaluated in this Opinion. This measure is necessary to further minimize ecological impact risks to listed summer chum salmon by limiting maximum hatchery salmonid production within the action area to current levels.

3. The action agencies shall conduct monitoring and evaluation programs described in HGMPs submitted for each supplementation or reintroduction program, and as specified in the SCSCI. This measure will help insure that program production and performance objectives are met and that the effects of the actions on listed summer chum salmon are adequately monitored.

4. The action agencies shall trap, handle and release all summer chum adults incidentally captured in broodstock collection operations directed at other salmonid species in a manner that minimizes injury and mortality. Trapped fish should be held in trap live boxes for no longer than 12 hours. All summer chum salmon destined for release must be carefully removed from traps, handled, and released immediately.

5a. The action agencies shall continue to coordinate the hatchery programs evaluated in this Opinion with the other fisheries management agencies to help insure that region-wide fish production objectives are agreed to and jointly evaluated.

5b. All action agencies shall provide a separate annual report that summarizes numbers, pounds, dates, tag/mark information, and locations of hatchery releases and adult return information from each hatchery. Adult return information should include the estimated number of hatchery fish on the spawning grounds and number and location of adults that were recovered outside the release areas. Results from any required monitoring and evaluation of ecological interactions should be included in the annual report. This report shall be submitted by January 31, of each year to the Hatchery/Inland Fisheries Branch, NMFS, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232-2737.

D. Specific Agency Reasonable and Prudent Measures

The following reasonable and prudent measures are provided to minimize and reduce the anticipated level of incidental take associated with specific agencies' summer chum supplementation and reintroduction, and other artificial propagation programs:

Summer Chum Supplementation and Reintroduction Programs

U.S. Fish and Wildlife Service Funded Programs

a. The USFWS shall conduct the proposed actions in such a way as to minimize adverse genetic and ecological effects on naturally-produced listed summer

chum salmon and chinook salmon. The Service shall also conduct the proposed actions to minimize adverse genetic and ecological effects on summer chum salmon propagated through the proposed programs.

b. The USFWS shall conduct monitoring and evaluation programs directed at juvenile summer chum salmon releases and resultant adult returns in the action area to assess ecological and genetic interactions with listed natural summer chum salmon, and potential ecological interactions with listed chinook salmon. The USFWS shall also conduct monitoring and evaluation programs directed at identifying the ecological and genetic effects of the programs on summer chum brought into the hatchery for artificial propagation.

Hatchery Programs Producing Other Species Within the Action Area

1. U.S. Fish and Wildlife Service Funded Programs

a. The USFWS shall conduct the proposed actions in such a way as to minimize the risk of injury and mortality to listed summer chum, and to minimize the risk of adverse ecological and genetic effects on listed summer chum salmon.

b. The USFWS shall conduct monitoring and evaluation programs directed at juvenile salmon releases and resultant adult returns in the action area that include assessment of potential ecological interactions with listed summer chum salmon.

2. BIA (Point No Point Treaty Tribal) Funded Programs

a. The BIA shall conduct the proposed actions in such a way as to minimize the risk of injury and mortality to listed summer chum, and to minimize the risk of adverse ecological and genetic effects on listed summer chum salmon.

b. The BIA shall conduct monitoring and evaluation programs directed at juvenile salmon releases and resultant adult returns in the action area that include potential ecological interactions with listed summer chum salmon.

E. Specific Agency Terms and Conditions

To carry out these reasonable and prudent measures, the following terms and conditions shall be implemented by the action agencies, and the private and volunteer co-operators administered by those agencies:

Summer Chum Supplementation and Reintroduction Programs

1. U.S. Fish and Wildlife Service Quilcene NFH

a1. USFWS shall constrain the annual number of Quilcene stock summer chum salmon adults collected from Quilcene Bay and the Big Quilcene River for use as broodstock for the Big Quilcene River supplementation and Big Beef Creek reintroduction programs to a maximum of 500 fish (250 females and 250 males). The Quilcene stock will be the only stock used as broodstock for these programs.

a2. USFWS shall constrain the total annual number of fed summer chum fry liberated from Quilcene NFH into the Big Quilcene River to 373,000 fish. Only indigenous Quilcene stock juvenile summer chum may be released through the program.

a3. All summer chum juveniles produced through the hatchery program shall be marked, either with an adipose fin clip or an otolith mark.

a4. USFWS shall implement practices during broodstock collection operations that minimize incidental harm to listed summer chum and chinook salmon, including avoidance of contact with redds, minimal holding and careful handling and release of all adult fish not needed for the broodstock program, and avoidance of "take" of fish in the act of spawning.

a5. USFWS shall apply prudent measures in the operation of the hatchery to minimize the risk of catastrophic loss of summer chum under propagation, including continuous site monitoring by hatchery staff, ready availability of back-up water supplies and power sources, and the use of low flow alarms for hatchery rearing areas or water supplies.

b1. The USFWS shall conduct spawning ground surveys to estimate the number of hatchery-origin summer chum salmon that are spawning naturally in the watersheds targeted for supplementation and reintroduction.

b2. USFWS shall conduct monitoring and evaluation to collect biological information on summer chum salmon returning to the Quilcene area, and to monitor the effects of the supplementation program. Information to be collected through biological sampling of a representative sample of the population brought into the hatchery will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, the occurrence of malformed fry in off-spring, scales for age determination, tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples, and the occurrence of marks. Mortality data for the propagated population shall be collected during the incubation and rearing periods. Length, weight, and condition factor data shall be collected from fry produced at release.

2. Hamma Hamma Hatchery - (USFWS-funded cooperative program)

a1. USFWS, WDFW and the non-governmental groups shall limit the annual number of summer chum salmon adults collected from the Hamma Hamma River watershed for use as broodstock for the supplementation program to a maximum of 100 fish (50 spawning pairs) or 50% of the total number of summer chum escaping to the river, whichever is lower. In future years, as run sizes to the watershed increase from currently depressed levels, and subject to written approval by NMFS, WDFW shall constrain the annual number of summer chum salmon adults collected from the Hamma Hamma River watershed for use as broodstock for the supplementation program to a maximum of 712 fish or 50 % of the total number of

summer chum adults escaping to the river, whichever is lower. No other stocks will be used as broodstock for this program.

a2. USFWS, WDFW and the non-governmental groups shall limit the total annual number of fed summer chum fry liberated into the Hamma Hamma River through the program to a maximum of 125,000 fish In future years, as run sizes to the watershed increase from currently depressed levels, and subject to written approval by NMFS, WDFW shall constrain the total annual number of fed summer chum fry liberated into the Hamma Hamma River through the program to 802,000 fish. Only indigenous Hamma Hamma River-origin juvenile summer chum may be released into the Hamma Hamma River watershed through the program.

a3. All summer chum juveniles produced for release shall be otolith marked to allow monitoring and evaluation of program performance.

a4. USFWS, WDFW and the non-governmental groups shall implement practices during broodstock collection operations that minimize incidental harm to listed summer chum and chinook salmon, including avoidance of contact with redds, careful handling and release of all adult fish not needed for the broodstock program, and avoidance of "take" of fish in the act of spawning.

a5. USFWS, WDFW and the non-governmental groups shall apply prudent measures in the operation of the hatchery to minimize the risk of catastrophic loss of summer chum under propagation, including implementation of consistent site monitoring protocols, implementation of continuous site monitoring during flood events, use of multiple spring sources for incubation and rearing at the site, and transfer of one-half of all green eggs taken each year (divided proportionally by family spawned) to Lilliwaup Hatchery for incubation to the eyed egg or swim-up fry stage prior to transfer back to the Hamma Hamma site.

b. USFWS, WDFW and the non-governmental groups shall conduct monitoring and evaluation to collect biological information on summer chum salmon returning to the Hamma Hamma River, and to monitor the effects of the supplementation program. Information to be collected through biological sampling of a representative sample of the population brought into the hatchery will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, the occurrence of malformed fry in off-spring, scales for age determination, tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples, and the occurrence of marks. Mortality data for the propagated population shall be collected during the incubation and rearing periods. Length, weight, and condition factor data shall be collected from fry produced at release.

