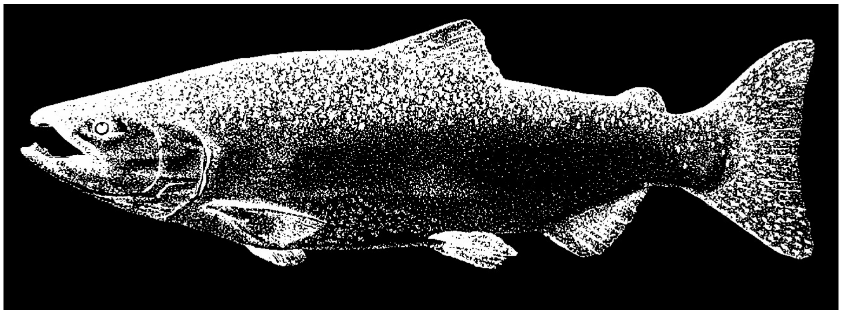
Puget Sound Chinook



Salmon Hatcheries

a component of the

Comprehensive Chinook Salmon Management Plan

developed by

Washington Department of Fish and Wildlife

&

Puget Sound Treaty Tribes

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SUMMARY

Northwest Native Americans called the largest of the salmon the tyee, or chief. Reaching a weight of up to 125 pounds, and occupying rivers from the Ventura River in California to Point Hope, Alaska, the tyee, king, or Chinook salmon (*Oncohynchus tshawytscha)* has always been an icon of northwest culture. Now, Puget Sound Chinook salmon are about one-third as abundant as they were in 1908 (Meyers et al., 1998), and they have been listed since 1999 as "threatened" under the Endangered Species Act (FR 64 14308).

As comanagers, our goal is to protect, restore, and enhance the productivity, abundance, and diversity of salmon and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries, non-consumptive fish benefits and other cultural and ecological values. Restoring populations of Puget Sound Chinook salmon will depend on integrated management of all factors affecting the salmon throughout their life cycle, including freshwater, estuarine and marine habitats, ecological interactions, harvest, and hatchery programs.

The purpose of this plan is to describe the operating procedures for Chinook salmon hatcheries in Puget Sound, their role in achieving the comanagers' resource management goals, and their consistency with the protection given to Puget Sound Chinook salmon by the Endangered Species Act (ESA). The plan describes both Tribal and WDFW hatcheries, because these hatcheries are tightly linked – they often operate in the same watersheds, exchange eggs, and share rearing space to maximize the effectiveness of the programs. The benefits of the programs are also shared, including the perpetuation of critically depressed populations and the harvest of returning adults.

Providing harvest opportunities is an important, legally defined role for hatcheries, for in *United States v. Washington* the court concluded:

> "The hatchery programs have served a mitigating function since their inception in 1895. 506 Supp. at 198. They are designed essentially to replace natural fish lost to non-Indian degradation of the habitat and commercialization of the fishing industry. Id. Under these circumstances, it is only just to consider such replacement fish as subject to allocation. For the tribes to bear the full burden of the decline caused by the non-Indian neighbors without sharing the replacement achieved through the hatcheries, would be an inequity and inconsistent with the Treaty." *United States v. Washington*, 759 f.2d 1353m 1360 (9th Cir)(en banc), cert. Denied, 474 U.S. 994 (1985).

The court-ordered Puget Sound Salmon Management Plan provides the framework for coordinating these programs, treaty fishing rights, artificial production objectives, and artificial production levels. Based on this framework, the parties to *United States v. Washington,* with the National Marine Fisheries Service (NMFS), developed this plan jointly as part of the Comprehensive Chinook Salmon Management Plan, which identifies interim goals for harvest and hatcheries.

This plan describes the scientific foundation and general principles for evaluating artificial production programs and for continued hatchery reform. It builds on a biological assessment of

tribal hatchery programs submitted to NMFS by the Bureau of Indian Affairs (BIA) in October, 1999, as required by section 7 of the ESA, and incorporates management alternatives subsequently developed by NMFS and the tribes. It also draws from the recommendations of the Hatchery Scientific Review Group (HSRG), a panel of independent scientists charged by the U.S. Congress with promoting hatchery reform.

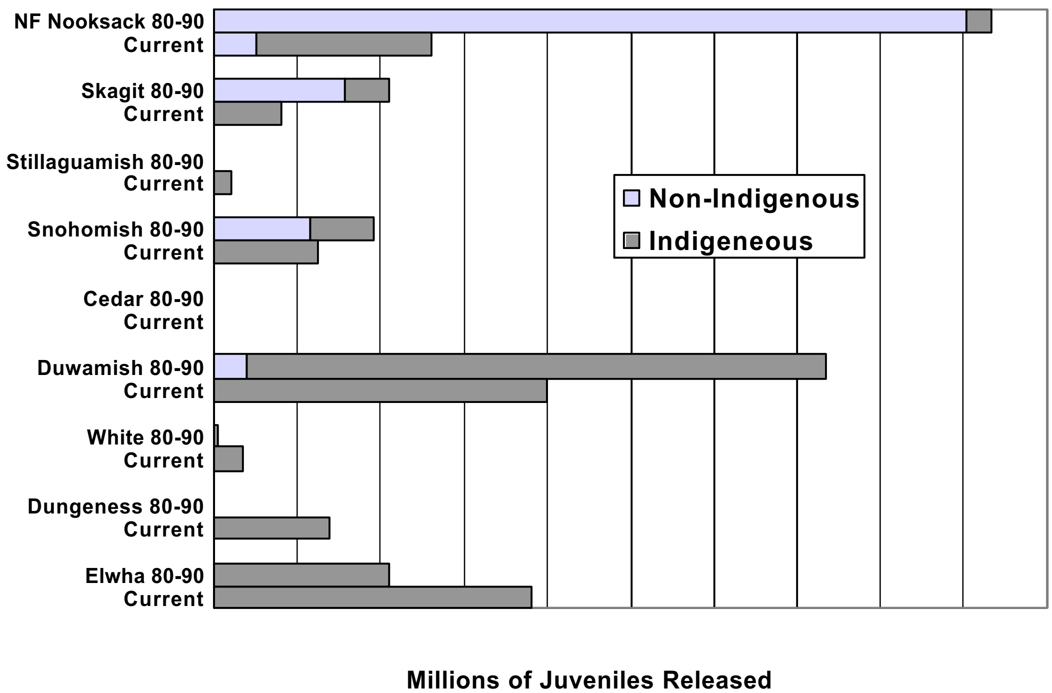
The following general principles guide this plan.

- Hatchery programs need clearly stated goals, performance objectives, and performance indicators.
- Hatchery programs need to coordinate with fishery management programs to maximize benefits and minimize biological risks so that they do not compromise overall plans to conserve populations.
- Priorities for brood stock collection of listed fish depend on the status of the donor population, relative to critical or viable population thresholds. Highest priority for brood stock collection of listed populations below the viable threshold is conservation. Brood stock collection for other priorities depends on meeting the conservation goals and not appreciably slowing recovery to viable levels.
- Hatchery programs need protocols to manage risks associated with fish health, brood stock collection, spawning, rearing, and release of juveniles; disposition of adults; and catastrophes within the hatchery.
- Hatchery programs need to assess and manage the ecological and genetic risks to natural populations.
- Hatchery programs must have adequate facilities and maintenance to rear fish, maintain fish health and diversity, and minimize domestication in fish of naturally spawned brood stock.
- Hatchery programs should be based on adaptive management, which includes having adequate monitoring and evaluation to determine whether the program is meeting its objectives and a process for making revisions to the program based on evaluating the monitoring data.
- Hatchery programs must be consistent with the plans and conditions identified by Federal courts with jurisdiction over tribal harvest allocations.
- Hatchery programs will monitor the "take" of listed salmon occurring in the program and will provide that information as needed.

In addition to the benefits provided by artificial production, the scientific literature indicates that artificial production may pose risks to wild Chinook salmon populations. These potential risks include: 1) genetic impacts, which affect the loss of diversity within and among populations and reproductive success in the wild; 2) ecological impacts, such as competition, predation, and disease; and 3) demographic impacts, which directly affect the physical condition, abundance, distribution, and survival of wild fish.

The risks and benefits resulting from each artificial production program for Chinook salmon in Puget Sound were evaluated in multiple ways, including the Benefit Risk Assessment Procedure, recommendations of the Hatchery Science Review Group (HSRG), and extensive discussions with NOAA Fisheries staff. This multifaceted review, in conjunction with numerous actions previously initiated by the comanagers, has resulted in significant improvements in Chinook salmon programs in Puget Sound, and extensive commitments to monitoring and evaluation. Key elements of the plan are summarized below:

Genetic Impacts. The development and implementation in 1991 of a new stock transfer policy (WDFW 1991) designed to foster local brood stocks resulted in a significant reduction in the transfer of eggs and juveniles between watersheds. In recent years brood stocks established from Green River fish have been also been eliminated or replaced in rivers with extant indigenous stocks.



Summary Figure 1. Current annual releases and average annual releases from 1980-1990 of non-indigenous and indigenous brood stocks in river systems with indigenous populations in the Puget Sound by WDFW and the tribes. Some river systems contain more than one indigenous population. Indigenous hatchery stocks in the Elwha, Dungeness, White, Stillaguamish were identified by NMFS as essential for recovery and listed under ESA.

Further review of the programs during the development of this plan led to additional actions, including:

1) terminating net pen programs at Fidalgo, Oak Harbor, Roche Harbor, San Juan, Mukilteo, Langley, Ballard, Elliot Bay, Des Moines, Fox Island, Hood Canal Marina, Pleasant Harbor, and Sund Rocks;
2) terminating the McAllister Creek Hatchery program;
3) reducing the Samish Fingerling fall Chinook program from 5.2 to 4.0 million;
4) reducing the Kendall Creek spring Chinook production from 1.6 to 0.70 million;

5) reducing the Wallace Yearling summer Chinook production from 520,000 to 250,000; and
6) reducing Hood Canal fingerling/fry production by 830,000.

Ecological Interactions. The Puget Sound Tribes, WDFW, and the HSRG are now conducting numerous studies to evaluate the risks posed by ecological interactions of Chinook salmon of hatchery and natural origin. Data collected through the studies will be used to adjust, if necessary, release numbers, release timing, or characteristics of the programs. In the interim period, hatchery programs will apply measures based on the best available science to reduce the risks posed by ecological interactions. These actions include:

1) terminating the net pen programs discussed above;
2) terminating the McAllister Creek Yearling program;
3) reducing the Wallace Yearling summer Chinook production from 520,000 to 250,000;
4) releasing fish at a time, size, and physiologically condition that provides a low likelihood of residualization and promotes rapid migration through the estuary to marine waters. Programs typically release subyearling Chinook salmon that are in the 40 to 90 fish per pound (77 to 100mm fork length) during the months of May and June. Fish released at this time and size are fully smolted, are unlikely to residualize, and are expected to move rapidly through estuarine areas;
5) releasing subyearling fish that are a larger size than natural-origin Chinook salmon of the same brood year to reduce the potential for diet overlap with any co-occuring natural origin fish in marine waters.
6) limiting the total releases of Chinook salmon in Puget Sound and reducing or minimizing releases affecting key stocks. The Chinook salmon programs proposed in this plan constitute a 37% reduction in production relative to 1990, including a 35% reduction in yearling production;
7) implementing fish health policies and procedures (PNFHPC 1989; Co-managers 1991; WDFW 1996);
8) maintaining state-of-the-art fish health monitoring, facility disinfecting, and disease management procedures presently applied in the operation of Puget Sound hatcheries.

Direct Demographic Impacts. The operation of hatchery facilities was analyzed, potential concerns identified, and actions undertaken and/or capital funding requested for facility modification. These actions and funding requests include:

1) screening all water intakes at Dungeness Hatchery to prevent adverse impacts to listed fish;
2) exploring removal of the Canyon Creek intake to allow passage of juvenile and adult Chinook salmon to available spawning and rearing habitat;
3) building an expanded incubation and early rearing facility at the Elwha Hatchery; and
4) exploring capital improvements to the pollution abatement system and the adult trapping/holding ponds at the Wallace River Hatchery to facilitate sorting of natural and hatchery-origin fish.

Research, Monitoring and Evaluation. Significant uncertainty exists in the threats posed by artificial production programs. To address these uncertainties, this plan includes substantial commitments to research, monitoring, and evaluation:

1) marking all Chinook salmon artificial production from Puget Sound, including program specific marks where multiple program(s) may affect a stock;
2) monitoring Chinook salmon escapements to estimate the number of tagged, untagged, and marked fish;
3) collecting and analyzing genetic data, including natural spawners in the North Fork Stillaguamish River, South Fork Stillaguamish River, Puyallup River, Nisqually River,
4) conducting a study to determine the relative reproductive success of naturally and hatchery produced Chinook salmon in the Green River;
5) conducting studies on the incidence and effects of competition and predation in fresh and marine waters.

The comanagers are committed to the ongoing transformation of hatcheries from one of the all-H (habitat, hydro, harvest, and hatcheries) risk factors to an integrated, productive, recovery tool. This plan takes a significant step forward, while recognizing the role that hatcheries must play in mitigating for the land and water-use decisions that have resulted in the permanent loss or degradation of salmon producing habitat.

INTRODUCTION

Purpose

Northwest Native Americans called the largest of the salmon the tyee, or chief. Reaching a weight of up to 125 pounds, and occupying rivers from the Ventura River in California to Point Hope, Alaska, the tyee, king, or Chinook salmon (*Oncohynchus tshawytscha)* has always been an icon of northwest culture. Now, Puget Sound Chinook salmon are about 1/3 as abundant as they were in 1908 (Meyers et al., 1998), and they have been listed since 1999 as "threatened" under the Endangered Species Act (FR 64 14308, March 24, 1999).

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Hatchery Reform and Adaptive Management

Hatchery reform is the ongoing, systematic application of scientific principles to improve hatcheries for recovering and conserving naturally spawning populations and supporting sustainable fisheries (Hatchery Scientific Review Group 2000). A key component of this is adaptive management. Adaptive management is a management process that incorporates research, monitoring, and scientific evaluation to allow managers to make good decisions while operating in the face of uncertainty about future circumstances and consequences (Holling 1978, Walters 1986).

Adaptive management is often associated with large-scale experiments (i.e. active adaptive management), where the best decision can be made only when the outcome of the experiments is known. Adaptive management also includes other strategies, however, such as passive adaptive management and evolutionary problem solving (Anderson et al. 2003), which are better suited to hatcheries. Passive adaptive management uses the best available scientific information to make decisions initially but also specifies multiple, future decision points where new information is

Figure 1. Locations of salmon hatcheries in the Puget Sound.

analyzed and incorporated into decisions and the best apparent decision is chosen at each point. Evolutionary problem solving encourages managers to experiment with innovations independently and share results. Change depends largely on encouraging communication. Evolutionary problem solving is most useful when programs have multiple, incommensurable goals (Anderson et al. 2003).

The co-managers' adaptive management framework combines passive adaptive management and evolutionary problem solving. It has seven key elements:

- An integrated strategy for prioritizing actions across the ESU
- Defined goals and objectives for hatchery programs
- A framework of artificial production strategies for reaching goals and objectives
- Strategy-specific guidelines for operating hatchery programs
- Scientific tools for evaluating hatchery operations, including statistical analyses, risk-benefit assessments, and independent scientific review
- A decision-making framework for considering in-season, annual, and long-term changes in hatchery objectives and standard operating modes described in HGMPs and resolving disputes
- Implementation using available resources

Overall Strategy for the ESU

The overall strategy for managing hatcheries at the ESU scale recognizes that risk of extinction to an ESU, potential recovery of habitat to sustain natural populations, and harvest needs are different in different watersheds of the Puget Sound.

Overall Strategy for Threatened Salmon

1. Protect and recover indigenous populations of salmon in watersheds where they still occur (Recovery Category 1 watersheds).

2. Implement management actions that use the most locally adapted stock to reestablish and sustain natural production in watersheds that no longer have indigenous populations, but where natural production is possible given existence of suitable or productive habitat (Recovery Category 2 watersheds).

3. Manage watersheds that historically may have not supported self-sustaining, naturally spawning populations for hatchery production, when desired, while maintaining habitat for other species that are supported by these watersheds (Recovery Category 3 watersheds).

4. Protect treaty rights by providing fish for harvest.

Historically, WDFW and the tribes have managed hatcheries according to their impacts on salmon within a watershed or fishery. Because Puget Sound salmon also interact over much larger geographic and evolutionary scales, recovery of the ESU also calls for strategies that address opportunities across the whole region.

The opportunities vary. The Puget Sound includes areas where the habitat can still support sustainable natural production, areas where habitat for natural production has been irrevocably lost, and areas where some species of salmon were never self-sustaining, independent populations. 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 strains. Extensive genetic analyses of spawning aggregations throughout the Puget Sound show naturally-spawning aggregations in many river basins that are genetically different despite a history of inter-basin transfers. In some areas where natural production has been lost, hatchery production is used to mitigate for lost natural production and to protect tribal treaty rights. Consequently, in a few major river systems that historically contained indigenous populations of salmon, natural production is derived from hatchery fish or admixtures of native and introduced populations. In addition, salmon sometimes spawn in smaller, independent watersheds, which historically did not contain independent sustainable populations. In many cases, current spawning in these watersheds comes from hatchery fish released from nearby facilities. In other areas, mitigation hatcheries can be located in areas where the returning adults tend to be geographically isolated from naturally-spawning aggregations.

Applying this strategy leads to a general approach for integrating Chinook salmon hatchery production and recovery throughout the ESU (Table 1).

Goals and Objectives

Clearly defined goals are a key element of a passive adaptive management process. The co-managers' overall goal begins the Introduction to this plan (above). The co-managers describe specific goals and objectives for hatchery programs in HGMPs. These goals address legal obligations and social benefits of hatcheries as well as their role in conserving natural populations. Defining the relationships between multiple, incommensurable goals is important for developing an evolutionary problem solving strategy in adaptive management.

Artificial Production Strategies

Hatcheries meet a variety of needs from providing fish for harvest to preventing extinction. Production strategies to meet these needs carry different benefits and risks. Because hatchery reform is based on balancing benefits from hatcheries with risks to natural populations, different strategies are necessary for different hatcheries.

This plan recognizes four basic strategies, based on the intended benefits of hatcheries and whether the hatchery fish are intended to spawn in the wild with naturally produced fish (2). The two main benefits of hatcheries are **harvest** or **recovery of natural populations**. The two main reproductive strategies that determine the degree of interaction with natural populations are **integrated production** strategies or **isolated production** strategies. Integrated projects intend that artificially propagated fish spawn in the wild and become fully reproductively integrated as a single population. Isolated programs are designed to keep artificially propagated fish from spawning in the wild or to prevent genetic interactions with natural populations. HGMPs identify the strategy of each program.

Table 1. Distribution of Puget Sound Chinook salmon stocks (WDF et al., 1993) by recovery strategy.			
Region	**Watershed**	**Stock**	**Recovery Category**
Strait of Juan de Fuca	Dungeness River	Dungeness spring/summer Chinook	1
	Elwha River	Elwha summer Chinook	1
North Puget Sound	Nooksack River	North Fork Nooksack Chinook	1
		South Fork Nooksack Chinook	1
		Nooksack fall Chinook	2? (Non-native)
	Skagit River	Upper Skagit summer Chinook	1
		Lower Skagit fall Chinook	1
		Lower Sauk summer Chinook	1
		Upper Sauk spring Chinook	1
		Suiattle spring Chinook	1
		Upper Cascade spring Chinook	1
	Stillaguamish River	Stillaguamish summer Chinook	1
		Stillaguamish fall Chinook	1
	Snohomish River	Skykomish Chinook	1
		Snoqualmie Chinook	1
Mid Sound	Lake Washington	Issaquah summer/fall Chinook	Non-native
		North Lake Washington tributary summer/fall Chinook	Pending research
		Cedar River summer/fall Chinook	1
	Green River	Green River summer/fall Chinook	1
		Newaukum Creek summer/fall Chinook	= Green R.
	Independent tributaries	East Kitsap Independent tributaries	3
South Sound	White River	White River spring Chinook	1
		White River summer/fall Chinook	2
	Puyallup River	Puyallup fall Chinook	2
	Nisqually River	Nisqually summer/fall Chinook	2
	Independent tributaries	Independent South Sound tributary summer/fall Chinook	3
Hood Canal	Skokomish, Hamma Hamma, Duckabush, Dosewallips	Hood Canal summer/fall Chinook	2
	Union, Tahuya, Dewatto	Hood Canal summer/fall Chinook	3

Table 2. Artificial production strategies and their primary uses.

Primary Management Objective	Demographic relationship to natural population(s) in watershed: Integrated Production	Isolated Production
Recovery	• Prevent extinction • Increase natural origin recruits using the local stock • Reintroduction • Research	• Prevent extinction • Create 'reserve' population in case other recovery options fail • Gene banking until reintroduction • Research
Harvest	• When isolated approach is not feasible • Maintaining local stocks • During rebuilding • Mitigation • Research	• Create new or enhance existing fishing opportunities • Mitigation • Allocation • Research

Ultimately, the potential success of these strategies in any given program is unknown and depends on both innovation and communication (evolutionary problem solving) and implementing monitoring, evaluation, and decision-making at key points in future (passive adaptive management).

Guidelines

Guidelines describe the desired operating conditions for programs. General guidelines describing the ideal conditions for four basic artificial production strategies are in Appendix A. HGMPs describe in more detail the current operating procedures and guidelines adopted for each hatchery program. Current guidelines and operating procedures reflect the unique historical, legal, and logistical circumstances of each program and the opportunities for improvement. This plan specifically recognizes that current guidelines and operating procedures will change as a result of the adaptive management process the co-managers use to implement hatchery reform.

Scientific Evaluation

Tools for evaluating hatchery programs include monitoring, research, and risk assessments.

Monitoring and Research
Monitoring and research provide new information for evaluating hatchery programs under the passive adaptive management strategy. The tribes and WDFW monitor fish culture at all state and tribal facilities. With increasing scientific and policy interest on monitoring for salmon recovery (Washington Independent Science Panel 2000), the co-managers have developed more comprehensive frameworks for understanding direct and indirect effects of hatcheries through implementation, effectiveness, and validation monitoring. The Washington State Legislature directed that the State develop a comprehensive strategy and action plan for measuring success in recovering salmon, including the effects of hatcheries, in Substitute Senate Bill 5637. As a result, the Washington Comprehensive Monitoring Strategy and Action Plan for Watershed Health and Salmon Recovery (CMS) outlined a monitoring framework focused on implementation

monitoring of compliance with established best management practices (BMPs) for hatcheries and effectiveness monitoring of BMPs in reducing or eliminating adverse effects of hatchery fish on wild salmon (Monitoring Oversight Committee 2002). The CMS did not identify specific BMPs, which will need to be developed and agreed to by state and tribal the co-managers. Interim guidelines for operating hatcheries under different artificial production strategies, however, are in Appendix A. Additional guidelines are available from the Hatchery Scientific Review Group (HSRG 2002a).

Although the state and tribes conduct research on hatchery practices, lack of available money limits implementation of comprehensive hatchery monitoring. The Monitoring Oversight Committee (MOC) for the CMS—which was made up of policy representatives from state agencies, NOAA Fisheries, U.S. Fish and Wildlife Service, other federal agencies, and the tribes—recognized that monitoring all desired hatchery criteria was impossible, given the available resources for all salmon recovery activities. They determined that monitoring associated with hatcheries was a medium-level priority compared to other salmon recovery monitoring activities. Of the possible criteria for monitoring in hatcheries (e.g. HSRG 2002b), they prioritized monitoring that focused on 1) marking and sampling hatchery fish, 2) developing genetic baselines of hatchery and wild populations, 3) selecting hatchery brood stock, 4) disease control, 5) fish screening and passage, and 6) hatchery pollution abatement (Monitoring Oversight Committee 2002). Summaries of monitoring activities for these are in Appendix B.