3. Lilliwaup Hatchery - (USFWS-funded cooperative)

a1. USFWS, WDFW and the non-governmental groups shall be allowed to collect up to 100 % of the returning summer chum return each year as an emergency measure to forestall extirpation. When the total returning population is expected to exceed 200 adult fish, the annual number of summer chum salmon adults collected from Lilliwaup Creek for use as broodstock for the supplementation program will be limited to a maximum of 50 fish (25 spawning pairs) or 50 % of the total number of summer chum escaping to the river, whichever is lower. In future years, as run sizes to the watershed increase from currently depressed levels, and subject to written approval by NMFS, the annual number of summer chum salmon adults collected from Lilliwaup Creek for use as broodstock for the supplementation program will be limited to a maximum of 334 fish or 50 % of the total number of summer chum adults escaping to the river, whichever is lower. Only Lilliwaup stock summer chum broodstock may be used for the Lilliwaup Creek supplementation program.

a2. USFWS, WDFW and the non-governmental groups shall comply with the SCSCI production limit, and limit the total annual number of fed summer chum fry liberated into Lilliwaup Creek each year through the program to 376,000 fish. Only indigenous Lilliwaup Creek-origin juvenile summer chum may be released into Lilliwaup Creek watershed through the program.

a3. All summer chum juveniles produced for release shall be otolith marked to allow monitoring and evaluation of program performance.

a4. USFWS, WDFW and the non-governmental groups shall implement practices during broodstock collection operations that minimize incidental harm to listed summer chum and chinook salmon, including avoidance of contact with redds, careful handling and release of all adult fish not needed for the broodstock program, and avoidance of “take” of fish in the act of spawning.

a5. USFWS, WDFW and the non-governmental groups shall apply prudent measures in the operation of the hatchery to minimize the risk of catastrophic loss of summer chum under propagation. These measures shall include implementation of consistent site monitoring protocols, implementation of continuous site monitoring during operation of the weir for broodstock collection and during flood events, use of low flow alarms for hatchery rearing areas or water supplies, and the ready availability of back-up water supplies.

b1. USFWS, WDFW and the non-governmental groups shall conduct monitoring and evaluation to collect biological information on summer chum salmon returning to Lilliwaup Creek, and to monitor the effects of the supplementation program. Information to be collected through biological sampling of a representative sample

of the population brought into the hatchery will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, the occurrence of malformed fry in off-spring, scales for age determination, tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples, and the occurrence of marks. Mortality data for the propagated population shall be collected during the incubation and rearing periods. Length, weight, and condition factor data shall be collected from fry produced at release.

b2. USFWS, WDFW and the non-governmental groups shall conduct an evaluation of the status of the Lilliwaup Creek summer chum population, and the effects of the supplementation program in preserving the population and assisting its recovery by December 31, 2002. The evaluation will be considered by NMFS and the co-managers in making a determination regarding the continuance of the program beyond the 12 year supplementation program duration limit. This term and condition is considered appropriate given the critical status of the Lilliwaup Creek population, and the recent implementation of more effective supplementation measures than originally applied for the first six years of the program.

4. Union River- (USFWS-funded cooperative)

a1. USFWS, WDFW and the non-governmental groups shall constrain the annual number of Union stock summer chum salmon adults collected from the Union River for use as broodstock for the supplementation program to a maximum of 78 fish, or 50 % of the returning run to the river, whichever is lower. The Union stock will be the only stock used as broodstock for the program.

a2. USFWS, WDFW and the non-governmental groups shall constrain the total annual number of fed summer chum fry liberated through the Union program to 86,000 fish. Only indigenous Union stock juvenile summer chum may be released through the program.

a3. All summer chum juveniles produced for release shall be otolith marked to allow monitoring and evaluation of program performance.

a4. USFWS, WDFW and the non-governmental groups shall implement practices during broodstock collection operations that minimize incidental harm to listed summer chum and any listed chinook salmon, including avoidance of contact with redds, minimal holding and careful handling and release of all adult fish not needed for the broodstock program, and avoidance of “take” of fish in the act of spawning.

a5. USFWS, WDFW and the non-governmental groups shall apply prudent measures during hatchery operations to minimize the risk of catastrophic loss of summer chum under propagation, including use of stable, consistent gravity fed spring sources for eyed egg incubation and fish rearing, supply

of sufficient water flows to maintain appropriate summer chum incubation and fish rearing densities, implementation of consistent site monitoring protocols, implementation of continuous site monitoring during broodstock collection and during flood events, use of low flow alarms for hatchery rearing areas or water supplies, transfer of all green eggs taken for incubation to the eyed stage at WDFW's George Adams Hatchery where stable water supplies and continuous staffing are provided, and the ready availability of alternate power sources and back-up water supplies.

b. USFWS, WDFW and the non-governmental groups shall conduct monitoring and evaluation to collect biological information on summer chum salmon returning to the Union River, and to monitor the effects of the supplementation program. Information to be collected through biological sampling of a representative sample of the population brought into the hatchery will include fecundity, egg size, reproductive effort, pathogen screening, DNA/GSI sampling, gamete viability, the occurrence of malformed fry in off-spring, scales for age determination, tissues from hard parts, flesh and internal organs for viral, GSI, and DNA samples, and the occurrence of marks. Mortality data for the propagated population shall be collected during the incubation and rearing periods. Pre-release length, weight, and condition factor data shall be collected from fry.

Hatchery Programs Producing Other Species

1. U.S. Fish and Wildlife Service Quilcene NFH

a1. USFWS shall discontinue the release of coho salmon fry through the hatchery program to minimize the risk of predation of emigrating listed summer chum fry by yearling fish resulting from the fry plants. USFWS shall coordinate with the co-managers regarding restoration of coho salmon production in the Big Quilcene River upstream of the hatchery weir through the use of naturally spawning adult coho salmon.

a2. USFWS shall release all coho salmon smolts after April 15 each year to limit the risk of predation to emigrating summer chum fry in freshwater and estuarine areas.

b. USFWS shall monitor and document coho and fall chum salmon production for the hatchery program, including fish health certification data, release numbers, age class at release, size at release, date of release, and location of release. These data will be provided to NMFS in the annual report required for these programs.

2. Lilliwaup Hatchery (USFWS-funded cooperative)

a1. USFWS, WDFW and the non-governmental groups shall limit salmonid releases through this program to summer chum salmon fry produced through the Lilliwaup supplementation program. No other salmonid species may be intentionally released into Lilliwaup Creek.

a2. USFWS, WDFW and the non-governmental groups shall remove from the creek any straying, marked hatchery-origin adult chinook salmon that are trapped and

identified during summer chum broodstock collection to reduce adverse competition effects to summer chum adults.

b. USFWS, WDFW and the non-governmental groups shall monitor fall chinook salmon adult returns to Lilliwaup Creek to determine if straying of hatchery adults produced through transfers to the Skokomish River pose a risk to summer chum salmon.

3. Hamma Hamma Hatchery (USFWS-funded cooperative)

a1. USFWS, WDFW and the non-governmental groups shall release all steelhead and chinook salmon smolts produced through the Hamma Hamma recovery programs after April 15 to minimize the risk of predation on emigrating summer chum fry.

a2. USFWS, WDFW and the non-governmental groups shall release only acclimated, volitionally migrating steelhead smolts through this program to decrease the risk of residualization in summer chum streams.

b1. USFWS, WDFW and the non-governmental groups shall monitor and document the daily number, by species, of salmonids captured in all broodstock collection programs, the disposition of all fish collected or trapped (i.e. passed upstream, downstream, or removed as broodstock), and capture mortalities by species. These data will be provided to NMFS in the annual report required for the program.

b2. USFWS, WDFW and the non-governmental groups shall monitor the fish health status of all salmonids collected and reared through the program to minimize the risk of fish disease transfer to listed summer chum salmon.

4. BIA (Point No Point Treaty Tribal) Hatchery Programs

<u>Enetai Hatchery</u> -

a1. The BIA shall reduce the risk of adverse competition effects to emigrating listed summer chum juveniles by delaying releases of all fall chum salmon fry until after April 1.

a2. The BIA shall reduce the risk of adverse competitive effects to summer chum salmon that may result from adult fall chinook straying to summer chum production streams through termination of the juvenile fall chinook release program.

b. The BIA shall monitor and document juvenile salmon production for the tribal hatchery programs, including fish health certification data, release numbers, average fish sizes at release, dates of releases, and locations of releases. These data will be provided to NMFS in the annual report required for the programs.

<u>Quilcene Net-pens</u>

a. The BIA shall rear and release only coho salmon smolts originating from Quilcene NFH to minimize the risk of straying of returning adult coho to summer chum streams other than the Big Quilcene River, where most of the coho escaping can be removed. This measure minimizes the risk of adverse competition effects to summer chum salmon through redd superimposition.

b. The BIA shall monitor and document juvenile salmon production for the tribal hatchery programs, including fish health certification data, release numbers, average fish sizes at release, dates of releases, and locations of releases. These data will be provided to NMFS in the annual report required for the programs.

Little Boston Hatchery

a. The BIA shall reduce the risk of adverse competition effects to emigrating listed summer chum juveniles by delaying annual releases of all fall chum salmon fry until after April 1.
b. The BIA shall monitor and document juvenile salmon production for the tribal hatchery programs, including fish health certification data, release numbers, average fish sizes at release, dates of releases, and locations of releases. These data will be provided to NMFS in the annual report required for the programs.

Port Gamble Bay Net-pens

a. The BIA shall rear and release only coho salmon originating from Quilcene NFH, and reared and acclimated at George Adams Hatchery, to minimize the risk of straying of returning adult coho to summer chum streams. This measure minimizes the risk of straying, and adverse competition effects to summer chum salmon through redd superimposition.
b. The BIA shall monitor and document juvenile salmon production for the tribal hatchery programs, including fish health certification data, release numbers, average fish sizes at release, dates of releases, and locations of releases. These data will be provided to NMFS in the annual report required for the programs.

IX. Reinitiation of Consultation

This concludes formal consultation on the artificial propagation activities associated with Federal and non-Federal hatchery programs affecting listed summer chum salmon in the Hood Canal and Strait of Juan de Fuca regions. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the action agencies must immediately request reinitiation of section 7 consultation.

X. Magnuson-Stevens Act Essential Fish Habitat Consultation

"Essential fish habitat" (EFH) is defined in section 3 of the Magnuson-Stevens Act (MSA) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interprets EFH to include aquatic areas and their associated physical, chemical and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem.

The MSA and its implementing regulations at 50 CFR 600.920 require a Federal agency to consult with NMFS before it authorizes, funds or carries out any action that may adversely effect EFH. The purpose of consultation is to develop a conservation recommendation(s) that addresses all reasonably foreseeable adverse effects to EFH. Further, the action agency must provide a detailed, written response to NMFS within 30 days after receiving an EFH conservation recommendation. The response must include measures proposed by the agency to avoid, minimize, mitigate, or offset the impact of the activity on EFH. If the response is inconsistent with NMFS' conservation recommendation the agency must explain its reasons for not following the recommendations.

Thus, one of the objectives of this consultation is to determine whether the proposed actions - funding by USFWS and BIA of hatchery programs in the Hood Canal and eastern Strait of Juan de Fuca regions of Washington state - are likely to adversely affect EFH. If the proposed actions are likely to adversely affect EFH, conservation recommendations will be provided.

A. Identification of Essential Fish Habitat

The Pacific Fishery Management Council (PFMC) is one of eight Regional Fishery Management Councils established under the Magnuson-Stevens Act. The PFMC develops and carries out fisheries management plans for Pacific coast groundfish, coastal pelagic species, and salmon off the coasts of Washington, Oregon and California. Pursuant to the MSA, the PFMC has designated freshwater and marine EFH for chinook and coho salmon (PFMC 1999). For purposes of this consultation, freshwater EFH for salmon in Washington includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to Pacific salmon, except upstream of the impassable dams. In the future, should subsequent analyses determine the habitat above any impassable dam is necessary for salmon conservation, the PFMC will modify the identification of Pacific salmon EFH (PFMC 1999). Marine EFH for Pacific salmon in Oregon and Washington includes all estuarine, nearshore and marine waters within the western boundary of the U.S. Exclusive Economic Zone (EEZ), 200 miles offshore.

B. Proposed Action and Action Area

For this EFH consultation, the proposed actions and action area are as described in detail above. The actions are the operation of Federally funded hatchery programs that collect, rear and release salmon within the geographical boundaries of the Hood Canal summer chum salmon ESU and their effects on the survival and recovery of listed Hood Canal summer chum or Puget Sound

chinook salmon. The proposed action area includes Hood Canal and the eastern Strait of Juan de Fuca, including all river reaches accessible to salmon and nearshore marine areas within those regions. A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of the impacts on these species' EFH from the above proposed action is based on this information.

C. Effects of the Proposed Action

Based on information submitted by the action agencies, as well as NMFS' analysis in the ESA consultation above, NMFS believes that the effects of this action on EFH are likely to be within the range of effects considered in the ESA portion of this consultation.

D. Conclusion

Using the best scientific information available and based on its ESA consultation above, as well as the foregoing EFH sections, NMFS has determined that the proposed actions are not likely to adversely affect EFH for Pacific salmon.

E. EFH Conservation Recommendation

The Reasonable and Prudent Measures and the Terms and Conditions outlined above are applicable to designated salmon EFH. Therefore, NMFS recommends that those same Reasonable and Prudent Measures and the Terms and Conditions be adopted as the EFH Conservation Recommendation for this consultation.

F. Statutory Response Requirement

Section 305(b)(4)(B) of the MSA and implementing regulations at 50 CFR section 600.920 require a Federal action agency to provide a detailed, written response to NMFS within 30 days after receiving an EFH conservation recommendation. The response must include a description of measures proposed by the agency to avoid, minimize, mitigate or offset the impact of the activity on EFH. If the response is inconsistent with a conservation recommendation from NMFS, the agency must explain its reasons for not following the recommendation.

G. Consultation Renewal

The action agencies must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

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Appendix A. Biological Requirements and Status: Hood Canal Summer Chum Salmon and Puget Sound Chinook Salmon.