Research helps explain trends in monitoring, provides information for developing better risk assessments, and tests new ideas for improving hatcheries. Although funding for research is also limited, scientists from the tribes and WDFW are actively working with NOAA Fisheries and the HSRG to identify and conduct critical research in the Puget Sound region that will help indicate the genetic, ecological, and demographic effects of salmon artificial propagation programs on the survival and productivity of listed and non-listed salmonid populations. Summaries of recent research are in Appendix C.

Risk-Benefit Assessments

As co-managers experiment with different ways of adapting hatchery programs to be consistent with operating guidelines and the unique circumstances of the watershed, they will not be able to monitor everything. Under the evolutionary problem solving strategy of adaptive management, models for systematically assessing risks and benefits in an objective, transparent framework at key decision points provide an important way of linking the strategy to passive adaptive management. The co-managers have developed and will continue to refine these models to regularly evaluate their hatchery programs (Currens and Busack, in press). For example, because no comprehensive model for evaluating hatcheries existed, WDFW and the tribes developed the Benefit-Risk Assessment Procedure (BRAP) as a tool to evaluate the risks and benefits of hatchery programs in the ecological context of each watershed. WDFW used BRAP to analyze risks and benefits of hatchery programs systematically for Chinook salmon and identify changes. BRAP has been reviewed by the Hatchery Scientific Review Group, a panel of independent scientists, to ensure that it is scientifically sound and consistent with overall approaches to hatchery reform. Following an additional review by the Independent Science Review Panel of the Northwest Power Planning Council in 2003, Drs. Ken Currens (Northwest Indian Fisheries Commission), Craig Busack and Todd Pearsons (WDFW), and Lars Mobrand (Mobrand Biometrics) received funding to improve the analytical foundation of the tool and develop software to make it easier to use. This will be available by January 2005 (Appendix D).

Analytical tools such as these are important for informing policy decisions. They do not create or dictate policy changes for implementing hatchery reform. Implementation also depends on political, social and legal goals, which are incorporated through co-manager policy review, and having available resources to make the changes to achieve a consistent balance of political and social goals and benefits. The process for policy review, implementation or modification of technical recommendations generating from monitoring and evaluation, risk assessments, or independent scientific review is reached through the legal and policy framework described below.

Independent Scientific Review

Independent scientific review provides a critical role in ensuring that technical recommendations are objective and credible. Independent scientific review may take several forms. Independent review may consist of a group of independent scientists gathering information on hatchery programs, conducting their own assessment, and generating recommendations. Alternatively, independent scientific review may focus on reviewing the scientific merits of the co-managers' own assessment methods, results, and recommendations.

The co-managers currently have at least three major mechanisms for independent scientific review. The Hatchery Scientific Review Group (HSRG) was created by Congress in 2001 to serve as an independent panel working with agencies and tribes to produce guidelines and recommended actions and ensure that the goals of hatchery reform are carried out. During 2001-2003, the HSRG reviewed all hatchery programs in western Washington and developed recommendations for changes in those programs based on dual goals of recovering natural populations and providing for sustainable fisheries.

The Independent Science Panel (ISP) for Washington can also provide independent review of hatchery programs. Created under ESHB 2496 by the Washington State Legislature in 1998, the ISP was charged with providing independent scientific review of the state's salmon recovery and planning efforts, including hatchery programs.

Finally, the co-managers may use ad hoc independent scientific review panels to address specific issues on a case-by-case basis. The key to these kinds of reviews is identifying reviewers with appropriate expertise and willingness to participate. The ISP helps coordinate and organize independent scientific review panels as does the American Fisheries Society.

Decision Making Framework

The Puget Sound Salmon Management Plan (PSSMP) under *U.S.* v *Washington*, provides the legal framework and identifies tools for making changes in hatcheries. These tools include 1) descriptions of standard modes of operating hatchery programs developed under regional planning by the co-managers (equilibrium brood documents and equilibrium brood programs), 2) annual descriptions and review of the operating objectives and changes from the standard program that can be used for annual planning (Future Brood Document and Co-managers' Fish Disease Policy), 3) regional management plans to coordinate co-manager activities and priorities, 4) exchange of technical information and analyses through coordinated information systems, and 5) dispute resolution.

Many of the tools and processes developed under PSSMP are being updated and reinvigorated to meet the needs of hatchery reform and the Endangered Species Act. HGMPs contain much the same information as equilibrium brood documents. The Future Brood Document, which under PSSMP annually describes proposed changes in operating objectives for co-manager review, will be complemented by a new database that tracks implementation of recommended changes to hatchery programs developed from co-manager and independent scientific review. Using both these databases, co-managers will be able to review recommendations and changes to programs.

Implementation occurs with policy review, decisions, and allocation of resources to continue programs or make changes. The co-management process focuses on decisions as they occur at regular points in future in a three-tier process (Table 3), which is consistent with an integrated passive adaptive management and evolutionary problem solving strategy. The most important review and decision-making cycle is every 3-5 years when regular, regional review of hatchery programs and monitoring data may lead to recommendations for changing HGMPs or equilibrium brood documents and programs (Tier 1). Conducting these reviews using a variety of jointly developed analytical models is the responsibility of the co-managers. Independent scientific review is also important to provide new insights and scientific credibility. If co-managers disagree about recommendations, regional technical and policy meetings between the co-managers are used to resolve the differences. If this fails, the issue is identified for discussion at the annual state-tribal co-managers' meeting between the WDFW director and the tribes. The annual co-managers' meeting has been a regular forum for lead policy representatives from state and tribes to identify significant issues that cannot be resolved locally or that affect multiple tribes and to identify the process and schedule for resolving them. The PSSMP describes additional legally recognized dispute resolution measures, should they be necessary, but these have not been used in many years.

Table 3. Three-tiered process of co-management review and decision-making for hatchery reform and adaptive management.

	Time Period	Implementation Document	Evaluation Tool	Dispute Resolution
Tier 1	3-5 years	• Hatchery plans • Equilibrium brood • HGMP	• Monitoring & evaluation • Independent scientific review • Risk assessment	• Regional co-management meetings; • annual state/tribal co-managers' meeting
Tier 2	Annual	• Future Brood Document • Hatchery Reform Recommendations	• Risk assessment • Co-manager review	• Regional co-management meetings; • annual state/tribal co-managers' meeting
Tier 3	Intra-annual	• Fish transfer requests • Co-managers' Fish Disease Policy	• Risk assessment • Co-manager review	• Regional co-management meetings;

Evaluation also occurs annually for individual programs (Tier 2). The Future Brood Document, which describes annual production objectives and program changes, and list of hatchery reform recommendations developed by independent scientific review are the key implementation documents for review. These are compiled annually by WDFW and reviewed by the co-managers. Risk assessment modeling provides a tool for analyzing the changes, should it be necessary. If co-managers disagree about proposed actions, technical and policy meetings between the co-managers in the region are needed to resolve the differences. If this fails, the issue is identified for discussion at the annual state-tribal co-managers' meeting between the WDFW director and the tribes.

Finally, the co-managers also evaluate intra-annual changes from the Future Brood Document (Tier 3). By their nature, these changes involve transfers of fish (adults, gametes, or juveniles for growing and release) between watersheds that would not be permitted under the Co-managers' Fish Disease Policy and other fish transfer guidelines. Failure of the co-managers at the regional level to agree to the fish transfer may lead to dispute resolution or ultimately to the transfer not occurring.

History of Artificial Propagation in the Puget Sound

Chinook salmon have been propagated in hatcheries within the Puget Sound region since before 1900. Since that time, the objectives for hatcheries have changed. The earliest purpose for hatcheries was to produce large numbers of fish for harvest. As salmon habitat was altered or destroyed by dams, forestry, and urbanization, mitigation for lost natural production and fish opportunity became a major purpose for hatchery production. Over the last 20 years, the purposes for hatcheries have evolved to include rebuilding wild populations, preserving unique genetic races, and reintroducing fish to areas where they have been extirpated.

Improvements in Hatchery Technology Increase Production

Constant improvements in husbandry and hatchery technology over the last century have made Washington hatcheries one of the largest producers of Chinook salmon in North America. The earliest hatcheries in Puget Sound were not originally built to propagate Chinook salmon, but hatchery managers adjusted operations to focus on production of that species. By 1903, however, eight state and two federal hatcheries were producing Chinook salmon (WDFG, 1904). Major improvements followed with development of strategies for producing Chinook salmon based on releasing them at different life stages as fry, fingerlings, subyearlings, or yearlings (Figure 2).

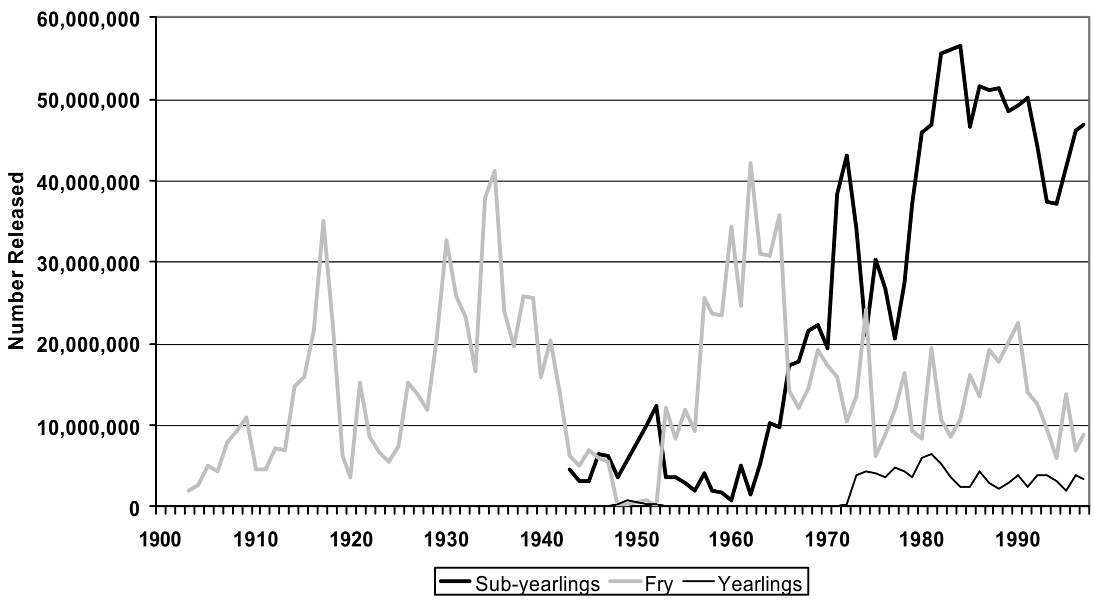

Figure 2. Total annual Chinook salmon releases by age class from hatchery facilities within the Puget Sound region.

From the late 1890s through 1905, the predominant strategy to enhance Chinook salmon abundance was based on collecting large numbers of eggs and releasing fry with very limited or no rearing (WDF, 1958; Becker, 1967). As early as 1902, research indicated that post-release survival would increase by releasing fed fry and fingerlings (WDFG, 1903). Between 1906-1936, hatcheries used large-scale egg-taking and short term rearing of fish to release larger, more viable hatchery Chinook salmon and also unfed fry (WDF, 1958; Becker, 1967).

Beginning in 1937, hatchery technology improved with intensive rearing of fish in ponds. By 1939, results of feeding studies had indicated the economic necessity of rearing salmon at least a few months in freshwater (WDF, 1939). This change resulted in overall decreases in releases of unfed fry, and the better survivals let hatchery managers reduce the volumes of eggs collected (Becker, 1967). By 1942, over half of the total eggs taken in Washington were hatched and reared two months or more prior to release (WDF, 1942), and by 1943, 42 % of the Chinook salmon reared in Puget Sound region hatcheries were being released as fingerling or yearling smolts.

Continued expansion and modernization of the hatchery system, advances in nutrition, fish health, fish cultural technology, and greater scientific understanding of the benefits of releasing larger fish led to the production of many millions of fingerlings, subyearling smolts, and yearling smolts each year (Table 4). Since 1935, WDFW and the tribes have liberated 962 million fry, 1.35 billion subyearlings, 96 million yearling Chinook salmon into Puget Sound region waters from hatchery programs. By 1968, release of subyearlings had surpassed fry production levels and has remained the predominate strategy.

Development of Hatchery Brood Stocks

As hatcheries demonstrated the ability to increase juvenile production, they became a popular tool to mitigate for lost natural production and fishing opportunity. Hatcheries capable of taking large numbers of eggs became distributors of eggs and fish to other programs where brood stocks were not abundant or available. This institutionalized the assumption that fish of the same species were largely interchangeable. Fish were transferred to watersheds where they were not indigenous without knowledge of the impacts on genetic diversity, fish health or ecological interactions. Hatchery practices, including spawning protocols, evolved to maximize efficiency and were not based on genetic principles.

In the early part of this century, hatcheries used Chinook salmon brood from regions outside of Puget Sound as well as Puget Sound sources. Especially between 1913 and 1927, hatcheries imported large numbers of Chinook salmon eggs from the lower Columbia River Basin (WDFG, 1916; 1917). This practice declined in the 1930s (WDF, 1938).

Within the Puget Sound, Chinook salmon eggs from Green River Hatchery accounted for the majority of the hatchery fall Chinook salmon. From 1904 -1913 and 1927 -1957, releases from the Green River Hatchery averaged 69.9 % and 67.7%, respectively, of all Chinook salmon releases. As Chinook salmon production increased throughout the region due to more hatcheries, increased survivals from improved hatchery diets, better understanding of fish health requirements, and better ocean conditions, the importance of releases from Green River Hatchery diminished. Between 1957-1988 and 1990-1997, annual releases from Green River Hatchery were 11.4% and 12.6%, respectively, of the total releases of fall Chinook salmon.

Table 4. Releases of Chinook salmon in watersheds with historical natural production in the Puget Sound. Watersheds are identified by water resource inventory area (WRIA). Data are from WDFW annual reports (1902-70), liberation summaries in Myers et al., 1998.

WRIA - Drainage	Years Planted with Chinook	Total Number Released (1950 - 1997)
WRIA 1 -		
Nooksack R.	1899-1929, 1952-	161,196,511
Samish R.	(1899) 1914-1998	198,346,933
WRIA 3 and 4 -		
Skagit R.	1906-98	88,368,134
WRIA 5 -		
Stillaguamish R.	1905-15, 54, 57-98	16,861,494
WRIA 7 -		
Snohomish R.	1900-66, 89-93	2,729,047
Snoqualmie R.	1904-60, 63-75, 77	74,076,904
Skykomish R.	1904-51, 53-98	1,457,481
WRIA 8 -		
Lake Washington	1920-98	126,879,771
WRIA 9 –		
Duwamish/Green R.	1909-98	206,446,248
WRIA 10 -		
Puyallup R.	1917-98	2,480,424
White R.	1901-08, 1990-	87,477,207
WRIA 11 -		
Nisqually R.	(1899-) 1937-98	63,179,038
WRIA 16 -		
Skokomish R.	1899-1922, 1957(?) -98	5,733,696
Hamma Hamma R	1971-92	4,174,621
Dosewallips R.	1959-92	117,729,948
Duckabush R.	1959-92	3,745,211
WRIA 17 -		
Big Quilcene R.	1900-96	27,733,343
WRIA 18 -		
Dungeness R.	1902-82, 1996-	48,768,322
Elwha R.	1914 -?; 1953-98	17,416,767

Brood stock from the Green River also provided most of the eggs used to found many of the fall Chinook salmon hatchery programs in the Puget Sound. Eggs from Green River Chinook salmon were used in Samish Hatchery beginning in 1929 (WDFG, 1932; WDF, 1938) and to found production at Issaquah Hatchery in 1937 (WDF, 1935). Voights Creek Hatchery in the Puyallup River initially procured small numbers of eggs from native fall Chinook salmon after it was built in 1917 but subsequently augmented local collections with transfers from Green River and lower Columbia River hatcheries (WDFG, 1925). The Nisqually Hatchery on Muck Creek received consistent annual transfers of Green River Hatchery Chinook eggs beginning in 1945. Brood stocks for Minter Creek Hatchery and Hood Canal Hatchery were also founded from transfers of Green River eggs (Salo and Noble, 1953; WDF, 1957; K. Kloempken, WDFW, pers. comm., July, 1998). In addition, Green River fall Chinook were introduced to the Deschutes River in 1946 to found a hatchery brood stock there.

These transfers continued off and on until 1991. In the early 1990s, a new stock transfer policy designed to foster local brood stocks was developed (WDF, 1991). This led to large reductions in the transfer of eggs of Green River lineage to other watersheds. In recent years brood stocks established from Green River fish have been also been eliminated or replaced in rivers with extant indigenous stocks (Figure 3).

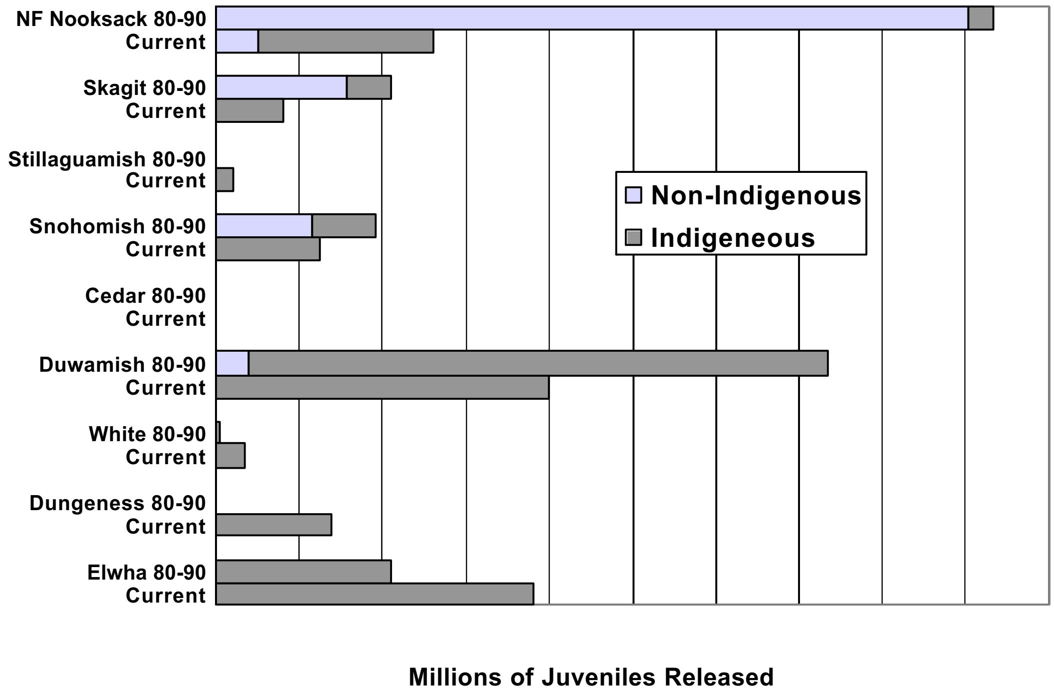

Figure 3. Current annual releases, and average annual releases, from 1980-1990 of non-indigenous and indigenous brood stocks in river systems with indigenous populations in the Puget Sound by WDFW and the tribes. Some river systems contain more than one indigenous population. Indigenous hatchery stocks in the Elwha, Dungeness, White, Stillaguamish, and Nooksack Rivers were identified by NMFS as essential for recovery and listed under ESA.

Impacts of the Boldt Decisions

In the 1970s, two Federal court decisions on treaty rights, commonly known as the Boldt decisions, became the legal framework for defining fish production objectives in Washington. *United States v. Washington* affects hatchery production in the Puget Sound and coastal Washington, whereas the *United States v. Oregon* affects hatchery production in the Columbia River. Affirmation of treaty Indian fishing rights and tribal standing as co-managers of the salmonid resource led to more definitive and restrictive management guidelines for hatchery production. Many tribes began building their own hatcheries to provide opportunity to fish where they had not been able to for many years. This placed greater emphasis on producing salmon for harvest in specific, traditional tribal marine and freshwater fishing areas and led to refinement of many hatchery practices, including the selection and transfer of appropriate brood stocks for hatchery programs. Annual planning evolved around the assembly of the Future Brood Document, in which annual production plans are proposed and reviewed by the co-managers. In some areas, court-ordered production plans set precise levels of production by species that will occur each year.

During this period, changes in two different fishery management paradigms converged to fostered greater emphasis on developing self-sustaining local brood stocks and maintaining genetic diversity. The legal framework of *United States v. Washington*, which elevated the role of Indian tribes from different watersheds in fishery management, meant that fishery managers needed more precise river-specific hatchery management. During the same period, the stock-concept—a management philosophy that emphasized the local adaptation of salmon returning to different natal streams—also became important. These led to formation and adoption of several important production guidelines and policies. In the early 1980s, WDFW developed genetic guidelines for fish transfers and spawning operations (Hershberger and Iwamota, 1981). WDFW and the tribes also developed and implemented the Co-Manager's Salmonid Disease Control Policy (WDFW et al., 1993), which limited the exchange of fish among watersheds to help prevent the spread of fish pathogens.

Hatcheries for Conservation

In the late 1970s, the decline of several important wild stocks of spring and summer Chinook salmon due to habitat deterioration led fishery managers to propose using hatcheries to maintain abundance and prevent extinction. In the White River, for example, annual returns of 5,000 spring Chinook salmon had declined into the teens. In 1977, WDFW began an intensive captive/gene banking hatchery program to maintain these fish before they became extinct. Programs for other populations soon followed for Chinook salmon in the Nooksack, Elwha, Stillaguamish and Dungeness Rivers. Currently, approximately one-third of hatchery programs statewide focus on maintaining and rebuilding wild salmon runs.

By the early 1990s, concern for natural populations became critical. Downturns in productivity resulting from back-to-back El Niño events in the ocean and high harvest rates produced fewer and fewer fish to the spawning grounds. Restrictions in harvest failed to improve the condition of depleted wild salmon stocks. At the same time, genetic research had documented the existence of unique, indigenous populations in some watersheds and suggested that transfers of non-indigenous hatchery fish had eliminated indigenous populations in other regions.

These concerns led to new initiatives emphasizing wild salmon and a role for hatcheries in conserving stocks that were threatened. In 1991, WDF revised its stock transfer guidelines (WDF, 1991). During the same period, WDFW and some Puget Sound tribes initiated the Wild Stock Restoration Initiative (WSRI). In 1993, WDFW and the tribes completed the first step of the WSRI—the Salmon and Steelhead Stock Inventory (SASSI)—a comprehensive inventory of salmon stocks and their status. This became a baseline to identify those salmon populations in immediate or future need of rebuilding. After SASSI, WDFW and the tribes began developing a Wild Salmon Policy that would serve as a framework for managing wild salmonids and their habitats. This policy was completed in 1998. Other regulations and policies implemented by the co-managers in the early 1990s included the National Pollution Discharge Elimination Systems (NPDES) permit requirements, assembly of Hatcheries Operations Plans and Performance Summaries, which detail operational practices employed at each WDFW hatchery to produce healthy hatchery salmon populations and define actions taken at each to minimize effects on wild salmonids (Fuss and Ashbrook, 1995).

Coded-Wire-Tag Indicator Stock Program

The development of coded-wire-tags (CWTs) in the early 1970s provided an important tool for the management of salmon populations. A report from the Pacific Salmon Commission (ASFEC 1995) provided the following description of the CWT program:

> "Stock assessment and management of Chinook and coho salmon must contend with harvests by diverse gear types over extensive geographic areas. Until the late 1970's, the total fishing mortalities by age and stock were unknown and the status of our wild Chinook and coho populations was uncertain. The development of the CWT fundamentally changed our assessment and management capabilities for these species. Tagged juvenile salmon, usually those released from hatcheries, provided information on the marine distribution of stocks, total mortalities and exploitation rates in fisheries, and variations in marine survival. Under the assumption that the distribution and exploitation rates of hatchery stocks were representative of nearby wild stocks, this information was subsequently applied to their management. Managers could now investigate the population dynamics and status of wild stocks, develop stock-specific abundance predictions, and estimate stock compositions in fisheries. Numerous management agencies, fishery councils, and the PSWC technical committees rely on the CWT program to assess and manage Chinook and coho salmon."