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I. Evolutionarily Significant Units Addressed

On March 25, 1999, Hood Canal summer chum salmon (*Oncorhynchus keta*) were listed as "threatened" under the ESA (64 FR 14508). The listed chum salmon population includes naturally spawned chum salmon residing below impassable natural barriers (e.g. long-standing natural waterfalls). After an examination of the relationship between hatchery and natural populations of summer chum salmon in the ESU, NMFS determined that none of the hatchery populations are currently essential for recovery, and therefore, the hatchery populations (and their progeny) are not listed.

Puget Sound chinook salmon (*Oncorhynchus tshawytcha*) were listed as "threatened" under the ESA on March 24, 1999 (FR 64 14308). The Puget Sound chinook salmon ESU includes all naturally spawned chinook populations residing below impassable natural barriers (e.g. long-standing, natural waterfalls) in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula, inclusive. NMFS identified 38 hatchery stocks associated with the Puget Sound chinook ESU. Of the 38 stocks, five were determined to be essential for recovery of the ESU and listed, with all naturally spawning populations, under the ESA: Kendall Creek (Nooksack River), N. Fork Stillaguamish River, Elwha River, Dungeness River, and White River (spring-run chinook).

II. Species Life History and Population Trends - Hood Canal Summer Chum Salmon

A. Life History

The following information was taken from the co-managers' Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000). While much of the following life history summary is based on specific information about summer chum salmon, some of the descriptive material is derived from observations made on fall chum salmon.

Description

Adult chum salmon and sockeye salmon are distinguished from other Pacific salmon by a lack of distinct black spots on the back and caudal fin. The 19 or 20 short, stout gill rakers on the first arch of the chum salmon distinguish it from sockeye, which have 28 to 40 long, slender gillrakers (Wydoski and Whitney 1979). Juvenile chum salmon are distinguished by parr marks of relatively regular height that are smaller than the vertical diameter of the eye, and that are faint or absent below the lateral line (Wydoski and Whitney 1979). When in spawning condition, adult chum salmon have greenish to dusky mottling on the sides, with males exhibiting distinctive reddish-purple vertical barring. Adult chum in Puget Sound range in size from 17 to 38 inches, with an average weight of 9 to 11 pounds.

One distinguishing characteristic of this group of summer chum populations is an early nearshore marine area, adult run timing (early August into October). This early timing creates a temporal separation from the more abundant indigenous fall chum stocks which spawn in the same area, allowing for reproductive isolation between summer and fall chum stocks in the region (WDF et al. 1993). The distance between summer chum spawning tributaries of Hood Canal and the eastern Strait of Juan de Fuca, and the rest of the Puget Sound streams, creates a geographical separation among the stocks.

Hood Canal and Strait of Juan de Fuca summer chum populations are one of three genetically distinct lineages of chum salmon in the Pacific Northwest region (Johnson et al. 1997). WDFW concluded that the Hood Canal and Strait of Juan de Fuca summer chum comprise a distinct major ancestral lineage, defined as stocks whose shared genetic characteristics suggest a distant common ancestry, and substantial reproductive isolation from other chum lineages (Phelps et al.1995, WDFW 1995). NMFS (Johnson et al. 1997) designated Hood Canal and Strait of Juan de Fuca summer chum as an evolutionarily significant unit, based upon distinctive life history and genetic traits. Genetic differences between summer chum and all other chum stocks in the U.S. and British Columbia are a result of long-standing reproductive isolation of the Hood Canal and Strait of Juan de Fuca summer chum populations (Tynan 1992). This isolation has been afforded by a significantly different migration and escapement timing, and geographic separation from other chum stocks in the Pacific Northwest (Tynan 1992, Johnson et al. 1997)

Distribution

A total of 11 streams in Hood Canal have been identified as recently having indigenous summer chum populations : Big Quilcene River, Little Quilcene River, Dosewallips River, Duckabush River, Hamma Hamma River, Lilliwaup Creek, Union River, Tahuya River, Dewatto River,

Anderson Creek, and Big Beef Creek (Tynan 1992). Summer chum are occasionally observed in other Hood Canal drainages, including the Skokomish River which was once a major summer chum stream. SASSI (WDF et al. 1993) lists two, distinct summer chum populations in Hood Canal - the Union River population and a group including all other Hood Canal summer production streams, but this assessment has been modified for this recovery plan. Summer chum salmon populations in the eastern Strait of Juan de Fuca have been reported in Chimacum Creek, located near Port Hadlock in Admiralty Inlet, Snow and Salmon creeks in Discovery Bay and Jimmycomelately Creek in Sequim Bay. (WDF et al. 1993, Sele 1995). Recent stock assessment data indicate that summer chum also return to the Dungeness River, but the magnitude of returns is unknown (Sele 1995).

Summer chum in the region use Hood Canal and the Strait of Juan de Fuca estuarine and marine areas for rearing and seaward migration as juveniles. The fish spend two to four years in northeast Pacific Ocean feeding areas prior to migrating southward during the summer months as maturing adults along the coasts of Alaska and British Columbia in returning to their natal streams. Adults may delay migration in extreme terminal marine areas for up to several weeks before entering the streams to spawn. Spawning occurs in the lower reaches of each summer chum stream.

Life History Strategy

Summer chum have evolved to exploit freshwater and estuarine habitats during periods, and for durations, when interaction with other Pacific salmon species and races is minimized. The uniqueness of summer chum is best characterized by their late summer entry into freshwater spawning areas, and their late winter/early spring arrival in the estuaries as seaward-migrating juveniles.

Summer chum spawning occurs from late August through late October, generally within the lowest one to two miles of the tributaries. Depending upon temperature regimes in spawning streams, eggs reach the eyed stage after approximately 4-6 weeks of incubation in the redds, and hatching occurs approximately 8 weeks after spawning (L. Telles, Quilcene National Fish Hatchery, Quilcene, WA, pers. comm., 1996). Alevins develop in the redds for additional 10-12 weeks before emerging as fry between February and the last week of May. Estimated peak emergence timings for Hood Canal and Strait of Juan de Fuca summer chum populations are March 22 and April 4 respectively. By contrast, indigenous fall chum stocks spawn in Hood Canal streams predominately in November and December, and the resulting fry emerge from the spawning gravels approximately one month later than summer chum salmon, between late April and mid-May (Koski 1975, Tynan 1997). Chum fry recovered in Hood Canal marine areas during the summer chum emergence period range in size from 35-44 mm.

Freshwater Juvenile Life History
Incubation

Developing chum salmon incubate as eggs or sac fry in the gravel for five or six months after fertilization, a time period determined mainly by ambient temperature regimes characteristic of Pacific Northwest streams (Bakkala 1970, Koski 1975, Schreiner 1977, Salo 1991). Stream flow, dissolved oxygen levels, gravel composition, spawning time, spawning density and genetic characteristics also affect the rate of egg/alevin development, and hence gravel residence time (Bakkala 1970, Koski 1975, Schroder 1981, Salo 1991). The earliest eggs deposited enter the tender stage starting the first week in September, with the majority of incubating eggs reaching the eyed stage by November 3. Bakkala (1970) reported total gravel residence times for chum ranging from 78 to 183 days across the range of chum salmon distribution, dependent on stream temperature. Koski (1975) documented an average gravel residence time from spawning to 50% (peak) population emergence for Big Beef Creek summer chum of 166 days, with 95 % emergence after 177 days. Telles (1996) reported 100 % emergence (swim-up) of 1994 brood Big Quilcene River summer chum 111 days after fertilization at QNFH.