To maximize the value of CWTs, an indicator stock program was established. In this program, a fixed set of representative stocks are tagged on an ongoing basis to provide estimates of stock statistics. Estimates obtained from the indicator stocks are accurate only to the extent that the biological characteristics of the stock are represented by its indicator.

The ability to estimate population abundance and the distribution of stock-specific mortalities is critical to salmon management. CWT-based estimation methods underlie most tools that are currently used for stock-specific assessment of coho and Chinook salmon. Stock-specific parameters derived from CWT-based estimates of fishery and escapement contributions include distributional statistics, estimation of exploitation rates by stock, age, fishery and time period and total initial cohort size of stocks at time of recruitment."

The importance of this management tool has been recognized in provisions of the Pacific Salmon Treaty. The Memorandum of Understanding states "The Parties agree to maintain a coded-wire-tagging and recapture program designed to provide statistically reliable data for stock assessments and fishery evaluations."

Several of the hatchery programs included in this plan are a key part of the indicator stock program for monitoring exploitation rates, survival rates, and other stock-specific statistics. These include: Tumwater Falls fall Chinook, Samish River fall Chinook, North Fork Stillaguamish summer Chinook, George Adams fall Chinook, Clear Creek fall Chinook, Elwha Channel summer/fall Chinook, Skagit spring Chinook, Skagit summer Chinook, Skagit fall Chinook, Kendall Creek early returning Chinook, and White River Hatchery spring Chinook.

Summary of Institutional and Operational Changes

The history of hatcheries shows that managers have adapted hatcheries to meet different priorities. These have led to different institutional and operational changes that are still continuing. Originally, hatcheries were used to mitigate socially acceptable losses of wild populations. In recent years, however, hatchery operations have begun to emphasize rebuilding wild populations and reducing negative impacts with wild fish. These changes provide the momentum for continued hatchery reform.

Institutional Changes

- 1970s–Spawning escapement objectives for natural spawning salmon developed.
- 1974—*United States v Washington*
- 1980s—WDF implements genetic guidelines for stock transfers and spawning operations.
- 1980s—WDF and the tribes develop Co-Managers Salmonid Disease Control Policy.
- 1985—Puget Sound Management Plan developed under *United States v Washington*. This plan lead to the development of the Future Brood Document, which ensured co-managers reviewed annual production plans so that they complied with legal agreements and mandates, wild stock management needs, and harvest management objectives.
- 1991—WDFW and Puget Sound tribes initiate Wild Stock Restoration Initiative.
- 1993—First species in the Salmon and Steelhead Stock Inventory (SASSI) completed which provided baseline information for identifying those salmon runs in need of recovery.
- 1998—Wild Salmonid Policy formalized to serve as a framework for managing wild salmonids, including habitat, spawner abundance, genetic conservation, ecological interactions, harvest management and hatcheries. Note: not all tribes agreed to or endorsed this State Policy.
- 2000—WDFW and tribes develop a Risk/Benefits Analysis Procedure (BRAP) for hatchery programs, which provides a systematic method for evaluating genetic and ecological risks of hatchery programs.
- 2000—Western Washington Hatchery Reform Initiative creates an independent review panel, the Hatchery Scientific Review Group (HSRG), to oversee hatchery reform and provide funding for hatchery reform.

Operational Changes

- *Reduction of cross-basin transfers of salmon stocks:* Once a common practice, this practice has been dramatically reduced to protect the local genetic adaptations and to reduce the risk of disease.
- *Reduction of fry plants:* Until the 1960s, fry plants were the primary release strategy but they are used today only where it is ecologically and genetically appropriate.
- *Establishment of fish health programs:* Building on the fish disease policy, WDFW and the tribes have developed extensive fish health monitoring and treatment programs to ensure the health of hatchery fish.
- *Development of improved release strategies:* Improved release strategies focus on increasing survival by releasing fish at physiologically appropriate stages and minimizing competition and predation on wild fish.
- *Reduction in total releases of Chinook:* Releases of Chinook salmon increased during the late seventies and eighties, with the peak of approximately 76 million Chinook occurring in 1990. (fry, subyearlings and yearlings). Recent annual release levels have been about 50 million Chinook. Further reductions are being considered.
- *Implementation of recovery programs using hatcheries:* Beginning with the White River program in 1977, geneticists and fish culturists have been improving techniques for using artificial propagation to prevent extinction and to maintain genetic diversity.
- *Development of genetic baselines to distinguish specific stocks:* During the 1980s and 1990s, and continuing today, genetic profiles for most Chinook stocks have been developed, providing specific information useful for harvest analysis and hatchery operations.

- *Development of the coded wire tag and resultant data:* This has allow fishery managers to acquire information pertaining to stock contribution and distribution in marine and freshwater areas.

Key Actions to Reduce Risk

Hatchery production continues to be important to the tribes and people of the State of Washington. In recent years, WDFW and the tribes have made major changes in hatchery production to reduce risk of these programs across the ESU. These include reducing levels of hatchery production, stopping production of non-indigenous hatchery strains from rivers with indigenous populations (Figure 3), and shifting emphasis towards recovering declining populations. Total releases of Chinook salmon within the Puget Sound ESU have decreased to about 50 million fish annually from a maximum of 76 million in 1990. WDFW and the tribes have reduced annual yearling production in Puget Sound from about 4.0 million to 2.9 million and terminated use of nets pens for nearly all Chinook salmon yearling production. Hatchery production in river systems with indigenous populations has increased only where NMFS has identified hatchery production as essential for recovery and protected the hatchery stock under the Endangered Species Act (Figure 3).

Not all hatchery reform has yet been implemented. State and tribal hatcheries will continue to make changes. Because Chinook salmon released from hatcheries may take up to six years to return and resources to modify hatcheries depend on legislative funding, many changes will be made transitionally over the next five to six years. Although actions will be different at different programs, several key actions to reduce risk that apply throughout the ESU include:

- Marking and recovering hatchery fish to assess their success
- Using listed fish for brood stock only when the benefits outweigh the risks
- Releasing no stocks from outside the ESU
- Reviewing and changing as necessary rearing and release strategies to avoid substantial negative genetic and ecological effects on listed fishes
- Improving hatcheries facilities
- Designing and implementing monitoring plans.

DESCRIPTION OF HATCHERY PROGRAMS

Overview

This section summarizes the proposed hatchery operations, strategies, and commitments for WDFW and tribal hatcheries in the Puget Sound. These are based on 46 Hatchery and Genetic Management Plans (Table 5) prepared by WDFW and the tribes in five major geographic regions of the Puget Sound: 1) Strait of Juan de Fuca; 2) North Sound; 3) Mid-Puget Sound; 4) South Sound; and 5) Hood Canal. Hatchery and Genetic Management Plans (HGMP) describes the goals, objectives, operation, and facilities for WDFW and tribal hatcheries in detail.

Table 5. Chinook salmon hatchery programs in the Puget Sound.

	Releases by Watershed (x1000)		**Programs within Regions**				
Region	**Sub-yearling**	**Yearling**	**Watershed**	**Recovery Category**	**Program (HGMP)**	**Agency**	**Program Type**
Strait of Juan de Fuca	3,850		Elwha R.	1	Elwha Chinook	WDFW	Integrated Recovery
	2,000		Dungeness R.	1	Dungeness Chinook	WDFW	Integrated Recovery
North Sound	300	200	Islands	3	Glenwood Springs Fall Chinook	WDFW	Isolated Harvest
	5,800	100	Nooksack R.	1	Kendall Creek Spring Chinook	WDFW	Integrated Recovery
				3	Lummi Bay Fall Chinook	Lummi Tribe	Isolated Harvest
			Samish R.	3	Samish Fingerling Fall Chinook	WDFW	Isolated Harvest
				3	Samish Yearling Fall Chinook	WDFW	Isolated Harvest
	672	150	Skagit R.	1	Marblemount Fingerling Spring Chinook	WDFW	Integrated Research
				1	Marblemount Yearling Spring Chinook	WDFW	Integrated Research
				1	Marblemount Fall Chinook	SSC/WDFW	Integrated Research
				1	Marblemount Summer Chinook	SSC/ WDFW	Integrated Research

Region	Releases by Watershed (x1000)		Programs within Regions				
	Sub-yearling	Yearling	Watershed	Recovery Category	Program (HGMP)	Agency	Program Type
	220		Stillaguamish R.	1	NF Stillaguamish Summer Chinook	Stillaguamish Tribe/ WDFW	Integrated Recovery
				1	Whitehorse Summer Chinook	WDFW	Integrated Recovery
	1,000	250	Snohomish R.	1	Wallace Fingerling Summer Chinook	WDFW	Integrated Harvest
				1	Wallace Yearling Summer Chinook	WDFW	Integrated Harvest
	1,740		Tulalip Bay	3	Tulalip Bay Summer Chinook	Tulalip Tribe	Isolated Harvest
				3	Tulalip Bay Fall Chinook	Tulalip Tribe	Isolated Harvest
				3	Tulalip Bay Spring Chinook	Tulalip Tribe	Isolated Harvest
Mid Sound	2,265		Issaquah Ck.	3	Issaquah Fall Chinook	WDFW	Isolated Harvest
			Lake Washington	1	Portage Bay Fall Chinook	UW / WDFW	Isolated Research
	3,700	410	Green R.	1	Soos Creek Fingerling Fall Chinook	WDFW	Integrated Harvest
				1	Icy Creek Yearling Chinook	WDFW	Integrated Harvest
				1	Keta Creek Fall Chinook	Muckleshoot Tribe	Integrated Harvest
	2,850	150	Grovers Ck	3	Grovers Creek Fall Chinook	Suquamish Tribe	Isolated Harvest
			Gorst Ck	3	Gorst Creek Fall Chinook	Suquamish Tribe	Isolated Harvest
South Sound	2,770	90	Puyallup R.	3	Voights Creek Fall Chinook	WDFW	Integrated Harvest
				2	Diru Creek Fall Chinook	Puyallup Tribe	Integrated Harvest
			White R.	1	White River Spring Chinook	Muckleshoot Tribe	Integrated Recovery
				1	White River Spring Chinook Accl Site	Puyallup Tribe	Integrated Recovery

Region	Releases by Watershed (x1000)		Programs within Regions				
	Sub-yearling	Yearling	Watershed	Recovery Category	Program (HGMP)	Agency	Program Type
	4,000		Nisqually R.	2	Clear Creek Fall Chinook	Nisqually Tribe	Integrated Harvest
				2	Kalama Creek Fall Chinook	Nisqually Tribe	Integrated Harvest
	7,456	790	Chambers Ck.	3	Garrison Springs Fingerling Fall Chinook	WDFW	Isolated Harvest
			Chambers Ck.	3	Chamber Creek Yearling Fall Chinook	WDFW	Isolated Harvest
			Minter Ck.	3	Minter/Coulter Fall Chinook	WDFW	Isolated Harvest
			Deschutes R.	3	Tumwater Falls Yearling Fall Chinook	WDFW	Isolated Harvest
			Deschutes R.	3	Tumwater Falls Fingerling Fall Chinook	WDFW	Isolated Harvest
Hood Canal	7,000	475	Skokomish R.	2	George Adams Fingerling Fall Chinook	WDFW	Integrated Harvest
			Skokomish R.	2	Rick's Pond Yearling Fall Chinook	WDFW	Integrated Harvest
			Finch Ck.	3	Hoodsport Fingerling Fall Chinook	WDFW	Isolated Harvest
			Finch Ck.	3	Hoodsport Yearling Fall Chinook	WDFW	Isolated Harvest
			Hamma Hamma R.	2	Hamma Hamma Chinook	WDFW	Integrated Recovery
			Big Beef Ck.	3	Big Beef Creek Fall Chinook	WDFW (UW)	Isolated Harvest

Strait Of Juan De Fuca Region

The Puget Sound Chinook Salmon ESU includes two major rivers in the eastern portion of the Strait of Juan de Fuca, the Elwha and Dungeness Rivers. Chinook salmon in Morse Creek are part of the Elwha summer/fall Chinook population (WDF et al., 1993). Hatcheries exist on both the Elwha and Dungeness Rivers, and include programs directed at recovery and maintaining natural production. Hatchery fish used in the Elwha and Dungeness programs were identified by NMFS as essential for recovery and are protected under the ESA.

Table 6. Proposed annual releases of Chinook salmon for the Strait of Juan de Fuca.

Number Released	Brood lineage	Production Strategy	Release Site	Sponsor
3,850,000	Elwha	Integrated recovery	Elwha River	WDFW
600,000	Dungeness	Integrated recovery	Dungeness River, upper watershed	WDFW
800,000	Dungeness	Integrated recovery	Dungeness Hatchery	WDFW
400,000	Dungeness	Integrated recovery	Gray Wolf Acclimation Pond	WDFW
200,000	Dungeness	Integrated recovery	Gray Wolf Acclimation Pond	WDFW
5,850,000			**TOTAL**	

Elwha River

Geography

The Elwha River, which originates deep within the Olympic Mountains, is the largest river draining into the Strait of Juan de Fuca. Two dams located at river miles 4.9 and 13.4 block passage of salmon to the majority of the watershed. Below the dams, the river drops quickly from moderate to low gradient until it empties into a limited estuary.

Natural Production

The Elwha Chinook is one of the most genetically distinct populations in Puget Sound (Marshall et al, 1995). Elwha Chinook have also been described as a transitional stock, possessing some genetic characteristics similar to coastal Chinook, but having other features similar to Puget Sound Chinook (Marshall et al, 1995; Meyers et al, 1998). From the mid to late 1960s, a total of about 4.3 million Green River juvenile Chinook were released into the Elwha basin. Smaller numbers of Dungeness, Soleduck and Spring Creek (Columbia River) Chinook were also planted at various times throughout history. Overall, these levels are low relative to typical hatchery programs, and no genetic evidence suggests that the Green River, Soleduck, and Spring Creek plants were successful.

Elwha Chinook have an extended run timing. Adults begin entering the river in late May and continue through early September. Spawning ranges from early September through October. Peak redd counts are around October 5 (average of 1989, 1992-1994). The broad run timing could likely be the result of the river once supporting more than one stock.

Opportunity for natural production in the Elwha is extremely limited. With over 70 miles of potential habitat blocked by the dams, only about 4.8 miles of habitat remains for natural production. Reservoir impoundments created by the two dams contribute to high water temperatures that occur during Chinook entry time into the river in August and September. High temperatures exacerbate infestation from the parasite *Dermocystidium*, often resulting in pre-spawning mortalities as high as 70%. Loss of natural gravel recruitment, loss of recruitment of large woody debris, and high water temperatures combine to further limit natural spawning success.

Restoration of all salmonids including Chinook salmon to the Elwha watershed above the dams is expected to occur in association with the removal of the dams in 2005. A fish recovery plan is being developed by the joint federal, state, and tribal agencies that will provide for use of existing hatchery facilities to help reestablish salmonid populations in the upper watershed. Accordingly, modification of the current hatchery programs is expected to occur in the near future. For the short term, however, current Chinook salmon hatchery operations will continue as described below.

Harvest

The fishing mortality of Elwha Chinook salmon occurs from Alaska to Canada. Based upon coded-wire tag recoveries from 1991-1996, harvest was 10% in Alaska, 55% in Canada, 5% in Washington troll fisheries, 9% in Washington net fisheries, and 21% in Washington sport fisheries (Joint Chinook Technical Committee, in prep.).

Stock Status

Both the natural and hatchery stocks are listed as "threatened" under the Endangered Species Act. The co-managers considered Elwha Chinook salmon to be "healthy" in the early 1990s (WDF et al., 1993), but the population has not met past escapement objective of 2900 spawners since then. Beginning in 2001 escapement objectives have been based on exploitation rates as defined in the Co-managers" Puget Sound Chinook Harvest Plan.

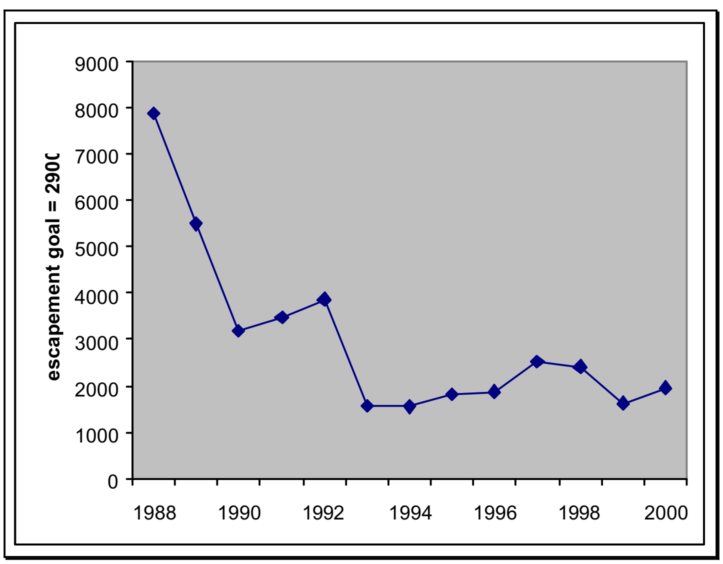

Figure 4. Annual escapements of Elwha River Chinook salmon

Chinook Hatchery Production

Facilities and Programs
The Elwha Rearing Channel is located on Elwha River, six miles west of Port Angeles. It was built in 1974 through joint effort of Crown Zellerbach, the City of Port Angeles and the WDFW and is operated by the WDFW. The purpose of the rearing channel was to mitigate for the loss of usable habitat from construction of the Glines Dam and Aldwell Dam, which prevent passage above river mile 4. The rearing channel has been ineffective in attracting adult spawners, but it is used as a large rearing channel, which can be separated into two individual compartments.

Objectives
The primary objective of the hatchery program is to maintain the population of Chinook salmon native to Elwha River, because all but four miles of the historic natural spawning and rearing habitat have been blocked by dams.

Stock: Elwha summer/fall Chinook salmon

Production Goals: Release of 3.85 million fingerlings annually from the Elwha Channel.

Hatchery Strategy: Integrated-recovery

Operations
Adults are taken at the hatchery rack and also seined and gaffed from the river. Homing of adult Elwha River hatchery fish to the hatchery rack is poor because of the environmental conditions (low flows, high temperatures, and limited habitat) in the river. Because incubation facilities are limited, eggs are transferred out of basin for incubation and early rearing. Hurd Creek hatchery is used to incubate Elwha Chinook eggs to the eyed stage, when they transferred to Sol Duc Hatchery for hatching and then moved back to the Elwha Channel in March and April for continued rearing.

Fish are released to optimize survive. The natural outmigration strategy is unknown, because of the mixing of hatchery and natural origin adults in the river and the likelihood that historical the outmigration strategies were altered dams that block passage to historical habitat. Habitat needs for yearling Chinook salmon rearing, for example, might not be available in the very limited stretch of river accessible to juveniles currently.

Operating Commitments

- WDFW will review brood stock capture protocol to assure that genetic diversity of the stock is maintained and pre-spawning mortality is minimized.
- WDFW will continue to use gametes procured from broodstocking adult fall Chinook salmon from the Elwha River to affect this program.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Elwha Hatchery to a total, maximum of 3,850,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU. The HSRG has recommended that the program be maintained at a level that provides an effective breeding number of at least 500 - 1,000 adults per year. Program success should not be equated with the numbers released but, rather, on the achieving the necessary effective number of adult broodstock. This program number would be consistent with the conservation and re-colonization goals for the stock. (HSRG Recommendation, February 2002)

- WDFW should explore new and expanded incubation and early rearing options, at Elwha, which eliminate or reduce the need to transport eggs or fry outside the watershed. (HSRG Recommendation, February 2002) WDFW has identified, via the Capital Request process, the need to build an expanded incubation and early rearing facility at the Elwha Hatchery.
- WDFW should design a program that mimics the natural life history patterns of the stock using a combination of release strategies, including yearling releases, growth modulation and natural rearing. (HSRG Recommendation, February 2002)
- Address long-term habitat improvement issues in order to improve the success of the hatchery recovery program. (HSRG Recommendation, February 2002)
- WDFW should develop an explicit schedule that takes into account both genetic and demographic risks as a function of spawner abundance, composition and population trends, to benefit broodstock management. (HSRG Recommendation, February 2002)
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Elwha Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the Elwha River to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Dungeness River

Geography

The Dungeness watershed is located in a rain shadow of the Olympic Mountains and has an average annual rainfall that ranges from 15 inches in the lower watershed to 50 inches the upper watershed (Pacific Northwest River Basins Commission, 1970). Due to a low storage capacity in the river, stream flows depend upon current-year precipitation levels. Flows generally peak in May and June as snow melts in the Olympic Mountains. Low flows are common in September and October (Smith and Wampler, 1995). The low flows in September are exacerbated by water withdrawals for irrigation.

Natural Production

Dungeness Chinook salmon have adult return and spawning timings that distinguish them from fall Chinook salmon populations in Puget Sound. Adult may return as early as June in recent years and continue through early September. Spawn timing of Dungeness Chinook currently ranges from early August through the third week in October with the peak number of redds observed around September 5 (average 1990-1994). Analysis of scale samples show that most adults return to spawn at age 4, with smaller percentages as age 3, 5, and 2, respectively. Although no baseline genetic description exists for this stock, samples are being collected from captive brood stock to develop a genetic profile. This should be available within the next year.

Most juvenile Dungeness Chinook salmon migrate to sea within their first year of life from mid-June through August. A small component migrates as yearlings. These yearling migrants come from naturally produced fish and from the captive brood program. These fish remain in the river over winter and migrate in the next spring, a year later than fingerlings (Mike Reed, Jamestown S'Klallam Tribe memorandum, 1998).

One of the most significant factors limiting natural production is the loss of redds from scouring in the lower river. Factors also contributing to these losses include loss of riparian habitat to urban development, sedimentation resulting from forest practices in the upper watershed, bank erosion and natural landslides, loss of spawning and rearing habitat from water withdrawals for irrigation, removal of larger woody debris, channelization from dikes; and pollution from storm water runoff.

Stock Status

Both natural and hatchery components of the Dungeness Chinook population are listed as "threatened" under the Endangered Species Act. The comanagers designated Dungeness River Chinook salmon as a critical stock in the SASSI review (WDF et al, 1993). Natural spawning abundance has ranged between a low of 43 to 453, in 2001.(Figure 5).

An intensive rebuilding effort, including a captive brood stock hatchery program, is underway to prevent extinction of this population. Recovery objectives and strategies are described by (Smith and Wampler, 1995). In addition to the hatchery program, intergovernmental and local forums are developing and implementing strategies for restoring fish habitat in the Dungeness River, including bank stabilization, placement of large woody debris in the main stem, and abatement of constraints caused by bridges and dikes.

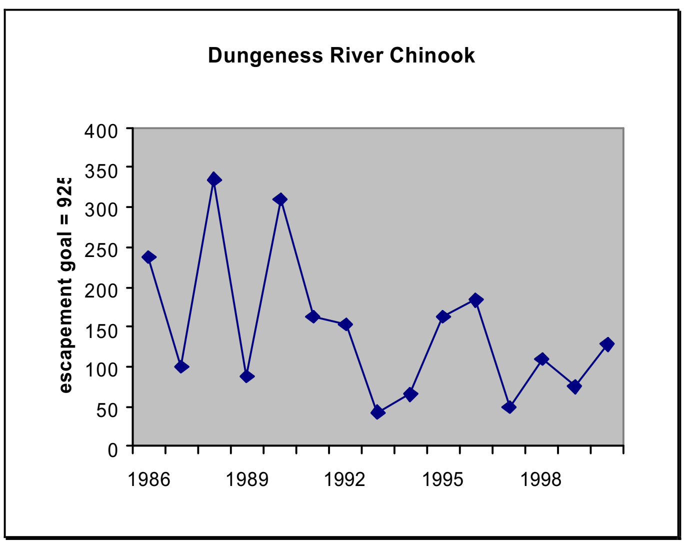

Figure 5. Annual escapements of Dungeness River Chinook salmon.