Emergence and Downstream Migration

Summer chum fry emergence timing in Hood Canal can range from the first week in February ("warm" years and/or earlier spawn date years) through the second week in April (colder and/or later spawn date years). The 10 %, 50 % and 90 % average emergence dates across years reported for Big Beef Creek summer chum were March 13, March 18, and March 27, respectively (Tynan 1997). The 10 % to 90 % emergence range observed across years was February 7 through April 14. Strait of Juan de Fuca summer chum generally emerge later than Hood Canal summers due to colder stream incubation temperatures. Estimated, average 10%, 50%, and 90% emergence dates for Strait of Juan de Fuca summer chum are March 6, April 4, and April 26, respectively. The 10% to 90% emergence range estimated across years for Strait chum is February 15 through May 26 (Tynan 1997).

Fry emerge with darkness, and immediately commence migration downstream to estuarine areas (Bakkala 1970, Koski 1975, Schreiner 1977, Koski 1981, Salo 1991), with total brood year migration from freshwater ending within 30 days for smaller streams and rivers (Salo 1991). Emerging chum fry have been shown to become very active with darkness (Hoar 1951), preferring the swiftest areas of downstream flow and exhibiting strong negative rheotaxis, often swimming more rapidly than the current (Hoar 1951, Neave 1955).

Estuarine and Marine Life History

Estuarine Behavior

Upon arrival in the estuary, chum salmon fry inhabit nearshore areas (Schreiner 1977, Bax 1982, Bax 1983, Whitmus 1985). Chum fry have a preferred depth of between 1.5-5.0 meters at this time (Allen 1974) and are thought to be concentrated in the top few meters of the water column both day and night (Bax 1983b). In Puget Sound, chum fry have been observed through annual estuarine area fry surveys to reside for their first few weeks in the top 2-3 centimeters of surface waters and extremely close to the shoreline (Ron Egan, WDFW, Olympia, WA, pers. comm.). Iwata (1982) reported that, in Japan, chum orientated in stratified surface waters (20-100 cm depth) upon arrival in the estuary, showing a very strong preference for lower salinity water (10 to 14 ppt) found above the freshwater/saltwater interface, perhaps as a seawater acclimation

mechanism. This nearshore and surface behavior could also be linked to survival, as small size exposes youngest fry to heavy predation. Onshore location may protect the fry from larger fish (Gerke and Kaczynski 1972, Schreiner 1977) and schooling behavior may be an adaptation to predator avoidance (Feller 1974).

Chum fry arriving in the Hood Canal estuary are initially widely dispersed (Bax 1982), but form loose aggregations oriented to the shoreline within a few days (Schreiner 1977, Bax 1983, Whitmus, 1985). These aggregations occur in daylight hours only, and tend to break up after dark (Feller 1974), regrouping nearshore at dawn the following morning (Schreiner 1977, Bax 1983). Bax et al. (1978) reported that chum fry at this initial stage of out-migration use areas predominately close to shore. "Early run" chum fry in Hood Canal (defined as chum juveniles migrating during February and March) usually occupy sublittoral seagrass beds with residence time of about one week (Wissmar and Simenstad 1980). Schreiner (1977) reported that Hood Canal chum maintained a nearshore distribution until they reached a size of 45-50 mm, at which time they moved to deeper off-shore areas.

Food

Chum fry captured in nearshore environments during out-migration in upper Hood Canal were found to prey predominantly on epibenthic organisms, mainly harpacticoid copepods and gammarid amphipods (Bax et al. 1978, Simenstad et al. 1980). Diet changed to predominantly pelagic organisms in early May for fry migrating in off-shore areas. Dabob Bay chum fry were reported to feed continuously (day and night) in using nearshore areas as a source of food (Feller 1974). Feller (1974) and Gerke and Kaczynski (1972) documented initial preference (and predominance in the diet) of epibenthic prey by chum fry in Dabob Bay, followed by a gradual switch to pelagic prey as time progressed. Several researchers have documented a reliance on drift insects by migrating chum fry in British Columbia (Mason 1974) and in Dabob Bay, Hood Canal (Gerke and Kaczynski 1972). Hatchery-released chum fry in southern Hood Canal were found initially to prey almost exclusively on terrestrial insects, likely made available as drift from the Skokomish River (Whitmus 1985). Faster-migrating fry that had moved further north of the Skokomish delta were found to feed entirely on neritic and epibenthic organisms. Simenstad et al. (1980) showed a gradual decrease in the epibenthic fraction of stomach contents as the chum increased in size. Migration off-shore could result from opportunistic movement of fry to take advantage of larger, more prevalent prey organisms in the neritic environment (Bax 1983).

Juvenile Seaward Migration

Summer chum entering the estuary are thought to immediately commence migration seaward, migrating at a rate of 7 - 14 km/day (Tynan 1997). Rapid seaward movement may reflect either "active" migration in response to low food availability or predator avoidance, or "passive" migration, brought on by strong, prevailing south/southwest weather systems that accelerates surface flows, and migrating fry present during the late winter-early spring time period, northward (Bax et al. 1978, Simenstad et al. 1980, Bax 1982, Bax 1983). Assuming a migration speed of 7 km/day, the southernmost out-migrating fry population in Hood Canal would exit the Canal 14 days after entering seawater, with 90 % of the annual population exiting by April 28

each year, on average. Applying the same migration speed, summer chum fry originating in Strait of Juan de Fuca streams would exit the Discovery Bay region 13 days after entering seawater, or by June 8 each year (90 % completion).

Ocean Migration

After two to four years of rearing in the northeast Pacific Ocean, maturing Puget Sound-origin chum salmon follow a southerly migration path parallel to the coastlines of southeast Alaska and British Columbia (Neave et al. 1976, Salo 1991, Myers 1993). The precise timing of this migration from Gulf of Alaska waters for Hood Canal summer chum is unknown. Genetic stock identification data collected from Canadian Strait of Juan de Fuca commercial net fisheries (LeClair 1995, 1996), Canadian fishery recoveries in 1995 of coded wire tagged Big Quilcene summers (PSMFC data, August 14, 1996) and a single recovery in Big Beef Creek of a summer chum tagged in a southeast Alaska ocean fishery study (Koski 1975), suggest that the southerly ocean migration down the Pacific Northwest coast and into the Strait of Juan de Fuca likely commences in mid-July, and continues through at least early September. Migrational timing of Strait of Juan de Fuca summer chum into Washington marine waters appears earlier than arrival timing observed for Hood Canal summer chum. The stocks in this region enter the terminal area (the Strait) from the first week of July through September (WDF et al. 1994). GSI data collected from Canadian net fisheries at the entrance to the Strait suggests that Hood Canal and Strait of Juan de Fuca summer chum are present through August and into early September (LeClair 1995, 1996).

Adult Nearshore Migration

Summer chum mature primarily at 3 and 4 years of age with low numbers returning at age 5 (there are rare observations of age 2- and 6-year fish). They enter the Hood Canal terminal area from early August through the end of September (WDF et al. 1994). Entry pattern data for Quilcene Bay provided by Lampsakis (1994) suggest that summer chum enter extreme terminal marine areas adjacent to natal streams from the third week in August, through the first week in October, with a central 80% run timing of August 30 through September 28, and a peak on September 16.

Comparison of extreme terminal area entry timing in Quilcene Bay with spawning ground timing estimates developed from Big Quilcene River data, suggests that summer chum may mill in front of their stream of origin for up to ten to twelve days before entering freshwater (with shorter milling times later in the run). Thus it is assumed that summer chum observed on spawning grounds entered the river five days earlier, based on a ten day average survey life. This behavior is likely related to the amount of time required for the chum to complete maturation and to acclimate to freshwater, but is also affected by available stream flows.