Chinook Hatchery Production

Facilities and Programs:
The Dungeness Hatchery is located on the Dungeness River, six miles southwest of Sequim. It is owned and operated by WDFW. Built in 1904 and renovated several times over the last century to keep up with advances in aquaculture, the Dungeness Hatchery is one of the oldest hatcheries in the Puget Sound. The

facility was built to increase production of coho salmon, Chinook salmon and winter steelhead. It is used to spawn, incubate, and rear the approximately 2.0 million juvenile progeny of Dungeness Chinook salmon produced through a captive brood program. Hurd Creek, a satellite facility, has been used to rear Dungeness River Chinook salmon for the captive brood stock.

The hatchery also supports other recovery programs, including a summer chum rebuilding program in Sequim Bay and Discovery Bay. Hurd Creek supports a Dungeness fall pink salmon recovery program, a Discovery Bay coho salmon rebuilding program, and incubation of Elwha River Chinook salmon.

Objectives
The purpose of the program is to prevent extinction and to aid restoration to healthy, self-sustaining population by

- Maintaining genetic integrity
- Achieving annual escapement goal of 925 adults. Beginning in 2001 escapement objectives have been based on exploitation rates as defined in the Co-managers" Puget Sound Chinook Harvest Plan.
- Making harvest opportunities available.

If these objectives are not met, the program will be re-evaluated.

Stock: Dungeness River spring Chinook

Production Goals
Annual production goals are to plant 1.7 to 2.0 million juveniles (Table 6) by using several different rearing and release strategies as follows: 400,000 fingerlings from the Gray Wolf Acclimation Pond; 200,000 zero-age smolts from the Gray Wolf Acclimation Pond; 600,000 fed fry scatter planted into several locations in the upper Dungeness; plant all remaining fish (up to 800,000) as zero-age smolts from the Dungeness Hatchery.

Actual release numbers vary from year to year depending upon the success of the captive brood program. Thirty-five thousand, 1.8 million and 2.2 million were released in 1996, 1997 and 1998, respectively.

Hatchery Strategy: Isolated-recovery and Integrated-recovery. The isolated-recovery (captive brood stock) strategy is being phased out as the remaining captive brood fish are released.

Operations
Cooperative efforts to assess the status of the Dungeness Chinook stock began in 1986. Development of a recovery plan was initiated in 1990, which identified a captive brood program as needed to rebuild Dungeness Chinook. The plan was implemented in 1992, when redds of indigenous Chinook salmon were identified as sources for captive brood stock. In 1993, about 2,500 Chinook salmon fry were collected through hydraulic sampling of the redds and electroshocking. Juvenile Chinook were marked by family to be able to maintain family integrity. One thousand fish were reared to adults in freshwater at Hurd Creek and 300 additional fish were reared to adults in saltwater in the South Sound net pens. Progeny from these adults were used in the hatchery program. Collections of the local brood stock were repeated annually through 1997, although scouring of redds during high water flows required that managers focus on collecting eyed eggs instead of fry.

Second generation progeny from the program have been released back into the Dungeness River using a variety of strategies since 1996. Because the freshwater life history of Dungeness Chinook salmon is unknown, multiple release strategies are used to increase the likelihood of success. The objective of these different release strategies is to mimic typical salmon natural life history and to imprint the fish to the upper parts of the watershed where indigenous Chinook salmon historically spawned and where habitat is more pristine. Prior to release, progeny of the captive brood are marked to allow evaluation using coded wire tags (CWT) with adipose clip, CWT without adipose clip, adipose clip only, blank wire tags only with no clips, or otolith marking. Data are being collected to determine genetic baselines, harvest impacts, distribution and migration patterns**,** marine and freshwater survival, and reproductive success of different release strategies being employed.

Operating Commitments

- WDFW will apply identifiable marks to 100% of the releases to allow monitoring and evaluation of the hatchery releases. WDFW in conjunction with the Tribe will also apply CWT's to a portion of the production to evaluate fishery contribution and survival rates.
- WDFW will adequately screen all water intakes at Dungeness Hatchery to prevent adverse impacts to listed fish.
- WDFW will monitor Chinook salmon escapement to the Dungeness River to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- WDFW, in cooperation with the Jamestown S'Klallam Tribe, and the Dungeness River Chinook Technical Advisory Committee will develop a new recovery plan. WDFW will explore phase-in of a new hatchery program that does not involve a captive broodstock. In the interim WDFW will 1) continue propagating the remaining captive broodstock on hand, and 2) discontinue zero age releases in July and August and will, instead, produce a mix of zero-aged and yearling Chinook to maintain the existing genetic resources and reduce the risk of extinction. (HSRG Recommendation, February 2002)
- WDFW will explore facility improvements that allow development of a warmer water supply than currently exists, (to facilitate growing program fish to a size and time of release that maximizes survival and enhances the potential of recovery of the listed stock. (HSRG Recommendation, February 2002) To date, WDFW has not been successful in developing an alternate well-water supply to accomplish this recommendation.
- WDFW will explore removal of the Canyon Creek intake to allow passage of juvenile and adult Chinook to available spawning and rearing habitat. (HSRG Recommendation, February 2002). WDFW has hired a consultant to explore specific removal options.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

North Puget Sound Region

This region consists of San Juan Islands, Nooksack and Samish River system, Skagit River, Stillaguamish River, and Snohomish River watersheds. Thirteen of the 18 indigenous populations in the Puget Sound are in this region. The San Juan Islands contain no sustainable natural populations. The co-managers identified two populations as in critical condition (North Fork and South Fork Nooksack spring Chinook), and two populations in healthy condition (Upper Sauk spring Chinook and upper Skagit summer Chinook), and other populations as depressed (WDF et al. 1993). Hatchery programs within North Sound watersheds are designed for recovery (North Fork Nooksack spring Chinook and Stillaguamish summer Chinook), as indicator stocks for fisheries (Skagit River), or for harvest (Nooksack fall Chinook; Tulalip Bay programs, and North Sound net pen facilities.

San Juan Islands

Geography

This miscellaneous grouping of island watersheds within the San Juan Islands is part of WRIAs 1, 2 and 3.

Natural Production

These watersheds are not considered natural producers of Chinook salmon because the streams and creeks are small and often flow intermittently.

Stock Status

There is no history of self-sustaining natural populations in this region.

Chinook Hatchery Programs

Facilities and Programs
One artificial production facility (Glenwood Springs on Orcas Island) remains in this region; seven net pen sites previously used in this region by cooperatives and Regional Fisheries Enhancement Groups (RFEG) have been terminated. Historically, the Samish Hatchery has also been used to rear fish for release in this region.

Objectives
This program is strictly intended for harvest and are major contributors to sport fisheries for "blackmouth" (residualized) Chinook salmon fisheries.

Stock: The stock is Green River Chinook salmon lineage, primarily reared at Samish Hatchery.

Production Goals
A total of 300,000 fingerlings and 200,000 yearlings are to be released annually within this region. Yearling net pen production has been eliminated (Table 7) because concerns about survival and stray rates indicate that the benefit these programs provide do not outweigh the risk to natural spawning stocks in adjacent watersheds.

Table 7. Proposed annual releases of Chinook salmon for the North Sound islands. Recently terminated releases are in parentheses.

Fingerling/ fry	Yearling	Brood Lineage	Production Strategy	Release Site	Sponsor
	(60,000)	Green River	Isolated Harvest	Fidalgo Bay Net Pens (Guemes Channel)	RFEG-2
	(7,500)	Green River	Isolated Harvest	Roche Harbor Net Pens	ALEA*
	(10,000)	Green River	Isolated Harvest	San Juan Net Pens	ALEA*
300,000	200,000	Green River	Isolated Harvest	Glenwood Springs (Orcas Island)	LLTK

*Aquatic Lands Enhancement Account – funding source for these volunteer cooperative net pens.

Hatchery Strategy: Isolated-harvest

Operations
The remaining North Sound production consists of Green River lineage Chinook released from Glenwood Springs (300,000 fingerlings and 200,000 yearlings).

Operating Commitments

- WDFW will limit annual production of fall Chinook for on-station release at Glenwood Springs Hatchery to 300,000 fingerlings and 200,000 yearlings.
- WDFW will terminate all net pens in north Puget Sound, including Fidalgo, Oak Harbor, Roche Harbor, San Juan, Langley and Mukilteo.
- WDFW will continue to provide harvest opportunities in the North Sound islands but will maintain focus on recovery of natural stocks within the North Sound region.
- WDFW will continue to use local brood stock voluntarily returning to Glenwood Springs and/or Samish River Hatchery for providing harvest opportunities.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon fingerling and yearling releases each year from Glenwood Springs to allow monitoring and evaluation of the hatchery program releases and adult returns.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Nooksack-Samish

Geography

This region includes the Nooksack and Samish Rivers, their tributaries, and several independent streams (California, Dakota, Chuckanut and Oyster creeks) in WRIA 1.
The Nooksack River is the main river system in this area. The two forks of the Nooksack River have very different environments. The North Fork Nooksack originates from the East Nooksack glacier and drains the west slopes of the Skagit Range and the North slopes of Mt. Shuksan and Mt. Baker (Dept. of Conservation, 1960). During spawning season, the North Fork Nooksack is typically turbid with moderate flows due to the glacial input. The South Fork drains the western slopes of the Twin Sisters Mountain. During the spawning season, the South Fork Nooksack is clear and low. The topography of each of the forks differs as well. Forty-two percent of the North Fork basin is below 4000 ft, compared to 88 percent of the South Fork Basin (Dept. of Conservation, 1960).

Flow patterns between the North and South Fork Nooksack vary widely. In the North Fork, the peak flows are in June and the low flow is typically in March. The snowfields formed in the winter release water as the temperatures increase in spring and early summer. Glacial melt in the North Fork basin occurs after the snow has melted and continues throughout summer and fall. In the summer, the North Fork produces 140,000 acre-feet more run-off than the South Fork for equal-sized drainage areas (Dept. of Conservation, 1960).

The non-glacial, low elevation South Fork has peak flows in May and December, and its lowest flow in August (Dept. of Conservation, 1960). The lower flows and lack of glacial input result in an average temperature that is 7.5^{o} C higher compared to the North Fork (Nooksack Spring Chinook Technical Team, 1986). The current low flow periods in the South Fork occur during the upstream migration of adult Chinook.

Natural Production

Nooksack River

Three spawning aggregations of Chinook salmon occur in the Nooksack River: two indigenous stocks of early returning Chinook in the North and South and an introduced summer/fall run of Green River lineage. Like the Elwha fall Chinook, the two Nooksack early returning Chinook stocks are among the most genetically distinct Chinook populations in Puget Sound. The genetic divergence of these stocks as measured by allozyme data is similar to the distance separating some ESUs, such as upper Columbia spring Chinook from Snake River spring Chinook and Snake River fall Chinook from upper Columbia fall and summer Chinook (Marshall et al, 1995).

Significant differences occur in the life history of these two stocks. The North Fork and South Fork stocks differ in spawn timing. The average date of peak redd count for the South Fork stock averaged September 24, while the peak for the North Fork is in early September (Marshall et al, 1995). This may result in earlier juvenile emergence from redds in the North Fork, but the warmer waters in the South Fork probably accelerate emergence of fish in this area. Peak catches of Chinook fry occurred earlier in the North Fork than in the South Fork (Wunderlich, Meyer, and Boomer, 1982). However, fry were present in both forks over the same general time frame of early February through early May. The two Nooksack stocks also differ in juvenile outmigration strategies. Based on limited data, approximately 95% of the natural-origin North Fork adults had outmigrated as subyearlings in their first year of life. In contrast, in the South Fork, 55-67% of the adults had yearling scale patterns, which indicates that a significant component of this stock remained in the river for over a full year before migrating to saltwater (Marshall et al, 1995).

The difference between these two environments may explain the low level of historical natural straying between the two forks. From 1984-1990, nine Chinook released from the South Fork hatchery program (where a large proportion of fish were tagged) returned as adults to the North Fork hatchery (1,988 sampled). None have been found on the North Fork spawning grounds (out of 425 sampled). During the same time period, one North Fork-origin Chinook was recovered from the South Fork spawning grounds (WDFW and Western Washington Treaty Indian Tribes, 1994). In recent years, however, North Fork early returning Chinook are straying more, and the fall Chinook (either from current releases, colonized past releases, or a mixture of colonized past releases with native fall Chinook) are also spawning in the South Fork. This may reflect present or past releases of fall Chinook, and the increased number of hatchery fish returning to the WDFW hatchery on the North

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

Samish River and Independent Watersheds
In addition to the Nooksack River, there are a number of other watersheds within this region, including Whatcom Creek, Padden Creek, Chuckanut Creek, Oyster Creek and Samish River. Samish River is the largest of these and has anadromous runs of Chinook, coho and chum salmon, along with steelhead and cutthroat. No evidence exists that the Samish River supported an indigenous, a self-sustaining run population. Chinook salmon spawning currently in the system are derived and supported by releases of Green River-lineage hatchery fish, which have occurred since 1914.. Natural spawning fish are estimated to be in the hundreds. It is not known if any, or what proportion, are recruits of natural spawning Chinook. Spawning and rearing habitat of Chinook is available, but it is unknown whether the quality and quantity of habitat can support long-term sustainability.

Stock Status

Both the North and South Fork natural populations and the hatchery component of the North Fork population are listed as "threatened" under the Endangered Species Act because of low abundance (Figures 6 and 7). The co-managers identified both populations as in critical condition (WDF et al., 1993). WDFW and tribal biologists believe that increases in natural spawning abundances are unlikely without major improvements to the habitat.

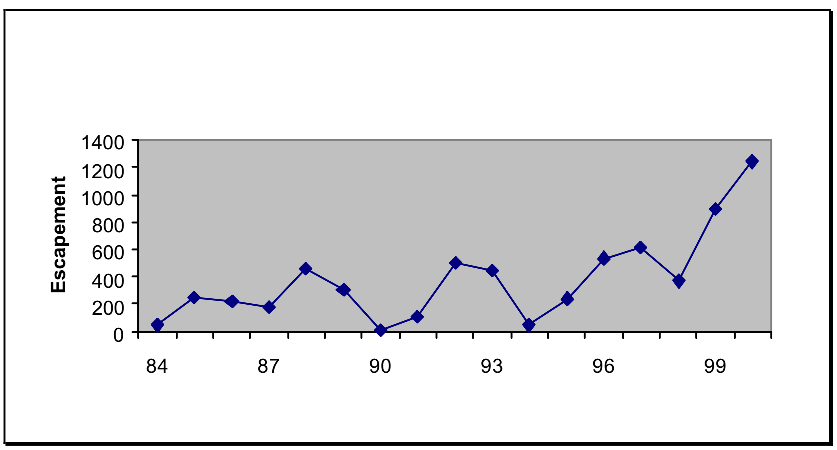

Figure 6. Annual escapements of North Fork Nooksack River early returning Chinook salmon.

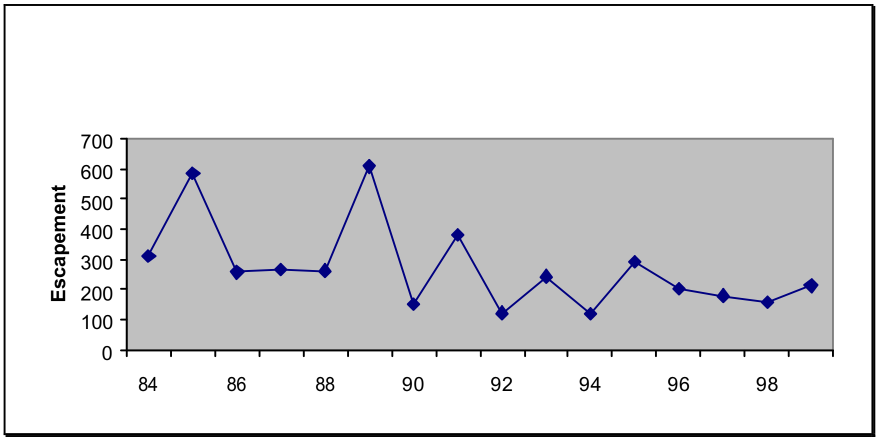

Figure 7. Annual escapements of South Fork Nooksack River early returning Chinook salmon.

Abundance of natural origin recruits (NOR) have increased in 1999-2001, but they remain a small proportion of the total escapement to the river and especially to the North Fork. In 1999, 164 and 91 NORs returned to the South and North forks, respectively; in 2000, NOR returns were 283 and 157; in 2001 NOR returns were 268 and 236, respectively.

Chinook Hatchery Production

Facilities and Programs:
Both the Lummi Tribe and WDFW operate hatchery programs in the Nooksack-Samish watersheds. The WDFW Nooksack Hatchery Complex includes Kendall Creek Hatchery, Samish Hatchery, Lake Whatcom Hatchery and Bellingham Hatchery. Kendall Hatchery is located on Kendall Creek, a tributary of the Nooksack River, 21 miles northeast of Bellingham. The hatchery was built in 1899 and has was operated until 1929, and re-started in 1952. Many improvements have been added in recent years. This facility has incubation and rearing capabilities and has been used for Chinook, coho, chum pink salmon, and steelhead. Samish Hatchery is located on Friday Creek, a tributary of the Samish River. This facility also has both incubation and rearing capabilities. In addition, there are two private facilities, Bellingham Maritime Heritage facility, located on lower Whatcom Creek, and the Squalicum Harbor Net Pens. Lake Whatcom Hatchery and Bellingham Hatchery rear trout and kokanee for releases in to lakes in Whatcom and Skagit counties, and in other areas in Washington, Idaho, and California.

Tribal facilities include Skookum Hatchery on the South Fork Nooksack, Lummi Sea Ponds, and Kwina Slough (Mamoya Ponds) located on the lower Nooksack, within the Lummi Reservation. There are currently no Chinook released from the Kwina Slough facility.

WDFW and the Lummi Tribe have operated three different programs in the Nooksack-Samish watersheds: 1) the North Fork native Chinook program; 2) South Fork native Chinook program; and 3) fall Chinook program. Only the North Fork and fall Chinook salmon programs are operating currently.

The potential effects of artificial production in the Nooksack-Samish area on the South Fork Nooksack population will continue to require special attention. In the fall of 2002, the co-managers will convene a work group comprised of technical and policy representatives from the

Nooksack Tribe, the Lummi Tribe, and WDFW to review the analysis of DNA samples, spawning escapement data, and monitoring plans with the intent of determining if any further modifications to artificial production programs are required.

Table 8. Proposed annual releases of Chinook salmon in the Nooksack watershed.

Subyearling	Yearling	Stock Lineage	Production Strategy	Release Site	Sponsor
North Fork Early returning Chinook					
150,000		North Fork	Integrated-recovery	Kendall Hatchery	WDFW
600,000		North Fork	Integrated-recovery	Acclimated releases, including Deadhorse, Excelsior, and Middle Fork	WDFW, tribes
50,000		North Fork	Integrated-recovery	Remote Site Incubators at river mile 49.9 and 53	WDFW, tribes
800,000				**TOTAL**	
Summer/Fall Chinook					
500,000		Green River	Isolated harvest	Direct release into lower Nooksack	Lummi Tribe
500,000		Green River	Isolated harvest	Lummi Sea Ponds	Lummi Tribe
4,000,000	100,000	Green River	Isolated harvest	Samish Hatchery	WDFW
5,000,000	**100,000**			**TOTAL**	

North Fork Early Returning Chinook Program

*Objectives***:** The intent of this program is to maintain gene pool of North Fork early returning Chinook salmon and contribute to the naturally spawning population in order to assist in rebuilding the wild spawning population.

Stock: North Fork Nooksack River early returning Chinook

Production Goals: See Table 8.

Hatchery Strategy: Integrated-recovery

Operations
This program is operated by WDFW with co-management by the tribes, and support and funding from U.S. Forest Service Mt. Baker District, Nooksack and Lummi tribes and the Nooksack Enhancement Association.

The program began from indigenous brood stock collected from 1980-1984 in the North Fork (RM 46-47). No additional wild fish have been used for brood stock, but genetic analysis indicates that these fish remain representative of the wild spawning population. Because non-native summer/fall Chinook of Green River stock have also been released from Kendall Creek, WDFW has been careful to avoid hybridization by separating the brood stock collection by return timing and by marking of native Chinook salmon. All early returning Chinook are otolith marked by exposing them to chilled water before they leave the hatchery. Upon returning as adults, otolith marks to read to ensure that the fish being spawned are exclusively from this hatchery program. To date, no naturally produced North Fork Nooksack early returning Chinook salmon have been encountered at the hatchery. Different otolith marks are used to identify fish released under different strategies, such as location and timing, to assess their success.

Fish are reared at Kendall Hatchery and either released from the hatchery, from acclimation sites or from Remote Site Incubators (RSIs). All fish are now released as fingerlings (except for the RSI fish). Yearling fish have been released in the past, but low return rates have prompted managers to emphasize fingerling releases. In addition, at least some of the returning adults in excess to the hatchery program are returned to the river to spawn naturally.

The first acclimated release occurred in 1988 from a temporary river flood plain enclosure at Boyd Creek (RM 62.1) in the upper basin. Four acclimation ponds at three sites are located in the upper basin (Table 9. These include two at the Excelsior Campground (RM 64.2), and one each at Deadhorse Creek (Rm 63.4) and Kidney Creek, a tributary of Canyon Creek (RM 55.0). Currently, the Kidney Creek pond is inactive. Recently Middle Fork releases were initiated to improve rebuilding efforts in that geographic area. A acclimation site is located at RM 9.7, and consists of a natural side channel which is temporarily ponded. The purpose is to better seed habitat in the Middle Fork, and to rebuild the upper Middle Fork portion of the population. This area was former habitat, and, while occasional adult salmon are observed ascending the dam, a ladder is planned which will greatly enhance fish passage into the upper Middle Fork.

Table 9. Descriptions of acclimation ponds in North Fork Nooksack.

Pond Name	Substrate	Water Source	Capacity (fingerlings)	Holding Period (days)
Deadhorse Creek	Asphalt	Surface-creek	200,000	3
Excelsior OC	Earthen with cover	Spring	40,000	3
Excelsior IS	In-channel, cobble	Surface-river	100,000	3
Middle Fork	In-channel, cobble	Surface-creek	200,000	3

Fish for the on-station release at Kendall (150,000) are reared to 60 fish/lb to 100 fish/lb and released after April 15 to minimize interactions with outmigrating naturally-produced Chinook and before June 1 to maximize survival. The North Fork acclimation pond group (400,000) is Double Index Tagged (DIT). Acclimation pond fish are hauled to the acclimation sites in 50,000-60,000 increments, allowed to acclimate for three days and are then volitionally released. After most of the group has exited the pond (usually 2-3 days), another load is brought from the hatchery. These fish are released during the same timeframe as the on-station release. Two hundred thousand Chinook salmon are also released into the Middle Fork Nooksack using this same scenario. Remote site incubators are utilized to hatch 50,000 eggs for release into the upper North Fork Nooksack. Success of this group of fish may aid in our understanding of egg to emergence survival problems affecting naturally reproducing Chinook salmon, and how respective releases are distributing on spawning grounds as returning adults.

South Fork Chinook Program Description

During the 1980s, an integrated-recovery program was begun for South Fork Nooksack early returning Chinook. Adult fish were collected in holding pools of the South Fork and transferred to the Lummi tribal hatchery at Skookum Creek. High adult mortality and low returns from juvenile releases prompted managers to discontinue the program. No hatchery activities are now directed at assisting this stock. However, recent coded-wire tag and otolith data demonstrates significant straying of NF Nooksack hatchery Chinook into the South Fork. Additionally, genetic analysis of outmigrating juveniles indicates a large portion of the outmigrants are fall Chinook, and a smaller portion are North Fork early returning Chinook. Recent reductions in the Kendall Creek on-station and acclimated releases are aimed at reducing this stray rate into the South Fork, and minimizing potential competition with natural origin juvenile Chinook. The Co-managers are continuing to analyze the data and are considering hatchery intervention to help this stock.

Summer/fall Chinook Program Description

Objectives: The intent of this program is to produce fish for harvest.

Stock: Nooksack-Samish summer/fall Chinook.

Production Goals: See Table 8.

Hatchery Strategy: Isolated-harvest

Operations
The majority of brood stock are collected from fish returning to Samish Hatchery. Eggs are shipped to Kendall Creek Hatchery for incubation and rearing. In the past, the fall Chinook were released from Kendall Creek Hatchery, but current protocol requires that they now be released from facilities in the lower river, including Lummi Sea Ponds and a direct plant into the lower Nooksack. This strategy is intended to minimize interaction with native Chinook salmon from the North and South Forks by reducing juvenile competition and by preventing cross-hybridization during brood stock collection. In the Samish River, fingerlings are released either into Friday Creek after extended rearing on Friday Creek water or Samish River, after acclimation to this water source. Fall Chinook have also been released from Whatcom Creek in Bellingham Bay, but this practice has been stopped. Beginning with the 1998 brood, fall Chinook salmon from all facilities in the Nooksack-Samish watersheds will be marked.

Historically, releases of fall Chinook have returned 26,000-130,000 adults to the terminal area. To minimize incidental harvest of the early returning, early returning Chinook salmon in the commercial and recreational fisheries conducted in Bellingham Bay and the main stem Nooksack River, co-managers have delayed fishing seasons. Ceremonial tribal fisheries are held during the first week of July to meet minimum tribal requirements. Tribal commercial fisheries in Bellingham Bay are delayed until August 1, with the non-treaty fisheries beginning in mid-August. River fisheries are delayed further to allow the listed Chinook salmon to clear the fisheries.

Regarding interactions of summer/fall and early native Chinook, recent changes have eliminated summer/fall releases at Kendall Creek Hatchery. However, monitoring of hatchery strays into the north fork should continue. More important is the need to continue evaluation of the current enhancement strategies. As a summary, the following changes have been made, or will be made, with Nooksack hatchery programs that should benefit recovery of the native Chinook stock:

1) Changes in native fish enhancement strategies
   - Acclimated releases reduced from 1,000,000 to 400,000
   - Reduction in on-station releases from 600,000 to 400,000 to 150,000
   - Initiation of remote site incubation, from 0 to 50,000 (with assessment)
   - Initiation of release into Middle Fork
2) Reduction and transfer of summer/fall Chinook,
   - No releases from Kendall Hatchery (originally was 5.2 million)

Reduction of Lummi Bay and Mamoya releases, from 4.0 to 1.0 million
Transfer of Kendall summer/fall Chinook to Whatcom Creek Hatchery (2.0 million in 1999 with 800,000 beginning 2000). Currently, releases from Whatcom Creek Hatchery have been discontinued as has Squalicum Bay net pens.
Samish Hatchery will release 4.0 million fingerlings and 100,000 yearling annually for on-station release

Operating Commitments

- WDFW, the Nooksack and the Lummi tribes will assure that all summer/fall Chinook are marked with adipose clips.
- WDFW will collect broodstock from adults returning to the Kendall Creek Hatchery prior to September 21. Egg usage will be as follows:
    a) Spawned prior to August 24 - use all eggs; and
    b) Spawned August 24 through September 21 - use only eggs from spawners that originated from Kendall Creek Hatchery

  The appropriateness of the September 21 date to separate early returning Chinook salmon will be evaluated as genetic data on run timing become available.
- WDFW will truck excess adults, in a 1:1 male to female ratio, to Canyon Creek and Middle Fork Nooksack and allow them to spawn naturally. Priority for the sites and the maximum numbers will be determined by the co-managers. The number of fish released plus the anticipated number of natural spawners will not exceed the carrying capacity of the North or Middle Fork Nooksack. These fish will be marked (i.e. opercle punch) to determine if they fall back and distribute themselves into the South Fork Nooksack. Any additional excess males will be utilized in the spawning process.
- WDFW will limit, as the management intent, annual production of early returning Chinook to a maximum of: a) 50,000 unfed fry from remote site incubators located on the North Fork Nooksack at river miles 49.9 and 53; b) 150,000 fingerling or subyearlings on station; c) 400,000 fingerling will be released from acclimation sites at Deadhorse Creek and /or Excelsior Creek; and d) 200,000 fingerling at an acclimation site on the Middle Fork Nooksack River. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will tag or mark all Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns.
- The comanagers will monitor Chinook salmon escapement to the Nooksack River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each year. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- WDFW will evaluate options for collecting natural origin spawners to incorporate in broodstock for the Kendall Creek Hatchery.
- WDFW will evaluate the source (Kendall Creek Hatchery, acclimation ponds, remote site incubators) and reproductive success of North Fork Nooksack Chinook spawners observed in the South Fork Nooksack River and recommend appropriate actions.
- In concert with the early returning Chinook surveys, WDFW, the Nooksack and Lummi tribes will continue to monitor potential straying of fall Chinook into natural spawning areas, using spawning ground surveys and smolt outmigration studies.
- Continue to monitor the commercial fisheries directed on this stock to determine incidental impacts on native Chinook returning to Nooksack River.

- WDFW, the Lummi Tribe and the Nooksack Tribe will continue to monitor and evaluate current North Fork hatchery strategies for early returning Chinook. Supplementation of native Chinook has been underway for nearly two decades, with little observed improvement of natural-origin Chinook. A number of acclimation ponds have been constructed in attempt to enhance imprinting into natural spawning areas. It is important to assess the present strategies and to determine time frames that would lead to reduction of supplementation efforts.
- WDFW will continue to mark early returning Chinook released from the North Fork and will continue to monitor success of the various hatchery release strategies.
- The Lummi Tribe will limit, as the management intent, annual production of juvenile fall Chinook salmon through the program to a maximum of 2,000,000 sub-yearlings.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Samish River Fall Chinook:
The primary concern at this time is to determine potential effects that Samish Hatchery Chinook might have on nearby native populations, and in this case Nooksack natives. It is not expected that straying is significant, but marking all hatchery fish is considered a necessary step in determining stray levels and of natural production within the watershed.

- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Samish Hatchery in May or June to a maximum of 4,000,000 fingerlings, or subyearlings and in March to a maximum of 100,000 yearlings. Reduction of the fingerling program from 5,200,000 to 4,000,000 will help reduce potential straying into the Skagit and Nooksack Rivers. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to Samish Hatchery to effect WDFW's hatchery programs. The collection of localized hatchery-origin broodstock at these locations will limit direct and incidental take effects on listed Chinook salmon.
- WDFW will apply an otolith mark specific to the Samish Hatchery or coded-wire tag all sub-yearling and yearling production from Samish Hatchery and with assistance from co-managers will conduct carcass recoveries throughout the Chinook spawning period and geographic area in the Nooksack watershed and read the tags in a timely manner to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW shall pass upstream of the hatchery rack on the Samish River all adults in excess to the brood stock program. These fish are intended to spawn naturally and enhance nutrients in the Samish River.

Skagit River

Geography

The Skagit River is the largest river basin in the largest in Puget Sound. Several major rivers, which arise from different parts of the Cascade Mountains, form branches to a main stem that begins in Canada. Overall, the river system contributes more than 20% of the fresh water flowing into Puget Sound (Weisberg and Riedel, 1991). The lower and upper parts of the Skagit River basin compose WRIAs 3 and 4, respectively.

Natural Production

Historically, the Skagit Basin supported the largest number and diversity of wild Chinook production in Puget Sound. Based on geographical distinctiveness, life history differences, and genetic evidence, the comanagers currently recognize six different populations (WDF et al., 1993):

- Suiattle River spring Chinook
- Upper Cascade River spring Chinook
- Upper Sauk River spring Chinook,
- Lower Sauk River summer Chinook,
- Upper Skagit River summer Chinook,
- Lower Skagit River fall Chinook.

Skagit River Chinook salmon form a genetically similar group within the Puget Sound that also includes summer Chinook salmon in the North Fork Stillaguamish River (Marshall et al, 1995). This similarity probably reflects historical hydrological connections between the river systems, when approximately 11,000 years ago, the Sauk-Suiattle system flowed into the Stillaguamish River (Weisberg and Riedel, 1991).

Spring Chinook

Three early spawning ("spring") Chinook salmon populations occur in the Skagit River Basin. These fish generally spawn in clear water tributaries in the upper watersheds, where gradients are moderate to high, water temperatures are cold (49-53^{o}F), and annual rainfall ranges from 80-120 inches per year (Pacific Northwest River Basins Commission, 1970).

Suiattle River spring Chinook salmon spawn from late July to early September (WDF et al., 1993). Spawning occurs primarily in the lower reaches of tributaries to the Suiattle River, including Big, Tenas, Buck, Straight, Lime, Downey, and Sulpher Creeks. Spawning may occur in the main stem, which is glacial runoff, but it appears to be limited to few fish.

Two other spring Chinook salmon populations occur in the Skagit River basin: Upper Sauk and Upper Cascade Chinook salmon. Both spawn from late July to early September (WDF et al., 1993). Upper Sauk River spring Chinook salmon spawn in the mainstem Sauk from river mile 32 – 41, in the South Fork Sauk River up to river mile 4, and in the Whitechuck River up to river mile 10. Upper Cascade River spring Chinook salmon spawn in the Cascade River from river mile 8 – 19 and in Found and Kindy Creeks.

Summer Chinook

Two summer Chinook populations occur in the Skagit Basin: Lower Sauk River summer Chinook and Upper Skagit River summer Chinook. These fish generally spawn in low to moderate gradient areas where mean annual rainfall is 70-80 inches (Pacific Northwest River Basins Commission, 1970). Both populations spawn from September to early October (WDF et al., 1993). Spawning in the lower Sauk Rivers occurs in the first 21 miles of the river and in Dan Creek.

Upper Skagit River summer Chinook are the most abundant salmon in the basin. These fish spawn from river mile 67-93 in the main stem and in Illabot, Diobsud, Bacon, Goodell, and Falls Creeks.

Fall Chinook
One late spawning ("fall") population occurs in the lower Skagit River. These begin spawning in the second week of September, peak in early October, and continues through October. Spawning occurs from river mile 22 – 67 in the lower main stem and in Baker River, Finney Creek and Day Creek.

Juvenile Chinook salmon migrating to the estuaries begins in late January and continues through mid-August. Most fall and summer Chinook salmon migrate as subyearlings. Spring Chinook salmon, however, migrate as both subyearlings and yearlings.

Stock Status

Naturally produced salmon in the Skagit River are listed as "threatened" under the Endangered Species Act. The individual status of these populations was mixed (Table 10, WDFW and WWITT 1994). A major factor contributing to the status of these populations is frequency of major flood events, which reduces survival of eggs and fry (Table 11).

Table 10. Status of Skagit River salmon populations (WDF et al. 1993).

Stock	**Status**
Suiattle spring Chinook	Depressed
Upper Cascade spring Chinook	Unknown
Upper Sauk spring Chinook	Healthy
Lower Sauk summer Chinook	Depressed
Upper Skagit summer Chinook	Healthy
Lower Skagit fall Chinook	Depressed

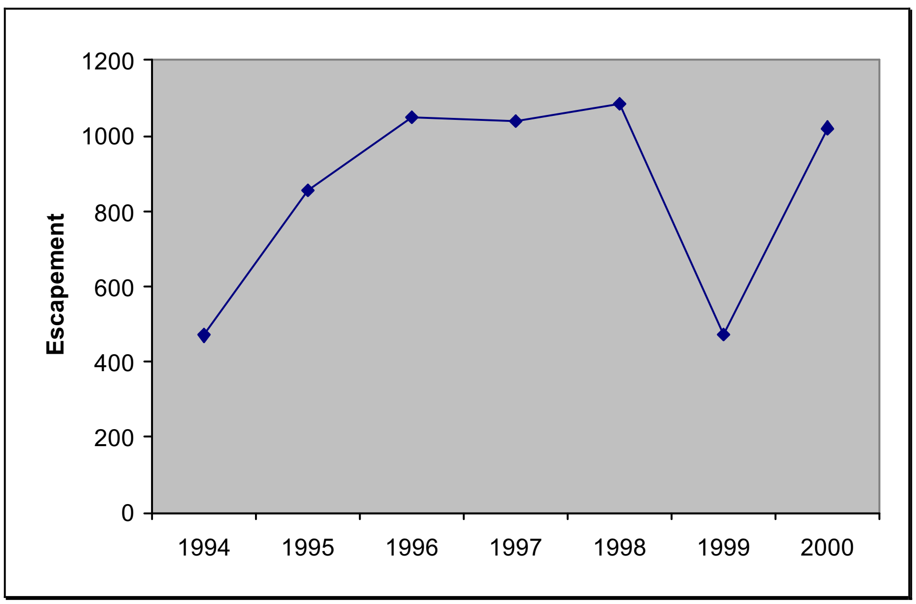

Figure 8. Annual escapement of spring Chinook salmon in the Skagit River Basin.

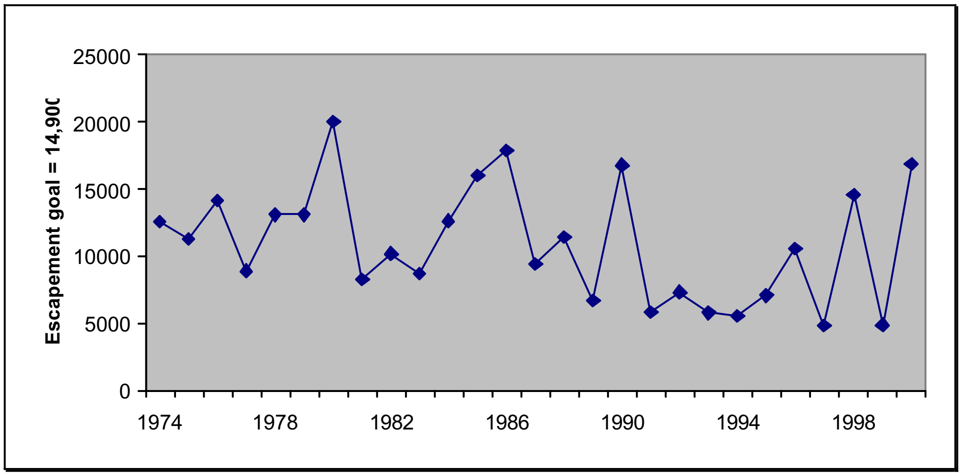

Figure 9. Annual total escapements of summer and fall Chinook salmon in the Skagit River Basin.

Table 11. Estimated abundance of subyearling wild Chinook salmon outmigrants and egg-to-outmigrant survival rates, 1989-2000 (Seiler et al., 2002).

Year	Outmigrant Abundance	Survival Rate
1989	1,800,000	8.7%
1990	500,000	1.2%
1991	2,400,000	13.7%
1992	3,000,000	14.4%
1993	2,700,000	16.7%
1994	1,500,000	10.2%
1995	700,000	3.8%
1996	4,500,000	15.6%
1997	2,400,000	16.4%
1998	6,400,000	16.5%
1999	1,700,000	12.7%
2000	6,000,000	13.5%

Chinook Hatchery Programs

Facilities and Program

Artificial production of Chinook salmon within the Skagit is currently limited to a spring Chinook, a summer Chinook, and a fall Chinook coded-wire tagged (CWT) indicator stock. The objective of the indicator-stock programs is to obtain representative data on harvest impacts and marine survival of Chinook salmon that the comanagers can use to infer effects on wild Chinook populations. Two net pen programs previously supplied by this facility have been terminated.

Table 12. Proposed annual releases of Chinook salmon in the Skagit River Basin.

Subyearling	Yearling	Stock Lineage	Production Type	Release Site	Agency/ Sponsor	Status
Spring Racek						
250,000	150,000	Suiattle	Integrated Research	Marblemount Hatchery	WDFW	Continue
Summer Chinook (native)						
200,000		Upper Skagit	Integrated Research	County Line Ponds	SSC/WDFW	Continue
Fall Chinook (native)						
222,000		Lower Skagit	Integrated Research	Baker River	SSC/WDFW	Continue
Summer/Fall Chinook (Non-native)						
	0 (30,000)	Green River	Isolated Harvest	Oak Harbor Net Pens	ALEA	Terminate
	0 (15,000)	Green River	Isolated Harvest	Fidalgo Net Pens	RFEG-3	Terminate
	0 (45,000)					

The program uses the WDFW Marblemount Hatchery, located at the confluence of the Cascade River, Clark Creek and Jordan Creek near the town of Marblemount. The hatchery was built to increase production of coho and Chinook salmon in Puget Sound. However, current objectives are directed at culturing releases for the Chinook indicator programs.

Spring Chinook Program

Objective:
To provide information on harvest and marine survival that can be used to manage wild spring Chinook salmon.

Stock: Suiattle River spring Chinook

This stock was founded by collecting wild Skagit spring Chinook broodstock from Buck Creek from 1976-1988. In 1981 the first adults of Buck Creek origin returned to the hatchery. Prior to this program, spring Chinook were released into the Skagit (1949-1961). However, the stock and location of release are unknown. Coded-wire tagging was not consistently provided for each brood during that time. Consequently, hatchery personnel relied on timing differences to separate spring and untagged summer and fall broodstocks, which were also reared and released from Marblemount Hatchery. This probably resulted in mixing of the brood stocks, because some overlap exists in timing. Genetic analysis indicated that Marblemount spring stock is very similar, but not identical, to the native Suiattle spring Chinook stocks in the basin. For that reason, this stock has not been used for supplementation of natural stocks.

Production Goals:
Annual production goals are 150,000 yearlings and 250,000 zero-age fish. In addition, 50,000-eyed eggs are to be transferred to the Tulalip Tribe for rearing and release of yearlings into Tulalip Bay, although the Tulalip Tribe chose not to use the eggs from the 2000 brood because they had temporarily suspended their spring Chinook program.

Hatchery Strategy: Integrated research

Operations
Brood stock are taken from fish returning to the Marblemount Hatchery. All releases occur from the hatchery after all fish have been marked with coded-wire tags. Fish are not intended to spawn in the wild, but marked adults do appear on the spawning grounds. Straying appears to be localized to the upper Skagit and lower Cascade River within 1.5 miles of the hatchery.

Summer Chinook Program

Objective:
To provide information on harvest and marine survival that can be used to manage wild summer Chinook salmon. This program is funded by the tribes through PSC implementation funds.

Stock: Upper Skagit River summer Chinook

This stock originates from wild brood stock collected annually from the main stem Upper Skagit River beginning in 1994. An earlier summer Chinook program was also founded from native populations in the late 1970s. Releases were not consistently marked, however, and over the subsequent 15 years the native summer Chinook hatchery strain mixed with introduced Green River fall Chinook salmon, which were also released annually from Marblemount Hatchery and which has overlapping spawning periods. The mixed summer strain was eliminated from production beginning with the 1993 brood. Currently, 100% of released fish are marked.

Production Goals: See Table 12.

Hatchery Strategy: Integrated research

Operations
Summer Chinook salmon used for hatchery propagation are obtained from the wild. Brood stock are collected with gill nets each year from the upper Skagit mainstem between RM 79 and 85. Approximately 40 females are collected, with equal number of males to acquire 240,000 eggs. All fish are marked with coded-wire tags. After tagging, juveniles are acclimated and released from the County Line Ponds back into their natal range. Although not designed as a supplementation project, juvenile summer Chinook in this program come from wild broodstock and are released off-station, so the returning adults contribute to the natural escapement.

Fall Chinook Program

Objectives:
To provide information on harvest and marine survival that can be used to manage wild fall Chinook salmon. The program began in 1999 and is funded under the U.S./Canada Letter of Agreement for the purpose of providing an indicator stock for native Lower Skagit fall Chinook.

Stock: Lower Skagit River fall Chinook salmon

Production Goals: The goal of the program is to release 222,000 fingerlings annually (Table 12). The first three releases were less than this (32,100 in 2000; 162,300 in 2001 and 172,800 in 2002) because many of the fish caught had already partially spawned; hence, too few fish were taken as broodstock.

Hatchery Strategy: Integrated research

Operations: Hatchery plans call for collecting approximately 60 males and 60 females (244,000 eggs) from the main stem of the Lower Skagit River or at the mouth of Baker River. In the start up of the program, 33 fish were collected in 1999, 89 were collected in 2000 and 77 were collected in 2001. All juveniles released will be marked with coded-wire tags.

Operating Commitments

Marblemount Hatchery Spring Chinook Program:

- WDFW will collect broodstock from adults returning to the Marblemount Hatchery prior to August 15. Only coded-wire-tagged adults originating from the Marblemount Hatchery Spring Chinook program will be used for broodstock. Marked adults entering the trap in excess of broodstock requirements will be transported and released into Baker Lake. This transfer to Baker Lake is a 4-year experiment running from 1999 to 2002, after which it will be reviewed to determine if it should be continued. Unmarked adults entering the trap will be returned to the Cascade River.
- For marked fish that enter the trap between August 15 and August 31: Up to 30 fish will be sampled for coded-wire tags. Any additional fish, beyond the 30 fish maximum, may be transported to Baker Lake, subject to the review described above. After August 31, all marked fish that enter the trap will be sampled for coded-wire tags. Unmarked fish will be returned to the Cascade River.
- WDFW will limit, as the management intent, annual production of spring Chinook for on-station release to a total, maximum of 250,000 fingerlings or sub-yearlings and 150,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will coded-wire-tag all spring Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns, and to evaluate separation during hatchery spawning of spring Chinook, summer Chinook, and fall Chinook stocks.
- WDFW will monitor Chinook salmon escapement to the Skagit River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- WDFW and the tribes will review the results from the spring, summer, and fall exploitation rate indicator stock programs to determine if all programs are required.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Marblemount Hatchery Summer Chinook Program:

- The Skagit System Cooperative (SSC) and WDFW will collect sufficient broodstock to provide 240,000 eggs via a gillnet fished in the Skagit River above Marblemount in the period from late-August to early-September.
- SSC and WDFW will limit, as the management intent, annual production of summer Chinook for off-station release to a total, maximum of 200,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.

- WDFW will tag or mark all summer Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns, and to maintain separation during hatchery spawning between spring Chinook, summer, and fall Chinook stocks.
- WDFW will monitor Chinook salmon escapement to the Skagit River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.

Marblemount Hatchery Fall Chinook Program:

- The Skagit System Cooperative (SSC) and WDFW will collect sufficient broodstock to provide 244,000 eggs via a gill net fished in the Skagit River below Concrete in the period from mid-September to mid-October.
- SSC and WDFW will limit, as the management intent, annual production of fall Chinook for off-station release to a total, maximum of 222,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will tag or mark all fall Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns, and to maintain separation during hatchery spawning between spring, summer and fall Chinook stocks.
- WDFW will monitor Chinook salmon escapement to the Skagit River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.

Fidalgo Chinook Net Pens

- WDFW will eliminate this program to assure that the genetic integrity of the Skagit River stocks is not compromised.

Oak Harbor Chinook Net Pens

- WDFW will eliminate this program to assure that the genetic integrity of the Skagit River stocks is not compromised.