Adult Freshwater Migration and Spawning

River Entry

Spawning ground entry timing in Hood Canal ranges from late August through mid-October. Lampsakis (1994) reported a central 80 % spawning ground timing in the Big Quilcene River of September 11 through October 14, with a peak on or about September 28, based on 22 years of

spawning ground survey data. Strait of Juan de Fuca summer chum begin spawning during the first week of September, reaching completion in mid-October (WDF et al. 1994). Time density analysis of Snow, Salmon and Jimmycomelately creek spawner survey data for the lower portions of the drainages indicates a central 80 % spawning ground timing of September 16 through October 20, with an average peak on October 2 (Lampsakis 1994).

Spawning

Hood Canal summer chum typically spawn soon after entering freshwater in the lowest reaches of natal streams (Koski 1975, Schroder 1977, Johnson et al. 1997). This characteristic may reflect an adaptation to low flows present during their late summer/early fall spawning ground migration timing, which confine spawning to areas with sufficient water volume. Spawning in lower river reaches during low flows, however, confines incubating eggs to center channel areas, exposing the eggs to increased risk of egg pocket scouring during freshets. Koski (1975) noted that Big Beef Creek summer chum spawning took place predominantly in the lower 0.8 km of stream. Cederholm (1972) reported that 100 % of the summer chum run to Big Beef Creek in 1966 and 1967 spawned in the lower 0.6 km of the creek. WDFW documentation of summer chum spawning in the Big Quilcene River indicates that 90% of spawning occurs in the lower mile of the 2.2 miles of river accessible to salmonids. Summer chum spawn in the lower mile of Salmon Creek and in the lower one-half mile of Snow and Jimmycomelately creeks (WDF et al. 1994). As with Hood Canal summer chum, low summer-time flows likely have acted to confine summer chum spawning in this region to the lowest reaches of each production stream.

B. Population Trends

Of the sixteen populations of summer chum identified in this ESU, seven are considered to be "functionally extinct" (Skokomish, Finch Cr., Anderson Cr., Dewatto, Tahuya, Big Beef Cr., and Chimacum). The remaining nine populations are well distributed throughout the ESU except for the eastern side of Hood Canal; those populations were among the least productive in the ESU (WDFW and PNPTT 2000).

This ESU has two geographically distinct regions: the Strait of Juan de Fuca (SJF) and Hood Canal (HC). Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends.

In the Hood Canal region, summer chum are still found in the Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Big and Little Quilcene, and Union Rivers. A few chum have been observed in other systems during the summer chum migration period, but these observations are sporadic and are thought to be strays from other areas. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum populations declined rapidly beginning in 1979, and has remained at depressed levels (Table 1). The terminal run size for the Hood Canal summer chum stocks averaged 28,971 during the 1974-1978 period, declining to an average of 4,132 during 1979-1993. Abundance during the 1995-1998 period has improved, averaging 10,844. However, much of the increase in abundance can be attributed to a supplementation

program for the Big/Little Quilcene River summer chum stock begun in 1992. Escapements in the Union have been stable or increasing in relation to historical levels. Escapements to the Dosewallips and Duckabush rivers have been generally above threshold levels of concern, but are highly variable. Escapements in the Hamma Hamma and particularly the Lilliwaup have been below threshold escapement levels that represent an increased risk to the population too often in recent years (Table 1).

Supplementation programs were instituted in 1992 for the Big/Little Quilcene, the Hamma Hamma and Lilliwaup stocks due to the assessment of high risk of extinction for these stocks (WDFW and PNPTT 2000). The Quilcene program has been quite successful at increasing the number of returning adults. The Hamma Hamma and Lilliwaup programs have been hampered by an inability to collect sufficient broodstock. A re-introduction program was also started in Big Beef Creek using the Quilcene stock. It is too early to assess the success of that program. Other re-introduction programs may be initiated in the future, but will depend on the development of additional broodstock sources so as not to become dependent on Quilcene as the sole donor stock.

In the Strait of Juan de Fuca, summer chum stocks are found in Snow, Salmon, and Jimmycomelately Creeks and the Dungeness River. (The Snow and Salmon are treated as a single stock complex.) The terminal abundance of summer chum in the Strait of Juan de Fuca region began to decline in 1989, a decade after the decline observed for summer chum in Hood Canal. Terminal abundance declined from an average of 1,923 for the 1974-1988 period to a average of 477 during 1989-1994 period. During the most recent period (1995-1998) the average for the region has increased to 1,039, however, much of the increase may be due to the supplementation program in the Snow/Salmon system that was initiated in 1992. Escapements in Jimmycomelately have continued to be poor, i.e., less than 100 spawners in the last three years. There are no systematic surveys for summer chum in the Dungeness. However, their presence is routinely noted in surveys for other species. The status of the summer chum population in the Dungeness is therefore unknown.

An assessment of the habitat in the Strait of Juan de Fuca chum watersheds concluded that these were among the most degraded watersheds in the ESU (WDFW and PNPTT 2000). Winter peak and summer low flows, and sediment aggradation are considered problems in the Dungeness, Jimmycomelately and Snow Creeks. Improvement in habitat conditions will be essential for successful recovery of summer chum in this region of the ESU.

Table 1. Hood Canal summer chum terminal abundance by population and year.
(Skokomish River includes only catch data. No escapement data is available.)

III. Species Life History and Population Trends - Puget Sound Chinook Salmon

A. Life History

Chinook salmon are the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations.

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers, et al. (1998) and Healey (1991).

This Puget Sound chinook salmon ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River in the east to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns.

B. Population Trends

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1992-96 is approximately 13,000. Both long- and short-term trends for these runs were negative, with few exceptions. In South Puget Sound, spawning escapement of the

natural runs has averaged 11,000 spawners. In this area, both long- and short-term trends are predominantly positive.

The Puget Sound chinook salmon ESU is large and complex, comprising many individual, discrete populations spread among the major Puget Sound region watersheds. WDF et al. (1993) identified 28 stocks that were distributed among five geographic regions and 12 management units or basins (Table 2). (The Hoko River stock was included in WDF's initial inventory, but was subsequently assigned to the neighboring ESU.) NMFS is currently engaged in delineating the population structure of PS chinook and other ESUs as an initial step in a formal recovery planning effort that is now underway. These determinations have not been finalized at this time, but it is likely that these 28 stocks represent the greatest level of potential stratification and that some further aggregation of these stocks is possible.

Puget Sound includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In addition, the Puget Sound contains areas where indigenous local stocks persist and areas where local stocks are a composite of indigenous stocks and introduced hatchery fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production. In response to these varied circumstances, the state and tribal Co-managers have developed a proposal to stratify stocks to provide a context for analyzing actions and considering recovery efforts. This stratification was initially proposed in conjunction with an ongoing section 7 consultation regarding Puget Sound chinook hatchery programs. The proposal is broadly applicable and used in this consultation as well, thus providing a common framework for analyzing hatchery activities. Although this stratification scheme has not been formally adopted by the Co-managers, it nonetheless provides a useful construct for analysis.

The stratification assigns stocks to one of three categories:

Category 1 stocks are core stocks that are genetically unique and indigenous to watersheds of Puget Sound. Maintaining genetic diversity and integrity of these stocks and achieving abundance levels for long-term sustainability is the highest priority for these stocks. Twenty stocks have been identified in this category (Table 2).