Stillaguamish River

Geography

The Stillaguamish River Basin consists of a large main stem, two main branches (the North and South Forks), and independent tributaries. Over 977 linear miles of river, stream, and tributaries exist in the basin. The North Fork begins near Finney Peak in the Mount Baker National Forest and flows south through steeply sloped terrain to near Darrington, where it turns west and flows across more gently sloped valley floor to join the South Fork near Arlington. The South Fork originates near Barlow Pass and flows northwest for nearly 52 before it joins the North Fork. The main stem formed by these two major streams and independent tributaries once meandered for approximately 18 miles across a broad flood plain before flowing into the Puget Sound. This area contains a variety of channels and sloughs, many of which have been extensively modified by human activities.

Natural Production

Two Chinook salmon populations current exist within the Stillaguamish watershed. They are genetically different based on allozyme frequencies (Marshall et al, 1995) and have different spawning timings and distribution (WDF et al, 1993). One stock originates from the North Fork Stillaguamish River and displays an earlier "summer" adult return timing. North Fork Chinook salmon are genetically more closely related to Skagit River Chinook salmon. Summer Chinook spawn in the first 34 miles of the North Fork, in Boulder River and in Squire Creek. Spawning may occur, at least in some years in other tributaries such as Grant, Deer, French, Brook and Seagelson Creeks. Spawning begins in late August, peaks in mid-September and continues through mid October.

The second population is associated with the South Fork Stillaguamish River and it exhibits a later "fall" return timing. They are genetically more closely related to the adjacent Snohomish River Chinook salmon (Marshall, pers. comm.,1997). Fall Chinook spawn in the main stem and South Fork Stillaguamish River up to river mile 35 during late September and early October. In the early 1950s, a ladder was constructed at the historical anadromous fish barrier at Granite Fall to allow access to the upper South Fork. Generally less than 100 adults spawn annually above the falls. Colonization may be limited by total escapement (<250) to the South Fork and by cool water temperatures in some years. Fall Chinook salmon may also spawn in Jim and Pilchuck Creeks.

Historically, early returning "spring" Chinook also used the Stillaguamish River, entering the river in April and beginning spawning in August. The existence of a distinct, self-perpetuating spring Chinook population in unknown. Currently, fish begin entering the river in May or early June with spawning starting in mid-August. What was considered to be springs may well have been the front edge of a larger overall population. Under current conditions, streams flows and warmwater make it impossible for spring Chinook salmon to survive naturally.

Loss of Chinook salmon habitat in the Stillaguamish River severely limits natural production. Between 1980 and 1992, natural spawning Chinook salmon in the North Fork Stillaguamish River failed to replace themselves seven out of ten years (Pess, per. comm). Over 1000 landslides within the water have increased sediments in the North Fork by six-fold. This has led to decreases in residual pool depth. In addition, changes in the hydrology of the system have led to increased flooding. The combination of loss of pools and increased flooding have led to up to 100% increases in potential scour (PFMC 1997, Pess and Benda, 1997).

Stock Status

The co-managers considered both the summer Chinook and fall Chinook salmon populations as depressed (WDF et al. 1993). Both natural populations and North Fork hatchery fish are listed as "threatened" under the ESA. The combined escapement goal for both stocks of 2000 adult fish has not been achieved since 1976 and total adult recruitment to Washington only exceeded the escapement goal in three of the last 17 years (PFMC, 1997).

Chinook Hatchery Production

Facilities and Program
The Stillaguamish Tribe and WDFW currently supplement North Fork summer Chinook salmon using the tribal facility at Harvey Creek and WDFW's Whitehorse hatchery. Fall Chinook salmon have never been artificially propagated at facilities in this basin.

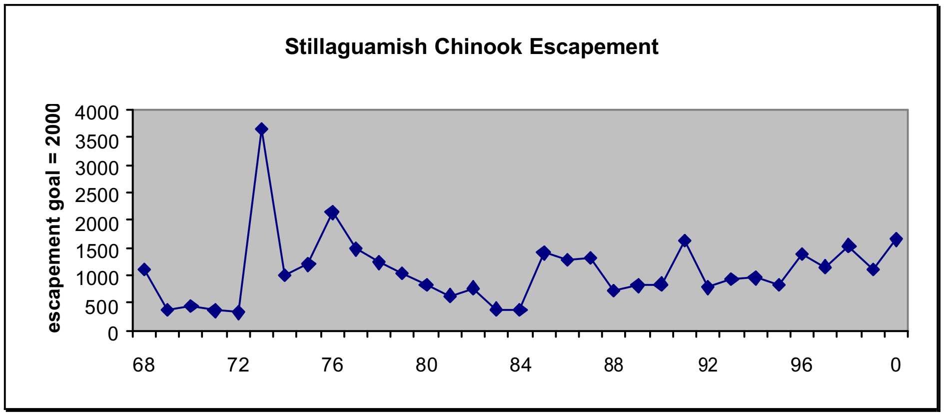

Figure 10. Annual total escapement of Chinook salmon in the Stillaguamish River 1968-1999.

Objectives
The purpose of the program is to maintain the present abundance of natural escapement until habitat conditions allow the population to recovery naturally. The long-term objective is to restore North Fork Chinook salmon to levels where the natural production can support recreational and commercial harvests of fish.

Stock: North Fork Stillaguamish summer Chinook

Production Goals

Table 13. Proposed annual releases of Chinook salmon for the North Fork Stillaguamish River.

Number Released (Subyearling)	Brood Lineage	Production Strategy	Release Site	Agency/ Sponsor
220,000	North Fork Stillaguamish	Integrated recovery	North Fork Stillaguamish River	Stillaguamish Tribe & WDFW

The annual release goal has not been consistently attained. Actual release numbers have ranged from 34,000 to 205,000.

Hatchery Strategy: Integrated-recovery

Operations
The program started in 1980 with the first brood stock collection from the North Fork. There has been no attempt to establish a hatchery strain that would return to the hatchery. Rather, brood stock are collected each year between river miles 15 and 30, the area where most of the spawning occurs. Brood stock are collected when water temperatures in the river collection areas are below 15 C and collecting on a given day is stopped if adult Chinook mortalities exceed 25 % of the

total number of fish collected in a gillnet pass. This measures are necessary to minimize the risk of harm to listed adult summer/fall Chinook salmon and their progeny.

The target is to obtain 65 males and 65 females to be able to obtain 250,000 eggs and ultimately release 200,000 juvenile fish. Should the abundance of non-marked natural spawners returning to the North Fork drop below 250 fish for three years, the brood stock collection efforts may be expanded to prevent extinction of the population.

Adult fish are taken to the tribal facility at Harvey Creek (RM 15) for spawning, incubation and early rearing. They are transferred to WDFW's Whitehorse Hatchery for final rearing and release. Fish are reared and released to mimic wild production. Fish are released from a large gravel, spring-fed pond, which runs directly into the North Fork Stillaguamish River, within the same area where naturally spawned fish rear. The hatchery juvenile Chinook salmon are allowed to move out volitionally starting in mid-May when they are approximately 70-90 fish per pound.

All the juvenile hatchery fish coded-wire tagged and data from the fish is an important indicator of fish mortality and marine survival for north Puget Sound summer Chinook salmon Survival from juvenile release to adults ranged from .01% to 1.9% during 1980-1994. From 1989 to 1996, hatchery fish were an average of 35% of the returning adults spawning in the North Fork Stillaguamish River.

Operating Commitments

- The Stillaguamish Tribe will continue to collect brood stock for the supplementation program under the protocols described above. The brood stock collection methods should be reviewed, and potentially alternative methods developed, to ensure compliance with the artificial production guidelines. Present collections occur in three to five pools in the upper river depending on flow and debris conditions prior to the onset of spawning. These fish may represent earlier returning adults but not the entire run-timing of the stock. Given that hatchery-produced Chinook salmon is a large fraction of the population, the full genetic diversity of this stock needs to be represented.
- WDFW, Tulalip and Stillaguamish tribes will develop contingency plans for the South Fork. Should the South Fork Stillaguamish fall Chinook run drop below a minimum level (to be determined by fish managers) for three consecutive years, then the co-managers will review and evaluate the potential for implementing a separate natural stock restoration program for the south fork stock.
- WDFW, Tulalip and Stillaguamish tribes will continue spawning ground surveys and conduct evaluations towards improving escapement estimates.
- The Stillaguamish Tribe and WDFW will continue to coded-wire tag 100% of the hatchery production to evaluate fishery contribution and survival rates, and straying levels to other Puget Sound watersheds.
- WDFW will evaluate rearing conditions at Whitehorse Ponds and make recommendations for capital improvements to benefit the summer Chinook program. Capital improvements to rearing ponds, water delivery systems and security systems should all be explored. (HSRG Recommendation, February, 2002)
- The Stillaguamish Tribe and WDFW should evaluate the consistency of time and size of release between the hatchery program fish and naturally produced Chinook, monitor juvenile growth, distribution, post-release survival, and the length-frequency/age-class distributions of hatchery-origin and natural-origin fish constituting adult returns. (HSRG Recommendation, February, 2002)

- WDFW will monitor straying of the summer Chinook program fish, and other out of basin hatchery fish, into the South Fork Stillaguamish River and take appropriate actions to prevent reduced genetic diversity in the South Fork Chinook stock.
- The Stillaguamish Tribe and WDFW will continue to collect and analyze genetic data from the hatchery program, and natural spawners in the NF and SF Stillaguamish River.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Snohomish River

Geography

The Snohomish River Basin (WRIA 7) includes the Snohomish River, its two principal branches, the Skykomish and Snoqualmie Rivers, and small independent streams flowing into Possession Sound and Tulalip Bay. It encompasses 1,780 square miles of which the Skykomish and Snoqualmie watersheds contribute 844 and 693 square miles respectively. Tulalip Bay is a small bay just north the Snohomish River where the Tulalip Tribe operates hatchery programs. Two small independent creeks flow into the bay.

Natural Production

The comanagers (WDF et al., 1993) previously identified four stocks:
1) Snohomish summer Chinook salmon, which spawn primarily in the main stems of the Skykomish and Snohomish Rivers;
2) Bridal Veil Chinook salmon, which spawn in Bridal Veil Creek and in the nearby North and South Fork Skykomish Rivers;
3) Snohomish fall Chinook salmon, which spawn in tributaries of the Sultan and Snoqualmie Rivers, such as the Tolt, Raging, and Tokul drainages; and.
4) Wallace River summer/fall Chinook salmon, which were believed to be the result of a mixture of stocks resulting from hatchery straying.

The Puget Sound Technical Review Team (Puget Sound TRT, 2001) reexamined the data and concluded that there were only two independent, naturally spawning populaions: Skykomish and Snoqualmie Chinook salmon.

The Skykomish population includes the previously identified Snohomish summer, Wallace summer and Bridal Vail Creek fall Chinook stocks, as well as a portion of the Snohomish fall Chinook stock. Spawning occurs throughout the mainstem Skykomish and Snohomish rivers, Wallace River, Sultan River, Bridal Vail Creek Sultan River, Elwell Creek and in the North and South Fork Skykomish including fish passed above Sunset Falls. Natural spawning also occurs in the Wallace River, but many of these spawners originate from the Wallace River Hatchery, located at the confluence of May Creek and Wallace River. Fish spawning in the Pilchuck River and Snohomish River proper are also included in this stock. Spawn timing occurs from September through October. Allozyme analysis has shown that this stock are genetically distinct from all other Puget Sound Chinook stocks.

The Snoqualmie population is composed of those Snohomish fall Chinook, which spawn in the Snoqualmie River and its tributaries, including Tolt and Raging rivers and Tokul Creek. Spawn timing occurs from mid-September through October.

Historically, early returning spring Chinook salmon also returned to the Snohomish Basin, but no evidence of a distinct, self-perpetuating spring Chinook salmon population presently exists. No self-sustaining populations of Chinook salmon were present historically in the streams draining into Tulalip Bay.

In 1958, the State installed a trap-and-haul program at Sunset Falls on the South Fork of the Skykomish River, a historical barrier to anadromous fish, to introduce salmon into new areas of the basin. Chinook spawning in this above the falls now contribute a significant proportion of the natural production in the river.

Snohomish natural Chinook salmon are genetically more similar to Chinook salmon from the Green River than to Skagit, Nooksack, and the Strait of Juan de Fuca populations. Unlike other summer and fall Chinook salmon populations, however, a significant proportion of Snohomish Chinook salmon migrate seaward as yearlings, a life history strategy that is more typical of spring Chinook salmon (Gilbert, 1912; see Healey, 1991) and is very unusual in later-timed fall Chinook salmon. These differences between Snohomish River populations and others may mean that survival and harvest rates determined from populations with a smaller yearling migrant component, such as North Fork Stillaguamish summer Chinook may not accurately reflect what is happening to Snohomish River Chinook salmon populations.

Until recently, the Wallace River Hatchery released both native summer Chinook salmon and imported Green River fall Chinook salmon, which have similar distributions and times of spawning. Releases of Green River-origin fall Chinook salmon ended in 1997. Beginning in 1998, all releases were from broodstock originally derived from fish taken in the Skykomish system. Both the Green River and Skykomish broodstocks, however, use eggs taken on-station from fish returning to the hatchery facility. Importation of brood fish only occurred initially when the broodstocks were first developed. Genetic analyses indicate, however, that some differences have been preserved. Natural spawning summer Chinook salmon are significantly different from Green River fall Chinook salmon from Soos Creek Hatchery (WDF et al., 1993).

Stock Status

The 2002 SaSI evaluation rates the Skykomish stock as depressed and the Snoqualmie stocks as healthy. The co-managers have managed natural production of these populations as a single unit with a total annual escapement goal of 5,250 natural spawners. This escapement goal was attained in 1998 for the first time since 1980 and then again in 2000. Beginning in 2001 escapement objectives were changed to be based on exploitation rates, as defined in the Co-managers' Puget Sound Chinook Salmon Harvest Plan. Spawning escapement for 2001 was nearly 8200 Chinook, which exceeded all other natural escapement levels for the Snohomish system 35-year data base.

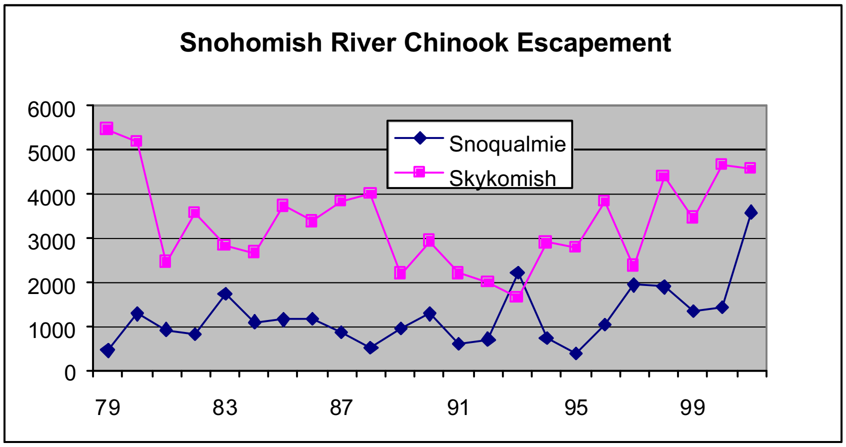

Figure 11. Annual total escapement of Chinook salmon in the Snohomish River 1979-2000.

Chinook Hatchery Programs

Four Chinook hatchery programs occur in this region. WDFW operates a program for Wallace River summer Chinook salmon. In Tulalip Bay, the Tulalip Tribe operates programs for fall, summer and spring Chinook. (Although the spring Chinook program has been temporarily suspended.)

WDFW Summer Chinook Program

Facilities and Program:
Wallace River Hatchery is located at the confluence of Wallace River and May Creek near the town of Startup. The hatchery was built for the production of coho and Chinook salmon. The hatchery has also served as an interim rearing site for fish destined for other hatchery programs, including marine net pen operations and cooperative rearing programs.

Table 14. Proposed annual release for Chinook salmon in the Snohomish Basin. Number in parentheses shows previous release goals.

Number Released Fingerling/ fry	Number Released Yearling	Brood Lineage	Production Strategy	Release Site	Sponsor
1,000,000	250,000 (530,000)	Skykomish summer Chinook	Integrated harvest	Skykomish River (Wallace Hatchery)	WDFW
	0 (20,000),	Green River fall Chinook	Isolated harvest	Mulkilteo Net Pens	ALEA
	0–40,000* (40,000)	Suiattle River spring Chinook	Isolated harvest	Tulalip Bay	Tulalip Tribe
1,500,000		Skykomish summer Chinook	Isolated harvest	Tulalip Bay	Tulalip Tribe
200,000		Green River fall Chinook	Isolated harvest	Tulalip Bay	Tulalip Tribe
2,700,000	250,000	**TOTAL**			

* program has been temporarily suspended

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Objectives
The primary goal is to enhance and maintain the Wallace River summer Chinook stock.

Stock: Wallace River summer Chinook (Skykomish summer Chinook brood lineage)

Wallace River hatchery brood originated from the native summer Chinook recruited from fish that returned to the fish passage facility at Sunset Falls on the Skykomish River in the early 1970s. Since that time the only source of eggs has been adult fish that return to the traps at the Wallace River Hatchery. Although there was no intentional integration of wild fish into the brood stock in recent years, wild fish were included incidentally. Based on otolith marks, about 10% of the fish collected at the Wallace Hatchery are from natural-origin Chinook (Rawson et al., 2001). A portion of the returning adults are passed upstream to spawn in the Wallace River above the hatchery site. Wallace fish show a prolonged spawning time (September through October) and spawn downstream from the Wallace River Hatchery, a facility that has had both summer Chinook and fall Chinook programs. For these reason, Wallace fish are thought to be a mixture of summer and fall fish.

Production Goals
Annual production goals call for 250,000 yearlings and 1,000,000 zero-age fish to be released on-station.

Hatchery Strategy: Integrated-harvest

Tulalip Chinook Programs

Facilities and Programs
The Bernie Kai-Kai Gobin Salmon Hatchery is located on the Tulalip reservation near Tulalip Bay. This facility rears and releases three types of Chinook: Skagit spring Chinook salmon, Snohomish summer Chinook salmon, and Green River fall Chinook salmon. Chinook salmon did not historically spawn in Tulalip Creek or Mission Creek, which flow into Tulalip Bay.

Tulalip Spring Chinook Program

Objectives
The spring Chinook program is intended to provide harvestable Chinook salmon for the Tulalip tribal members in an on-reservation terminal area fishery. The program is designed for limited harvest for ceremonial and subsistence uses, including First Salmon ceremonies in May and June. Fish returning to Tulalip Bay may be harvested at a rate approaching 100%, as long as the terminal fishery can target on hatchery production. They are also caught in mixed-stock areas and available for recreational fishers

Stock: Skagit River spring Chinook salmon.

Production Goals: The 40,000 spring Chinook program has been temporarily suspended with the 2000 brood.

Hatchery Strategy: Isolated-harvest.

Operations
The spring Chinook program was established by agreement between WDFW and Tulalip in 1993. This agreement is reflected in the annual Future Brood Document and draft Stillaguamish/Snohomish Equilibrium Brood Document. Skagit River spring Chinook salmon are used as brood stock, because Snohomish River spring Chinook are extinct. Brood stock are collected and spawned by WDFW at the Marblemount Hatchery on the Skagit River. Eyed-eggs are transferred to the Tulalip Hatchery for rearing and release.

Tulalip Summer Chinook Program

Objectives
The purpose of this program is to provide Chinook salmon for harvest by Tulalip Tribal members in a terminal area fishery. The program was begun in 1998 as an experimental program to replace non-native fall Chinook salmon with a more local origin, earlier-returning (summer) Skykomish Chinook salmon. Beginning in 2003, these summer Chinook salmon will serve as the primary brood stock for the harvest program.

Stock: Wallace River (Skykomish River) summer Chinook

Production Goals
Annual release goal is 1,500,000 fingerlings at 70-80 fish per pound (for the current experimental phase of the program).

Hatchery Strategy: Isolated-harvest

Operations
Brood stock are collected and spawned by WDFW at the Wallace River Hatchery. Eyed-eggs are transferred to the Bernie Kai-Kai Gobin Hatchery for incubation and earlier rearing. At a size of approximately 400 fish per pound, they are transferred to large raceways or rearing ponds. After coded-wire tagging of 100,000 fish in mid-April, the fish are transferred to lower Tulalip Creek pond for final rearing, acclimation, and release. Fish are released from the pond to the estuary in early to mid-May on a high tide.

Tulalip Fall Chinook Program

Objectives
This program is intended to support harvest opportunity for Tulalip Tribal fishers in a small on-reservation terminal area. Originally, the fall Chinook salmon program provided the bulk of the fish to the tribal fishery. Beginning in 2003, however, the Tulalip Tribe switched to using a local, earlier-returning Skykomish River summer Chinook salmon for brood stock. The main purpose of the original fall Chinook program now is to produce enough fish to allow the tribe to compare survival, contribution to fisheries, and straying between the fall and summer stocks.

Stock: Green River lineage fall Chinook

Production Goals: The annual release goal is 200,000 fry at 80 fish per pound.

Hatchery Strategy: Isolated-harvest

Operations
This program uses Green River origin fall Chinook, obtained from surplus escapement at Wallace River Hatchery. However, the last release of Green River-origin Chinook salmon from Wallace River Hatchery occurred in 1997. Beginning with the 1999 brood year, all releases were from a brood stock derived from fish taken from the Skykomish River system.

Operating Commitments

<u>Wallace River summer Chinook</u>

- In the years 2001 through 2003, WDFW will collect broodstock from adults returning to the Wallace River Hatchery from June 1 to August 15. WDFW will incorporate summer Chinook returning to Sunset Falls into the hatchery broodstock. (WDFW and tribes will develop implementation plan). Up to 10% of the broodstock coming from Sunset Falls. (HSRG Recommendation, February 2002.) Adults entering the trap during this time in excess to egg needs, or fish entering the trap subsequent to August 15, will be returned to the river to spawn naturally. (Tulalip Hatchery egg requirements in 2001-2002 will be met from adults returning to the hatchery from June 1 to August 15.)
- Beginning in 2004, only marked adult fish voluntarily entering the Wallace River Hatchery trap and wild adults returning to the Sunset Falls trap will be used to meet broodstock requirements. Unmarked fish, and marked fish in excess of broodstock requirements will be returned to the river to spawn naturally.
- WDFW will limit, as the management intent, annual production of summer Chinook for on-station release to a total, maximum of 1,000,000 fingerlings or sub-yearlings and 250,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will tag or mark all summer Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns, and to maintain separation during hatchery spawning between spring Chinook and fall Chinook stocks.
- WDFW will monitor Chinook salmon escapement to the Snohomish River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- All spawning will be in single-pair matings or 5 x 5 matrix spawning. (HSRG Recommendation, February 2002)
- WDFW should explore capital improvements to the pollution abatement system, rearing ponds, to facilitate volitional release, and the adult trapping/holding ponds, to facilitate sorting of natural-origin fish and hatchery-origin fish. These have been identified in the WDFW Capital Budget process. (HSRG Recommendation, February, 2002)
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Mukilteo Chinook Net Pens

- WDFW will eliminate this program to assure that the genetic integrity of the Stillaguamish, Snohomish, and Skagit stocks is not compromised.

Langley Chinook Net Pens

- WDFW will eliminate this program to assure that the genetic integrity of the Stillaguamish, Snohomish, and Skagit River stocks is not compromised.

Tulalip tribal Chinook programs

- WDFW and the Tulalip tribe will continue with the monitoring/evaluation program to determine the contribution of hatchery fish to the local fishery and the extent of hatchery straying
- WDFW will continue spawning ground surveys and evaluations towards improving escapement estimates. This will include estimating numbers of marked and unmarked Chinook, and assessment of the native population in achieving restoration objectives.
- The Tribe should collect mark and tag recovery data during annual spawning ground surveys to estimate the stray rate of hatchery-origin Chinook salmon to natural spawning areas and to estimate the abundance of both hatchery and natural-origin spawners.
- The Tribe will develop and implement protocols that foster attainment of annual Chinook salmon egg take goals through the collection of on-station adult returns for use as brood stock.
- The Tribe will limit, as the management intent, annual production of spring-run Chinook salmon for on-station release from Bernie Kai-Kai Gobin Salmon Hatchery in March to a maximum of 40,000 yearlings.
- The Tribe will limit, as the management intent, annual production of summer-run Chinook salmon for on-station release from Bernie Kai-Kai Gobin Salmon Hatchery in May to a maximum of 200,000 sub-yearlings for the duration of the experimental phase of this program.
- The Tribe will limit, as the management intent, annual production of fall Chinook for release from Tulalip Salmon Hatchery in May to a maximum of 1,850,000 sub-yearlings.
- The Tribe will, as a management intent, mark 100 % of the Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns. Thermally marked otoliths are an appropriate mark for this purpose.
- The Tribe will apply coded wire tags to a representative proportion of the total annual sub-yearling and yearling production to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The Tribe will conduct stream survey and mark recovery programs in the Stillaguamish and Snohomish watersheds to collect data for use in estimating Tulalip hatchery program Chinook salmon straying levels. Surveys will be conducted to minimize adverse effects on migrating and spawning natural Chinook salmon, and their redds.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Mid-Puget Sound Region

For the purposes of this plan, the Mid-Puget Sound region covers the marine waters from the southern end of Whidbey Island south to Vashon Island. The geography consists of two major watersheds: Lake Washington and the Green River systems. In addition this region covers the numerous independent tributaries draining the northeastern portion of the Kitsap peninsula. Two indigenous Chinook populations occur in this region: Cedar River and the Green River stocks. No historic self-sustaining Chinook stocks occur within the independent tributaries. Naturally low flow stream discharges during the summer months and limited spawning and rearing areas probably preclude self-sustaining Chinook populations within the smaller independent systems.

Lake Washington

Geography

The Lake Washington watershed (WRIA 8) includes Lake Washington and its tributaries; Lake Sammamish, the Sammamish River and its tributaries; and the Cedar River. The basin includes 470 identified streams and nearly 700 linear stream miles. Only 170 stream miles are currently accessible to anadromous salmonids. Most of these flow through highly urbanized areas of the Seattle metropolitan area where habitat and flow modifications have greatly reduced potential for natural production.

Natural Production

Natural spawning of Chinook salmon occurs in the Issaquah Creek, the north Lake Washington tributaries (including Big Bear Creek and Cottage Lake Creek.) and the Cedar River. These spawning aggregations are considered different populations (WDF et al 1993), based on their geographical distribution. The Cedar River population is an indigenous population stock.

The genetic relationships among these stocks are only partially known. Much of the spawning in Issaquah Creek is likely by hatchery fish released for harvest from the Issaquah Hatchery, which produces a Green River-origin stock. The spawning times of these fish are similar to the natural spawning Chinook in north Lake Washington tributaries and the Cedar River. Preliminary genetic data indicate that Chinook spawning in Issaquah Creek and north Lake Washington tributaries are similar to Green River Chinook salmon, which suggests that any population differences, if they existed historically, have been altered by hatchery production. It is unclear whether habitat in Issaquah Creek and the north Lake Washington tributaries, which flow through urban areas, can support self-sustaining natural production.

In contrast, genetic data do show significant, population differences between Green River and Cedar River Chinook salmon, although general similarities also reflect the historical biogeographical relationships between fish in the Cedar and Green Rivers (Marshall, pers. Comm.., 1995). Until recent times, the Black-Cedar River flowed into the Duwamish-Green River.

Cedar River Chinook salmon begin spawning in early September, peak in late September and early October, and continue through mid-November. Time of peak spawning has varied little throughout the 30 years it has been studied, with 50% of the run having spawned by October 6

(Cascades Environmental Services, Inc.1995). After hatching, Cedar River juveniles migrate downstream as fry from late January through early June. There has been extended trapping in the Cedar River since 1999 and some migration has been documented to occur after early June (Seiler, unpublished).

For urban streams, in general, poor stream flows, physical barriers, poor water quality, and limited spawning and rearing habitat as a result of urbanization limit natural production. Logging and clearing of land for urban development have increased seasonal flooding, which can scour spawning gravel and destroy Chinook salmon eggs. A major problem in the Cedar River is channelization, and riprap banks. The confined channel limits spawning areas and exacerbates the degree of scour during increased flows in the winter. Water temperatures are elevated in the Cedar during the summer but don't approach lethal levels. Otherwise, water quality in the Cedar is generally good. Locks, dams, and intermittent obstructions also limit passage. These include the Government Locks on the Lake Washington Ship Canal and the water diversion dam operated by the City of Seattle at river mile 21 on the Cedar River. Debris buildups, impassable culverts, or temporary impounds occur intermittently in nearly all the small and moderate-size streams in the watershed. Pollutants from domestic, agricultural, and industrial effluents accumulate in waters flowing through the Seattle metropolitan area and reduce water quality for salmon.

Stock Status

In the SASSI review, the co-managers identified the status of north Lake Washington tributary Chinook salmon and the Cedar River population as unknown (WDF et al., 1993). More recent data indicates that Cedar River Chinook salmon are depressed. The co-managers considered Issaquah fall Chinook salmon, which is supported by hatchery production, as healthy, but this assessment did not attempt to judge the status the natural spawning component. Under ESA, all naturally produced fish are listed as "threatened."

Escapement goals have been 1200 for Cedar River and 350 for the north Lake Washington tributaries. Returns in recent years have been less than 500 fish overall. Beginning in 2001 escapement objectives have been based on exploitation rates as defined in the Co-managers" Puget Sound Chinook Harvest Plan.

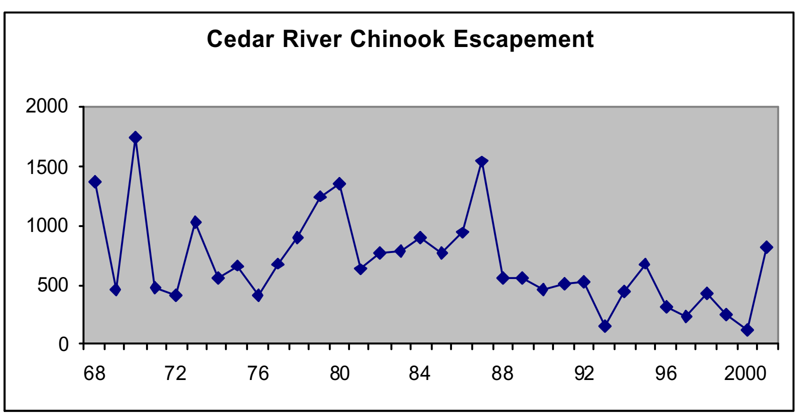

Figure 12. Annual escapement estimates for Chinook salmon in Cedar River from 1968-2001.

Chinook Hatchery Production

Facilities and Programs
Washington Department of Fish and Wildlife's Issaquah Hatchery, which is located in on Issaquah Creek, a tributary of Lake Sammamish, is the center of Chinook salmon production in Lake Washington. Three volunteer cooperative projects have recently been discontinued. The University of Washington also produces Chinook salmon for research at a small hatchery on Portage Bay in Lake Washington. Chinook salmon have been released from the Ballard net pens until recently, when the program was terminated.

Objectives:
The primary purpose of the hatchery production in the Lake Washington watershed is to produce fish for harvest in commercial and recreational fisheries in the Puget Sound and NE Pacific Ocean.

Stock: Green River Chinook salmon

Production Goals: See Table 15.

Hatchery Strategy: Integrated-harvest; research

Operations
Brood stock are taken at the Issaquah Hatchery and Portage Bay Hatchery (University of Washington). Fish are released from the hatcheries with limited releases in a few small streams as part of citizen projects. Releases have usually been untagged. Lack of tagging and surveys to recover tagged fish have precluded much information about the distribution and survival of these fish.

Table 15. Proposed annual releases of Chinook salmon for Lake Washington watershed.

Number Released (by life stage)					
Eggs	**Subyearling**	**Brood Lineage**	**Production Type**	**Release Site**	**Sponsor**
	2,000,000	Green River	Isolated harvest	Issaquah Hatchery	WDFW
	180,000	Green River	Isolated Research	University of Washington	UW
	0 (60,000)	Green River	Isolated harvest	Halls Lake	Coop
	0 (25,000)	Green River	Isolated harvest	Glendale Country Club	Coop
0 (150,000)		Green River	Isolated harvest	Kelsey Creek	Coop
0	2,180,000	TOTAL			

Operational Commitments

<u>Issaquah Hatchery fall Chinook</u>:

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Issaquah Hatchery to affect this program. The collection of localized hatchery-origin broodstock at this location will limit direct and incidental take effects on listed Chinook salmon.

- WDFW will limit, as management intent, annual production of fall Chinook for on-station release from Issaquah Hatchery to 2,000,000 sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Issaquah Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the North Lake Washington tributaries (including Issaquah Creek) to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

<u>Portage Bay fall Chinook (University of Washington)</u>

- WDFW and the University of Washington will collect eggs from fall Chinook adults voluntarily entering the Portage Bay Hatchery trap. The intent is to collect localized hatchery-origin broodstock at this location.
- WDFW and the University of Washington will limit, as the management intent, annual production of fall Chinook for on-station release to a total, maximum of 180,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW and the University of Washington will tag or mark all fall Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns.

<u>Ballard Chinook Net Pens</u>

- WDFW will eliminate this program to assure that the genetic integrity of the Green River / Lake Washington stocks is not compromised.

<u>Halls Lake, Glendale, and Kelsey Creek Cooperative Projects</u>:

- WDFW will eliminate this program to assure that the genetic integrity of the Lake Washington stocks is not compromised.

Green River

Geography

The Duwamish and Green River Basin is encompassed by (WRIA) 9. From the mouth of the river at Elliot Bay to Tukwila, the lower ten miles of the river system is known as the Duwamish River. Upstream from Tukwila it is the Green River. Entering the Puget Sound independently of the Green River are five smaller tributaries with limited spawning and rearing potential for anadromous salmonids. The basin includes 367 identified streams and 643 linear stream miles. The Green River originates in the high Cascades, but in the lower 30 miles where it flows across an open valley urbanization and industrialization are rapidly replacing open farmland and stands of conifer and deciduous forests. Extensive industrial development dominates the lower ten miles. The river is impounded at Howard Hanson Dam at river mile 64.5, and at the City of Tacoma municipal water supply diversion dam at river mile 61. This restricts fish from much of the upper watershed.

Natural Production

Two major spawning aggregations of Chinook salmon have been identified in the Duwamish and Green River system (WDF et al. 1993). These include Chinook salmon that spawn from river mile 25-61 in the Green River and an aggregation of similar fish that spawn in Neuwakum Creek. Natural spawners in Neuwakum Creek are genetically similar to Green River Hatchery fish (Marshall, pers. comm., 1995) and we consider them the same genetic population. Much (40-60%) of the spawning in the Green River is by Green River Hatchery fish, which are from the same stock. Chinook begin spawning in mid-September, peak at the end of the first week of October and continue spawning through the third week in October. Most juveniles migrate seaward within the first year of life.

Natural production in the Duwamish and Green River system is limited by habitat changes from industrial and urban development. Seasonal flooding, which can move spawning gravels and destroy eggs or spawning habitat, is exacerbated by storm water discharges from deforested urban areas. Water diversions contribute to low summer lows and warm water temperatures during summer months that impede passage and reduce fish production. Industrialization of the lower watershed has contributed to high levels of domestic and industrial pollutants in the Duwamish River.

Stock Status

The co-managers considered the Green River population as healthy based on trends in overall abundance (WDF et al., 1993). The goal for natural spawning escapement has been 5800 fish for the system, which has been exceeded in most years since 1987. Management objectives are defined in the Co-manager's Puget Sound Harvest Plan. Under ESA all naturally produced Chinook salmon are considered threatened.

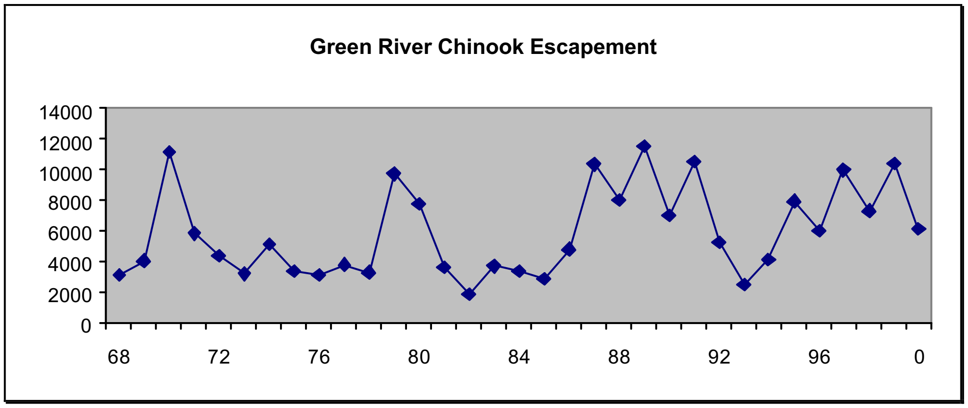

Figure 13. Total annual escapements for the Duwamish and Green River Basin from 1968-2000.

Chinook Hatchery Programs

Facilities and Programs
Chinook salmon hatchery production in the Green River is managed by WDFW and the Muckleshoot Tribe. Two major facilities support these programs. Soos Creek Hatchery is operated by Washington Department of Fish and Wildlife. Keta Creek Hatchery is run by the Muckleshoot Tribe. All egg collection and spawning is done at the Soos Creek Hatchery.

Objectives
The primary goal of hatchery production in the Duwamish/Green River system is to provide fish for harvest.

Stock: Green River Chinook salmon

The Green River hatchery program was founded with Chinook salmon originating from the Green River. Some additional stocks have been occasionally imported since the program began, but the program has depended upon volunteer returns for decades. Naturally produced Green River fish have been routinely incorporated into the brood stock used at the hatchery.

The Green River hatchery stock has been the source of Chinook eggs for a variety of other Puget Sound hatchery programs. Green River-origin Chinook have been used to establish populations at the following hatcheries: Samish and associated facilities, Tulalip, Issaquah, Green River and associated facilities, Voight's Creek, Deschutes, McAllister, Minter, Coulter, Chambers, Grover's/Gorst Creek, Kalama and Clear Creeks (Nisqually), Hoodsport, George Adams, Big Beef Creek, and Glenwood Springs. This has resulted in a variety of Green River lineage hatchery strains. In most cases, brood stock for these programs are sustained by adult returns to this facilities and Green River Chinook salmon eggs are no longer imported from the Green River.

In addition, Green River lineage Chinook salmon have been cultured and released from a variety of saltwater net pens throughout Puget Sound and Hood Canal, including locations at Sund Rocks and Pleasant Harbor (Hood Canal), South Sound Net Pens, Zittel's (south Puget Sound), Percival Cove, Fox Island, Elliott Bay, Des Moines, Ballard, Mukilteo, Oak Harbor, Langley Net Pens (Whidbey Is.), Anacortes and San Juan Island sites.

Production Goals:

Table 16. Proposed annual releases of Chinook salmon for the Duwamish and Green River Basin.

Number Released (by life stage) **Subyearling**	**Yearling**	**Brood Lineage**	**Production Type**	**Release Site**	**Sponsor**
3,200,000		Green River	Integrated harvest	Soos Creek Hatchery	WDFW
600,000		Green River	Integrated harvest/research	Keta Creek	Muckleshoot Tribe
	300,000	Green River	Integrated harvest	Icy Creek	WDFW
	0 (20,000)	Green River	Integrated harvest	Ballard Net Pens	Coop
	0 (60,000)	Green River	Integrated harvest	Elliott Bay Net Pen	Coop
	0 (30,000)	Green River	Integrated harvest	Desmoines Net Pens	Coop
3,800,000	**300,000**	TOTAL			

Hatchery Strategy: Integrated Harvest/Recovery

Operations
Soos Creek Hatchery—The Soos Creek Hatchery Chinook program started in 1901 largely in response to failing local salmon runs in the region. The hatchery, located on lower Soos Creek near Green River at RM 33.7 was founded primarily on local Green River broodstock. The hatchery was one of the largest facilities in the Puget Sound region for many years and between 1904 and 1913 accounted for nearly 70% of all Puget Sound Chinook releases. Due to its early success and the ready availability of broodstock, Green River Chinook stock became the brood source for most Puget Sound fall Chinook hatchery programs. The early hatchery program emphasized large numbers of fry plants into the watershed. Today the program is dominated exclusively by fingerling smolts reared and released from Soos Creek. The current release goal is 3.2 million fingerlings @ 80 fish per pound. In addition, the hatchery supports the Icy Creek yearling Chinook program, 300,000 yearlings, as well as the Muckleshoot Tribe Chinook program, 600,000 eyed eggs.

Adult fish are collected as volunteers into the in-creek adult trap in Soos Creek. Adults are spawned at the site and the eggs incubated at the hatchery. Approximately 3,500 adults are passed upstream to spawn naturally in Soos Creek. Additional adults are donated to food banks and/or the state contract carcass buyer. The incubation and rearing water utilized at Soos Creek is pumped water from Soos Creek. Water quality and quantity has degraded in recent years due to development in the watershed making incubation and rearing increasingly problematic because of periodic flooding, heavy silt loads and higher water temperatures. All of the juvenile hatchery Chinook are mass marked and an index group are coded-wire tagged. The mass mark is important to provide monitoring and harvest opportunity and the coded-wire tag index fish provide an indicator of mortality and marine survival of this stock. Survival from juvenile release to adult has ranged from .1% to 2.6% for 1986 to 1995 (Avg. .54%). The catch distribution for the 1990s' is approximately 12% Canadian, 25% Washington Commercial, 10.3% Washington Sport, 51% Washington Escapement and 1.7 misc. Soos Creek hatchery fish make up approximately 33.4% of the wild spawners in the Green River. Approximately 39.4 % of the fish returning to the Soos Creek rack are wild-origin fish.

Icy Creek Pond— Icy Creek Pond, located at Green River mile 48.5, is operated as a satellite of the Soos Creek Hatchery. The site, formerly known as "Pautzske's Ponds, is supplied by a large spring. The site has two large rearing ponds, only one of which is utilized at this time. There are no buildings on the site and access is limited by its remote location. Support is solely supported from the Soos Creek Hatchery.

The ponds are stocked each spring with approximately 320,000 fin-clipped fingerling Chinook from Soos Creek. They are reared until the following spring and 300,000 are released in May at 10 fish per pound.

The Icy Creek program is part of the WDFW recreational enhancement program and produces delayed-release Chinook. Delayed release Chinook salmon have a tendency to reside within the Puget Sound and contribute heavily to the in-sound recreational and commercial fisheries. The recreational harvest of this group is normally about 50% of the total survival.

Keta Creek Hatchery—The purpose of this program is to evaluate survival of fish above Howard Hanson Dam. Eggs for the Keta Creek Hatchery are transferred from Soos Creek Hatchery after they have been collected and incubated to the eyed-stage. The fish are hatched at Keta Creek Hatchery in Heath Tray incubation stacks and transferred to standard 100' x 10' x 4' raceways in mid-January at about 900 fish per pound. Fish are fed at a rate of approximately 2.5% body weight per day and their growth and health is monitored by hatchery staff and fish pathologists from the Northwest Indian Fisheries Commission. At approximately 150 fish per pound in size the fish are acclimated to stream temperatures and transported by truck for release in tributaries above Howard Hanson Dam.

Operating Commitments

<u>Soos Creek Hatchery fall Chinook</u>

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Soos Creek Hatchery to affect this program. The collection of localized hatchery-origin broodstock at this location will limit direct and incidental take effects on listed Chinook salmon.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Soos Creek Hatchery to a total, maximum of 3,200,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Soos Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds. WDFW will monitor Chinook salmon escapement to the Green River to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- WDFW will conduct a study to determine the relative reproductive success of naturally produced and hatchery produced fall Chinook spawning in Soos Creek.

- WDFW will investigate the feasibility of removing hatchery fish from the Green River above Soos Creek in an attempt to reduce the number of hatchery fish on the spawning grounds.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Icy Creek fall Chinook program

- WDFW will collect eggs for this program from adults voluntarily entering the Soos Creek Hatchery trap.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release to a total, maximum of 300,000 yearling. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will tag or mark all fall Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns.
- WDFW will apply coded-wire tags to a portion of the yearling fall Chinook production at Icy Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the Green River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Ballard Chinook Net Pens

WDFW will eliminate this program.

DesMoines Net Pen Fall Chinook Program

WDFW will eliminate this program.

Keta Creek Fall Chinook Program

- The Muckleshoot Indian Tribe reserves the right to discontinue current production of 600,000 fed fry; modify the current production level; or to change species reared to meet tribal needs.
- The Tribe will continue to use progeny originating from fall Chinook salmon adults volunteering to Soos Creek Hatchery for the Keta Creek hatchery program
- Unless prevented by exigent circumstances the Tribe will mass mark all fall Chinook.
- The Tribe will coordinate with WDFW to monitor Chinook salmon escapement in the Green River Bas in to estimate the number of fish spawning naturally each year

- The Tribe will coordinate with WDFW on the collectiom of mark and tag recovery data to estimate the proportion of hatchery-origin Chinook salmon in natural spawning areas and estimate the abundance of both hatchery and natural-origin spawners in the Basin.

East Kitsap Peninsula Streams

Geography

This area includes the streams of the East Kitsap Peninsula and islands along Case Inlet, Henderson Bay, Colvos Passage, Sinclair Inlet, Dyes Inlet, Port Orchard, Liberty Bay, Port Madison, which are part of Water Resource Inventory Area (WRIA) 15. The area includes 163 mostly short, low to moderate gradient, lowland streams and 346 stream miles. Minter, Coulter, Gorst and Burley Creeks are the primary watersheds.

Natural Production

Natural spawning of Chinook salmon has been documented in the larger drainages of this area, such as Coulter, Rocky, Minter, Burly, Gorst, Chico, and Dogfish Creeks. The largest natural spawning aggregation occurs in Burley Creek. Chinook salmon spawning in these areas are considered part of the complex South Sound fall population based on geography (WDF et al., 1993) and genetic traits, which indicate that they are part of a large geographic group that resembles Green River origin hatchery fish (Marshall, pers. comm., 1995). Although other resident and anadromous salmonids do use these streams, no historical evidence suggests that self-sustaining, independent Chinook salmon populations occurred in these systems. Historically, many of these streams may have been too small to support persistent, independent populations of Chinook salmon, although spawning and natural production may have occurred episodically.

Sustainable natural production of Chinook salmon in this region is largely limited by lack of typical Chinook salmon spawning and rearing habitat. Natural production that does occur is likely the result of hatchery-origin fish. Preliminary study results of out-migrating fry from these areas indicate that natural productivity is very low. What limited natural production from Chinook salmon and other salmonids occurs is threatened by changes in stream flows, passage, and water quality associated with increasing suburban development of the watersheds.

Stock Status

No historical evidence suggests that self-sustaining Chinook salmon production occurs or could occur in these systems. All naturally produced fish, however, are protected as "threatened" under the Endangered Species Act.