The status of these stocks varies. Some stocks (Dungeness and Nooksack) have fallen to such low levels that our ability to maintain their genetic diversity may be at risk. Other stocks are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield harvest rates. All of these stocks have escapement goals, which are actively managed for, but have not generally been achieved in recent years. In some cases (Elwha, Dungeness, Nooksack, Stillaguamish, and White River) hatchery operations are essential for recovery, and without them, the stocks would likely further decline and go extinct. In one case at least (Green River) the number of hatchery fish spawning naturally is a concern, in part because it masks our ability to evaluate the actual productivity of wild fish. The objective for category 1 stocks is to protect and recover these indigenous stocks.

Table 2. Distribution of stocks identified in WDF et al. (1993) by recovery category. Stock timing designations are spring (SP), summer (S), fall (F), and summer/fall (SF).

Region of Origin	Management Unit	Stock/Timing	Recovery Category
Strait of Juan de Fuca	Strait of Juan de Fuca	Elwha/Morse Cr./SF	1
		Dungeness/SP	1
Hood Canal	Hood Canal	Westside Tribs	2
		Eastside Tribs	3
		Skokomish	1/2
North Sound	Nooksack/Samish	NF Nooksack/SP	1
		SF Nooksack/SP	1
		Nooksack/F	2/3
		Samish R. /SF	3
	Skagit Spring	Upper Sauk/SP	1
		Suiattle/SP	1
		Cascade/SP	1
	Skagit Summer/Fall	Upper Skagit/S	1
		Lower Skagit/F	1
		Lower Sauk/S	1
	Stillaguamish	Stillaguamish/S	1
		Stillaguamish/F	1
	Snohomish	Snohomish/S	1
		Wallace/SF	1
		Snohomish/F	1
		Bridal Veil Cr/F	1
Mid-Sound	Lake Washington	Issaquah/SF	2/3
		N Lake WA Tribs/SF	2
		Cedar/SF	1
	Duwamish/Green	Duwamish/Green/SF	1
		Newaukum Cr/SF	1
South Sound	Puyallup	White River/SP	1
		White River/SF	2
		Puyallup River /SF	2/3
		S. Prairie Ck. /SF	2
	Nisqually	Nisqually River/SF	2
	South Sound Tribs	South Sound Tribs/SF	3

Category 2 stocks are located in watersheds where indigenous stocks may no longer exist, but where sustainable stocks existed in the past and where the habitat could still support such stocks. These are primarily areas in Hood Canal and South Sound that have been managed for hatchery production and harvest for many years. Natural spawning in these systems continues, but is

primarily the result of hatchery-origin strays. Stocks have been preliminarily assigned to category 2 based on current information, but further investigations will seek to identify remnant indigenous stocks which, if found, would cause them to be reassigned to category 1. The objective for category 2 stocks is to use the most locally adaptable stock towards reestablishment of naturally sustainable populations.

Category 3 stocks are generally found in small independent tributaries that may now have some spawning, but never had independent, self-sustaining stocks of chinook salmon. Many of these watersheds do not have the morphological characteristics needed for chinook and may be better suited for coho and chum salmon, cutthroat trout or resident species. Chinook salmon that are observed occasionally in these watersheds are primarily the result of hatchery strays. The objective for these systems is directed at habitat protection to insure the production of other species, but no specific actions are proposed to promote the natural production of chinook salmon.

Based on this framework, category 1 stocks are therefore the core stocks that provide the focus for the analysis of proposed hatchery actions in this biological opinion. Category 2 stocks may require additional consideration and possibly more targeted protections in the future. However, category 2 stocks, by definition, occur in watersheds where the indigenous stocks may no longer exist. Future decisions regarding the form and timing of recovery efforts in these watersheds will dictate the kinds of hatchery actions that may be necessary and appropriate in the future. In the meantime, hatchery management and production constraints designed to protect category 1 stocks will benefit category 2 stocks as well.

Circumstances pertinent to the status of each of the category 1 stocks vary considerably. Their status ranges from healthy to critical; some stocks are severely limited by the available habitat. The range of hatchery influence varies from completely dependent to stocks that are largely unaffected by hatchery strays. These circumstances are pertinent to the consideration of the kinds of hatchery management constraints that are necessary and appropriate. Following is therefore a brief review of factors relevant to the status of each of the category 1 stocks.

Elwha River Summer/Fall Chinook

Elwha chinook is one of the most genetically distinct stocks in Puget Sound. The Elwha River originates in the Olympic Mountains. Much of the drainage is still pristine and protected in the Olympic National Forest. Two dams at river miles 4.9 and 13.4 block passage to over 70 miles of potential habitat. The remaining habitat below the first dam is degraded by the loss of natural gravel, large woody debris, and the adverse effects of high water temperatures. The high temperatures exacerbate problems with the parasite *Dermocystidium;* resulting prespawning mortality is sometimes as high as 70%. Because of the limitations on natural production, the hatchery and naturally spawning stocks are fully integrated. Hatchery-origin fish commonly spawn in the river and broodstock is routinely supplemented by collecting adults from the river. No hatchery fish have been brought into the basin in recent years and the stock is considered unaffected by the few transfers that were made in earlier years. The escapement to the system has averaged about 1,900 over the last five years (range 1,546-2,527) compared to an

escapement goal of 2,900. However, the goal is largely a hatchery production goal and does not represent the natural production capacity of the current degraded habitat.

Dungeness River Spring/Summer Chinook
Although there is no genetic data for Dungeness chinook, they are considered distinct based on their spawn timing and geographic distribution. The Dungeness River is located in a rain shadow and as a result receives relatively little rainfall (less than 20 inches per year). The Dungeness is therefore particularly dependent on annual precipitation and snow pack and is susceptible to habitat degradations that exacerbate low flow conditions. Agricultural water withdrawals remove as much as 60% of the natural flow during the critical low flow period which coincides with spawning. Other land use practices have also substantially degraded the system. The escapement has averaged 114 over the last five years (range 50-183) compared to an escapement goal of 925. Dungeness River chinook are considered critically depressed. As a result, a captive brood stock program was initiated in 1992 to maintain an egg bank to reduce the risk of extinction and help rebuild the native run. In the last couple of years juvenile releases from the program have been on the order of two million; a variety of release strategies are being tested to evaluate which approach is most effective.

Nooksack River Spring Chinook
The Nooksack River has two distinct natural spawning stocks in the North Fork and South Fork. These stocks are genetically distinct from each other and all other Washington stocks as well. The stocks have differentiated because of the unique characteristics of the two watersheds. The North Fork is a higher elevation glacier fed stream; the South Fork is a lower elevation stream that receives no glacier melt. The South Fork is therefore generally low and clear during spawning. Adaptation to these diverse water flow patterns reinforces the biological isolation of these stocks despite their proximity. There is apparently little straying between the two as indicated by the very few out-of-basin coded-wire tag (CWT) recoveries. Because of the unique characteristics of these stocks, both are considered important to the overall health and recovery of the PS chinook.

Both stocks are depressed due to low spawning in recent years and the South Fork in particular is likely critical. Over the last five years the escapements to the North Fork and South Fork have averaged 354 (range 45-621) and 190 (range 118-290), respectively compared to interim escapement goals of 1,000 each. The North Fork and South Fork have been substantially degraded due largely to timber harvest and associated road building activities. Improvements in habitat quality are considered essential to recovery.

A hatchery program on the North Fork has operated since 1988; the North Fork hatchery stock is considered essential to recovery. There is both an on-station program to maintain broodstock and a system of off-station acclimated release sites to supplement the natural production. Returns from the supplementation program have contributed to escapements in recent years thus helping to reduce the immediate risks associated with very low returns. Early supplementation efforts on the South Fork proved unsuccessful and were discontinued. There is currently no supplementation program and South Fork.

Skagit River Spring Chinook
The Skagit watershed is the largest in Puget Sound, contributing over 20% of the freshwater flowing into Puget Sound. The Skagit has several major stream systems that differ substantially in terms of geomorphology and hydrography. Because of this diversity, six different stock groups are recognized including three spring stocks on the upper Cascade, Sauk, and Suiattle Rivers. The spring stocks occupy the upper portions of the watersheds where the gradients are moderate to high and water temperatures are generally cooler. The aggregate escapement goal for the spring stocks is 3,000. The combined escapements in recent years have been about 1,000, but returns have been reasonably well distributed and stable in each system. The average escapements to the Cascade, Sauk, and Suiattle rivers over the last five years have been 247 (range 173-323), 265 (range 130-408), and 389 (range 167-473). Critical threshold escapement levels have not been identified for these stocks in particular, but these stocks are depressed and are at least close to what could be considered critical levels.

The Skagit spring stocks are relatively unaffected by hatchery production. There is a spring chinook hatchery stock on the Cascade River that is used as an indicator stock for harvest and marine survival estimates. As a result, all fish released have a CWT. The program is not designed to supplement natural production.

Skagit River Summer/Fall Chinook
The Skagit also supports summer stocks on the lower Sauk and upper Skagit and a fall stock on the lower Skagit. The status of these stocks varies although all have declined in abundance over the last 20-25 years. The aggregate escapement goal for the Skagit summer/fall management unit is currently 14,900. However, more recent analysis, including that associated with this opinion suggests that the an MSY goal of about 9,000 is more consistent with the available information. The stock specific escapements for the lower Sauk, upper Skagit, and lower Skagit have averaged 450 (range 112-1,103), 7,193 (range 4,203-11,761), and 1,345 (range 409-2,388), respectively over the last five years. Escapements to the lower Sauk have been less than 300 in four of the last six years and so are likely at least approaching critical levels. The lower Skagit stock is depressed although the abundance in recent years is likely well above threshold levels. The upper Skagit stock is the most abundant and productive component with escapements that are routinely approaching and occasionally exceeding MSY levels. The Skagit summer/fall stocks are also largely unaffected by hatchery production. There is again a harvest and survival rate indicator stock program for Skagit fall chinook that involves the collection of 40 spawning pairs per year and the release of about 200,000 marked juveniles.

Stillaguamish Summer/Fall Chinook
Two stocks are distinguished in the Stillaguamish River. There is a summer chinook stock in the North Fork Stillaguamish and a fall chinook stock in the South Fork. The average aggregate escapement to the system over the last five years is 1,080 (range 822-1,540) compared to an combined escapement goal of 2,000. However, the distribution of escapement has been uneven with most fish returning to the North Fork. Escapements to the South Fork have averaged just 200 over the last five years (range 96-251) and have been less than 251 since 1985. Although still low, the escapements of the last three years are the highest since 1985. Escapements in the North Fork showed a similar upward trend.

There is a supplementation program in place for Stillaguamish summer chinook which is considered essential for recovery. The program was initiated in 1980. There is no on-station release program; rather brood stock is collected annually from the river (the collection goal is 65 pairs) to provide for a release of 200,000 juveniles. The hatchery-origin fish are all marked and also serve as a harvest and survival indicator stock. The marking also means that returning hatchery fish can be distinguished from natural-origin spawners for assessment purposes. Juveniles are acclimated and released volitionally from a large, spring-fed rearing pond. The program contributes a significant proportion of the annual escapement and is at least partly the reason why escapements to the North Fork Stillaquamish have been higher than those in the South Fork. The fall chinook stock in the South Fork Stillaguamish is largely unaffected by artificial production either from supplementation or fishery enhancement programs.

Snohomish Chinook
There are three natural-origin stocks in the Snohomish watershed, including Snohomish summer chinook that spawn in the Skykomish and Snohomish mainstems, Bridal Veil chinook which spawn in Bridal Veil Creek and in the North and South Fork Skykomish Rivers, and Snohomish fall chinook that spawn in the Sultan and Snoqualmie rivers and associated tributaries. There is a fourth population that spawns in the Wallace River that is associated with the Skykomish hatchery. The natural spawners in the Wallace River are primarily hatchery origin. This is the only chinook production facility in the Snohomish Basin. Hatchery strays apparently do not contribute substantially to other parts of the Basin.

The Snohomish system has a combined natural escapement goal of 5,250. The average escapement over the last five years is 4,450 (range 3,176-6,300). The escapement of 6,300 in 1998 is the first time the goal has been met since 1980. The distribution of spawners has also been relatively even across the four stocks with none that suggest critical stock concerns. Returns have been relatively stable, falling below 3,000 only twice since 1968.

Lake Washington Chinook
The Cedar River is the only category 1 stock in the Lake Washington system. Natural spawning occurs in Issaquah Creek, but this is supported primarily by releases from the Issaquah Hatchery which is a harvest-oriented production facility. Additional spawning occurs in several small tributaries that enter north Lake Washington including Big Bear Creek and Cottage Lake Creek. These are considered category 2 populations.

Production in the Cedar River is limited by a water diversion dam at river mile 21 which blocks passage to the upper watershed. Natural production is further limited by stream flows, physical barriers, poor water quality and limited spawning and rearing habitat related to watershed development. The escapement goal for the Cedar River is 1,200 natural spawners and 350 for the combined north Lake Washington tributaries. Escapement over the last five years has averaged 630 (range 294-930) primarily in the Cedar River. It is not known how much may be the result of hatchery straying.

Duwamish/Green Chinook

There is one category 1 stock identified in the Green River system. (The lower 10 miles of this drainage are referred to as the Duwamish; the upper portion of the drainage is known as the Green River.) The Green River population has two components; summer/fall chinook spawn from river mile 25-61 in the Green River, and an aggregation of summer/fall chinook that spawn in Neuwakum Creek. There is a large hatchery program at the Green River Hatchery on Soos Creek. The Green River Hatchery stock was founded using Green River origin fish and was the primary production stock that was distributed throughout Puget Sound in past years. (This practice of cross-basin transfers has now been largely eliminated.) There is considerable straying of the hatchery-origin fish into the Green River, but because there have been no out of basin stock transfer, this integrated Green River natural/hatchery-origin stock presumably retains most of is genetic characteristics.

The natural escapement goal for the Green River system is 5,800 chinook. Escapements to Newaukum Creek and the Green River have averaged 849 and 5,219 over the last five years ending in 1997. (The 1998 data was not immediately available.) However, this includes an unknown, but presumably substantial number of hatchery strays.

White River Spring Chinook

The only category 1 population in south Puget Sound is White River spring chinook. The White River is a tributary of the Puyallup River. White River spring chinook are the last remaining spring chinook population in south Puget Sound. The stock is genetically distinct from neighboring summer/fall stocks and is also distinguished by its life history characteristics.

The abundance of White River spring chinook reached critically low levels in the late 70s and early 80s; returns averaged just 60 fish over a period of 10 years and were below 30 for five years running. As a result, White River spring chinook have been the subject of an intensive rebuilding program since the 1970's. A hatchery program was developed that included both juvenile releases and a full life-cycle captive broodstock program. The hatchery population is considered essential for recovery. The current natural escapement goal is for 1,000 spawners per year. The supplementation program has been successful at substantially increasing the annual returns over the years. Escapements have averaged 469 over the last five years (range 316-628) although much of this is obviously still supported by the supplementation efforts. A number of significant habitat related problems will have to be addressed before the population can be weaned of its dependence on the supplementation program.

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