Chinook Hatchery Production

Facilities and Programs
The primary purpose of Chinook salmon programs in East Kitsap streams is to produce fish for harvest in commercial and recreational fisheries in the Puget Sound and NE Pacific Ocean. Two major facilities support hatchery production in this area. Minter Creek Hatchery is operated by the Washington Department of Fish and Wildlife (WDFW). It is the core facility of a complex

that includes Coulter Creek Hatchery, Hupp Springs Hatchery, and the Fox Island Net Pens. All WDFW brood-stock collection and egg incubation occurs at Minter Creek Hatchery. Grovers Creek Hatchery, in Miller Bay, is operated by the Suquamish Indian Tribe and is the core facility for their Chinook salmon production. Because of lack of incubation capacity, incubation of Grovers Creek eggs occurs at Minter Creek Hatchery. The majority of Grovers Creek fry are reared and released from the Gorst Creek facility in Sinclair Inlet.

Table 17. Proposed annual releases of Chinook salmon for the East Kitsap region.

Number released (by life stage)					
Fingerling/Fry	**Yearling**	**Brood Lineage**	**Production Type**	**Release Site**	**Sponsor**
2,100,000	150,000	Green River	Isolated harvest	Gorst Creek	Suquamish Tribe
500,000		Green River	Isolated harvest	Grovers Creek	Suquamish Tribe
200,000		Green River	Isolated harvest	Dogfish Creek	Suquamish Tribe
50,000		Green River	Isolated harvest	Clear Creek	Suquamish Tribe
2,850,000	**150,000**	TOTAL			

Suquamish Tribe Chinook Hatchery Program

Objective: To restore and maintain tribal fisheries on the west side of central Puget Sound adjacent to the Kitsap Peninsula

Stock: Grovers Creek (Green River lineage) fall Chinook
This stock was developed for use at Grovers Creek from eye eggs from Finch Creek in 1978 and from Soos Creek and Deschutes stocks in 1979-1981. Since 1982, returns to Grovers Creek have supplied all the brood stock for the program, except when returns have been very low. In those years, WDFW has provided eggs from other South Sound programs.

Production Goals: see Table 17.

Hatchery Strategy: Isolated-harvest

The programs are considered an isolated-harvest production strategy, because no self-sustaining natural populations exist in this area. The hatchery program was situated to avoid terminal harvest that would impact self-sustaining, wild populations. In addition, Grovers Creek spawners returning to the hatchery are protected from terminal harvests. Natural spawning in nearby streams is predominantly from hatchery fish that escaped the fisheries. Coded-wire tag data from returning adults suggest that straying of Grovers Creek Chinook salmon to locations outside of Kitsap Peninsula is very rare.

Operations
Brood stock are taken from Chinook salmon that enter the trap at Grovers Creek Hatchery. Brood stock are chosen throughout the entire spawning run. Eggs are incubated in pathogen-free 10^{o} C ground water in Heath trays or deep matrix boxes. At swim-up fry are moved to indoor circular ponds at Grovers Creek Hatchery for initial feeding. After fry have begun feeding, they are transferred to two outdoor ponds. When fish are 2-3 gm, approximately 400,000 are randomly collected and coded wire tagged. In late April, when Grover Creek salmon reach 90 fish/lb outlet screens to the ponds are removed to allow the fish to migrate at will when they are fully smolted to the estuary, which is approximately 100 yards away at high tide. Remaining fish are fed until 90-95% of the fish have migrated. An additional 200,000 Chinook salmon are tagged with coded wire tags and released from the Gorst Creek rearing ponds as part of a

cooperative study with WDFW on natural rearing. The Suquamish Tribe provides eggs for releases from Dogfish Creek—a natural, small stream rearing area—that is supported by the Mid Sound Fisheries Enhancement Group and that is the focus of a unique watershed restoration project.

Operational Commitments

Suquamish tribal Chinook programs

- The Suquamish Tribe will continue to use local fall Chinook brood stock volunteering to Grovers Creek Hatchery, or (secondarily) Gorst Creek, to affect the Tribe's hatchery programs. The collection of localized hatchery-origin brood stock at these locations will limit direct and incidental take effects on listed Chinook salmon.
- The Tribe will limit, as the management intent, annual production of fall Chinook for on-station release at Grovers Creek Hatchery in May or June to a maximum of 500,000 sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- The Tribe will limit, as the management intent, annual production of fall Chinook for release from the Gorst Creek Rearing Ponds in May or June to a maximum of 2,100,000 sub-yearlings and a maximum of 150,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not preclude, potential future options for the recovery of the listed Chinook ESU.
- The Tribe will limit, as the management intent, annual production of fall Chinook for release from the Websters Rearing Ponds and Channel in May or June to a maximum of 600,000 sub-yearlings and a maximum of 50,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not preclude, potential future options for the recovery of the listed Chinook ESU.
- The Tribe will limit, as the management intent, annual production of fall Chinook for release from the Clear Creek Rearing Ponds in May or June to a maximum of 50,000 sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not preclude, potential future options for the recovery of the listed Chinook ESU.
- The Tribe will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year with the financial support of WDFW to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- The Tribe will continue to apply coded wire tags to a representative proportion of the total annual sub-yearling production contingent and consistent with the support of the U.S./Canada program to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The Tribe will monitor Chinook salmon escapement in the East Kitsap region to estimate the number of fish spawning naturally in the river each year.
- The Tribe will collect mark and tag recovery data during annual spawning ground surveys to estimate the stray rate of hatchery-origin Chinook salmon to natural spawning areas and to estimate the abundance of both hatchery and natural-origin spawners in area streams.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

South Puget Sound Region

This region consists of three major river basins and many smaller independent streams that flow to the Puget Sound. The large rivers include Puyallup, Nisqually, and Deschutes Rivers. Smaller independent streams and creeks flow into Budd, Eld, Totten, Case, Carr and Hammersley Inlets. Chinook salmon historically existed within the Puyallup and Nisqually River basins. Tumwater Falls, a natural geological barrier in Deschutes River, prevented Chinook salmon from using the Deschutes River. Naturally low stream-flows during the summer months and limited spawning and rearing areas for Chinook salmon probably prevented self-sustaining natural production of Chinook salmon in many smaller independent tributaries.

The only indigenous Chinook salmon population remaining in this region is White River spring Chinook salmon. An intensive recovery program, which uses artificial propagation to sustain and rebuild abundance while other factors for decline are corrected, targets this population. Co-managers initiated a hatchery program for White River spring Chinook salmon at the WDFW Minter Creek and Hupp Springs facilities beginning in the late 1970s and also began a captive brood program using saltwater net pens at the NMFS facility in Manchester. As abundance of hatchery-reared fish has increased, juveniles have been reintroduced into the White River.

The remaining spawning aggregations of Chinook salmon consist of late-returning "fall" Chinook salmon of largely Green River hatchery origin. WDFW and the tribes raise and release approximately 18 million of these fish at hatcheries, acclimation sites, or marine net pens throughout South Sound to augment recreational, commercial, and tribal fisheries.

Puyallup and White Rivers

Geography

This region consists of the main stem of the Puyallup River and its tributaries, which make up Water Resource Inventory Area (WRIA) 10. The Puyallup River flows from Klapatche Ridge on the southwestern slopes of Mount Rainier. The basin includes over 728 identified streams and rivers providing 1287 linear miles of drainage. The largest tributaries are the White River and Carbon River. The White River originates from the Emmons Glacier on the NE face of Mount Rainier and is characterized by frequently shifting braided channels, high turbidity and frigid water temperatures. It flows approximately 68 miles from its glacial origin to its confluence with the Puyallup River at Sumner.

Natural Production

The Puyallup River Basin supports two major populations of Chinook salmon: the early-returning White River spring Chinook salmon, which spawn in the upper White River, and a later-returning "fall" Chinook salmon population that spawns in the lower White River, Carbon River, Puyallup River, and associated tributaries.

White River Spring Chinook
This population is genetically the most distinctive stock in central and south Puget Sound (Marshall et al, 1995). It differs from nearby Chinook salmon populations in allozyme frequencies, adult return time, spawn timing, and distribution. It is the last existing early-returning "spring" Chinook salmon population in southern Puget Sound.

An intensive recovery program has been underway since the 1970s to rebuild the native population of White River spring Chinook salmon in the White River watershed (WDF and South Sound Treaty Tribes, 1987) after they nearly went extinct in the wild. The co-managers have developed and implemented an interim recovery plan for this stock (South Sound Spring Chinook Technical Committee, 1996). The recovery efforts have relied heavily on artificial propagation, especially captive brood stock techniques, to prevent extinction and rebuild abundance for reintroduction while other factors for decline are corrected. The trend in recent abundances suggests that numbers of fish are increasing, although it has not been consistent from year to year.

Most natural spawning occurs in the main stem White River upstream of Mud Mountain Dam, and major tributaries such as the Clearwater River, Greenwater River, Huckleberry Creek, Boise Creek and potentially the West Fork White River. Some spawning also occurs in the White River downstream of the water diversion at river mile 24, where later-returning fall Chinook salmon also spawn.

River entry for White River spring Chinook salmon begins in May (Appleby et al, 1996). Fish return to the trap in Buckley from May and continue through early October. Natural spawning starts in late August, peaks in mid to late September, but continues through mid-October. Based on analysis of scales from a small numbers of naturally produced fish, it appears that most juveniles migrate towards the estuary as subyearlings (South Sound Spring Chinook Technical Committee, 1996). This differs from the yearling outmigration strategy that is more common in other spring Chinook salmon populations.

Puyallup fall Chinook
Puyallup fall Chinook salmon spawn naturally throughout the Puyallup basin. Spawning occurs in the mainstem Puyallup River, South Prairie Creek, Carbon River, Wilkeson Creek, Voights Creek, Clarks Creek, and Kapowsin Creek. Fall Chinook salmon also spawn in the White River. Chinook salmon begin spawning in mid-September, peak during early October and continue spawning through the third week in October. Juveniles migrate towards the estuary as subyearlings.

Genetic data, spawn timing, and outmigration strategy for hatchery and natural spawners indicate that Puyallup fall Chinook salmon are genetically similar to Green River Chinook salmon. It is unclear whether a different population of fall spawning Chinook salmon originally occurred in the White River. Genetic data suggest that these fish are currently similar to other Puyallup River fall Chinook. These similarities may reflect historical releases of Green River-origin salmon from Voight's Creek Hatchery in the Puyallup River and introductions of the stock into many areas of the watershed.

Human activities have significantly altered the Puyallup and White River watersheds. Industrial development of the Port of Tacoma has virtually destroyed estuarine and freshwater wetlands in the lower river. Construction of dikes from the White and Puyallup Rivers to Commencement Bay and the subsequent needs for additional bank protection and constant gravel removal because of the altered morphology of the stream have greatly reduced the effective Chinook salmon spawning and rearing habitat. Land uses that impact Chinook salmon in the White River include private and governmental logging, water withdrawal at river mile 24 in Buckley for hydropower generation, and a major flood control dam at river mile 30. Inadequate screens at the hydropower project operated by Puget Power contributed significant losses of juvenile Chinook salmon migrating out of the upper White River, until their replacement until 1996. The Electron Dam at river mile 42 currently blocks 26 miles of anadromous fish habitat, although passage using a fish ladder may soon be possible.

Stock Status

The co-managers considered the status of White River spring Chinook salmon and Puyallup fall Chinook salmon as critical and unknown, respectively, based on trends in overall abundance (WDF et al., 1993). Under the ESA, all naturally produced fish are protected as “threatened.” In addition in the White River, hatchery produced spring Chinook are also listed as ”threatened” because of their importance to recovery. The natural escapement goal for Puyallup River fall Chinook salmon is 3,250, but the actual escapement levels and proportions that are hatchery and natural-origin are largely unknown.

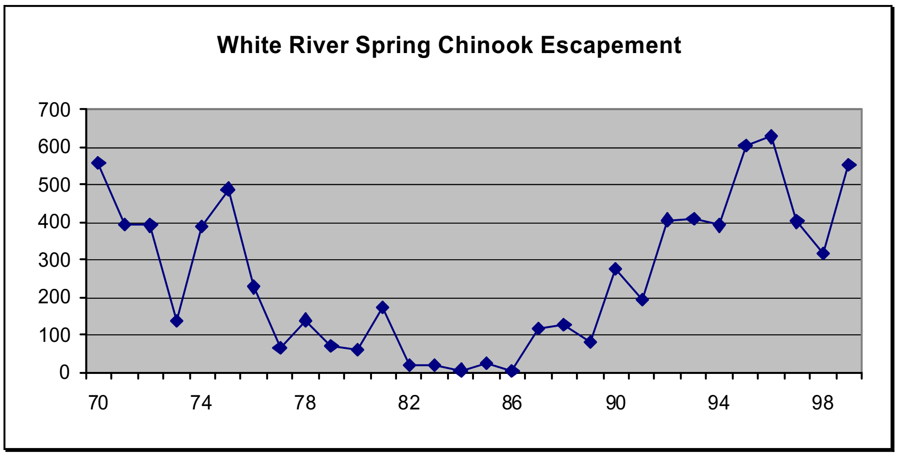

Figure 14. Total annual escapements for White River spring Chinook salmon (1970-2000).

Chinook Hatchery Programs

In this region, WDFW and the tribes operate two programs for Puyallup fall Chinook salmon in the Puyallup River and a third program for White River spring Chinook salmon. Although it is not geographically in this basin, WDFW also operates a fourth program for White River spring Chinook salmon on Minter Creek, an independent stream on the Kitsap Peninsula in the South Puget Sound region.

Table 18. Proposed annual releases of Chinook salmon for the Puyallup River basin.

Fingerling/Fry	Yearling	Brood Lineage	Production strategy	Release Site	Sponsor
Puyallup Fall Chinook					
Number Released (by life stage)					
200,000		Green River	Integrated harvest	Diru Creek	Puyallup Tribe
200,000		Green River	Integrated recovery	Acclimation ponds	Puyallup Tribe
1,600,000		Green River	Integrated harvest	Voights Creek Hatchery	WDFW
10,000		Green River	Integrated harvest	Canyon Falls	RFEG 5
2,010,000			TOTAL		
White River Spring Chinook					
260,000	90,000	White River	Integrated recovery	White River	Muckleshoot Tribe
280,000		White River	Integrated recovery	Huckleberry	Puyallup Tribe
280,000		White River	Integrated recovery	Clearwater	Puyallup Tribe
280,000		White River	Integrated recovery	Cripple Creek	Puyallup Tribe
250,000	85,000	White River	Isolated recovery	Hupp Springs	WDFW
1,350,000	**175,000**		TOTAL		

Puyallup Fall Chinook Programs

Facilities and Program
Two hatcheries focus on raising and releasing fall Chinook salmon in the Puyallup River Basin. WDFW operates the Voights Creek Hatchery, which is located 1.5 miles southeast of Orting on Voights Creek, a tributary of the Carbon River. This facility has the capacity to collect brood stock, incubate eggs, and rear fish. The Puyallup Tribe operates Diru Creek Hatchery. This hatchery is located on a tributary to Clark Creek in the Puyallup River and has only limited incubation and early rearing facilities. Acclimation ponds to support the tribal program are located on Cowskull Creek, Rushingwater Creek and Mowich River.

Objectives
The purpose of the two programs that release fish directly from Voights Creek and Diru Creek hatcheries is to produce fish for harvest in commercial and recreational fisheries in the Puget Sound and NE Pacific Ocean.

The purpose of the fish released from the acclimation ponds in the upper Puyallup River basin is to rebuild natural populations in areas that have been inaccessible to salmon since the construction of the Electron Dam 95 years ago.

Stock: Puyallup River fall Chinook salmon

Production Goals: See Table 18.

Hatchery Strategy: Integrated-harvest (on station releases); Integrated recovery (acclimation pond releases)

Operations
All brood stock are collected and spawned by WDFW at Voights Creek Hatchery. Eggs are incubated at Voights Creek Hatchery until eye-egg stage when 400,000 are transferred to the Puyallup Tribe's Diru Creek Hatchery for rearing and release on-station or in acclimation sites.

The bulk of the rearing and release of fall Chinook salmon done at the Voights Creek Hatchery. Volunteers from the local Region Fishery Enhancement Group also release 10,000 fish from remote site egg incubators at Canyon Falls.

Marking at Voights Creek has been inconsistent until recently when 50% of the juveniles from 1998 brood year were marked, some with coded wire tags. All Chinook salmon released from Diru Creek are currently marked with an adipose clip at the time of release. Fish intended for release in the upper Puyallup River above Electron Dam are also marked with an adipose clip and coded-wire tag and are transferred to ponds in the upper watershed for acclimation, imprinting, and release.

White River Spring Chinook Hatchery Program

Facilities and Programs
The White River Hatchery is operated by the Muckleshoot Tribe and currently focuses on the recovery of White River spring Chinook salmon. It is located at river mile 23 on the White River at the water diversion dam near Buckley, Washington. It has facilities for adult collection, incubation, and rearing. Acclimation ponds operated by the Puyallup Tribe for reintroduction of White River spring Chinook salmon to the wild are located on Huckleberry Creek, Cripple Creek, and Clearwater River. In addition to the tribal programs, WDFW operates a program for White River spring Chinook salmon at the Hupp Springs Hatchery, which is part of the Minter Creek Hatchery complex on Minter Creek, an independent stream on the Kitsap Peninsula. The WDFW program depends on an artificial run of White River spring Chinook salmon that was created in the late 1970s by releasing juveniles from that facility.

Objective: Assist in the recovery of White River Spring Chinook leading to the ultimate goal of increased harvest opportunity.

Stock: White River spring Chinook

Production Goals
Three production strategies are part of the White River hatchery program. The primary program is designed to release 260,000 fingerling-size fish from White River Hatchery. A second strategy is to release 90,000 yearling-age fish. If fish are available, the third program, which is operated by the Puyallup Tribe, focuses on releasing fish from the White River acclimation ponds. The targets for this program are 280,000 juveniles at each of three acclimation sites (Table 18).

Hatchery Strategy: Integrated recovery.

Operations
The co-managers collect brood stock at both the White River Hatchery and the Hupp Springs Hatchery. Both programs take all available eggs from tagged (hatchery) fish for spawning and rearing. Spawning is pairwise to minimize loss of genetic variation. If more than 350,000 juveniles are raised at each facility from a brood year, excess juveniles are are transferred at 200 fish per pound to the acclimation ponds in the upper White River and released at when they are 75 fish per pound to rebuild the run to this habitat (South Sound Spring Chinook Technical Committee, 1996). From the 1977 through 1993 broods, a portion of White River spring Chinook were also raised for their entire life cycle in net pens to ensure that brood stock would be available to perpetuate the run.

All of the core program releases are coded-wire tagged. Acclimation pond releases are fin clipped. Unmarked adults returning to either the White River Hatchery or the Buckley Trap are captured and released above Mud Mountain Dam for natural spawning.

Operational Commitments

White River Spring Chinook program at Minter Creek and Hupp Springs Hatcheries

- WDFW will continue to use gametes procured from White River spring Chinook salmon adults volunteering to the Minter Creek Hatchery or the White River trapping locations to affect this program.
- WDFW will limit, as the management intent, annual production of spring Chinook for on-station release at Hupp Springs Hatchery to a total, maximum of 250,000 fingerlings or sub-yearlings and 85,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the spring Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling spring Chinook production at Hupp Springs Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW and the tribes should evaluate the necessity for continuing the conservation program unless this program is demonstrated to be critical to the conservation effort on the White River spring Chinook. If the conservation program continues, protocols should be implemented to reduce domestication and minimize genetic changes resulting from artificial propagation.

White River Hatchery Component

- WDFW, Muckleshoot and the Puyallup tribes will continue to monitor escapement and assess potential straying and/or integration of other stocks into the spring Chinook program.
- Muckleshoot Indian Tribe (MIT) will continue to use gametes procured from marked spring Chinook adults captured at the White River trapping locations or from Minter Creek Hatchery. This will minimize the risk of inadvertently incorporating fall Chinook into the recovery program.
- MIT will coordinate with the Puyallup Tribe, WDFW and NMFS to develop brood stock protocols that lead to the incorporation of natural-origin recruit spring Chinook, with first generation hatchery-origin fish, into the brood stock collected for the White River program. This measure needs to address domestication rate concerns associated with the continued, long-term artificial propagation of the population, and to allow for consideration of appropriate strategies necessary to retain unique genetic characteristic of the spring Chinook stock. Consensus protocols should be in place for the program by return year 2004, if the program is still in operation.
- MIT will limit the annual production of spring Chinook for on-station release to not more than 260,000 fingerlings and 90,000 yearlings.
- MIT will apply hatchery management practices and risk adverse protocols that minimize

the likelihood for injury or mortality to spring Chinook under propagation due to facility failure and vandalism.

- MIT will tag or mark all spring Chinook juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns, and to maintain separation during hatchery spawning between the spring and fall Chinook stocks. Marks and/or tags applied should also allow for the differentiation of first generation acclimation pond-origin fish from spring Chinook released directly into the White River.
- MIT will help monitor salmon escapement to the White River adult trapping sites to estimate the number of marked and unmarked fish escaping into the river each year to assess the success of restoration objectives.
- The Puyallup Tribe will continue to use gametes procured from marked spring Chinook salmon adults captured at the White River trapping locations or at Minter Creek hatchery, or that were spawned from captive White River spring Chinook broodstock.
- The Puyallup Tribe will limit, as the management intent, annual production of spring Chinook for release from the three acclimation sites to a total, maximum of 830,000 fingerlings or sub-yearlings. The Puyallup Tribe will use hatchery management practices that minimize the likelihood for injury or mortality to spring Chinook under propagation due to facility failure and vandalism.
- The Puyallup Tribe will apply an identifiable mark to a representative proportion of the spring Chinook salmon juveniles released through the hatchery program each year to allow monitoring and evaluation of juvenile out-migrants and adult returns.
- The Co-managers will continue the current monitoring program in the White River Basin to estimate the number of fish spawning naturally in the river each year. This monitoring activity will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives.
- The Co-managers will collect mark recovery data during annual spawning ground surveys to estimate the contribution rate of acclimation pond-origin Chinook salmon to natural spawning areas and estimate proportions of hatchery and natural-origin spawners in the Basin.

<u>Puyallup River: (Voight Creek, Diru Creek</u>): The Puyallup River is considered a Category 2 watershed since sustainable natural populations of Chinook once existed. However, Chinook spawning naturally are now of Green River origin.

The major direction is to reestablish self-sustaining summer/fall Chinook production in Puyallup River. This must include: 1) completing any additional genetic analysis regarding the potential for native fish presence (in this case South Prairie Creek); 2) marking hatchery fish to determine stray rate and natural production potential; 3) determining production potential for natural stocks in the Puyallup River; and 4) reviewing hatchery programs to determine role in natural stock management and implement modified hatchery strategies that will support reestablishment of a self-sustaining population. The specific strategy has not been identified since there are a number of unknowns that must be reconciled before implementation.

<u>Voights Creek Hatchery fall Chinook</u>

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Voights Creek Hatchery to affect this program. The collection of localized hatchery-origin broodstock at this location will limit direct and incidental take effects on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Voights Creek Hatchery to a total, maximum of 1,600,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Voights Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the Puyallup River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each year. This monitoring will allow for assessment of the status of the target population. WDFW will repair the intake screens at Voights Creek hatchery to appropriate standards.
- WDFW will continue to collect and analyze genetic data from the hatchery and naturally spawning populations.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Diru Creek Hatchery fall Chinook

- The Tribe will continue to use gametes procured from fall Chinook salmon adults volunteering to Voights Creek Hatchery for the tribal hatchery programs.
- The Tribe will limit, as the management intent, annual production of fall Chinook for on-station release at Diru Creek Hatchery in May or June to a maximum of 200,000 sub-yearlings. Releases from the three upper Puyallup River acclimation sites will be limited to a total, maximum of 200,000 sub-yearlings.
- The Tribe will, as a management intent, apply an identifiable mark to 100 % of the fall Chinook salmon sub-yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- The Tribe will apply coded wire tags to a representative proportion of the total annual sub-yearling production to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The Tribe will monitor Chinook salmon escapement in the Puyallup River Basin to estimate the number of fish spawning naturally in the river each year
- The Tribe will coordinate with WDFW to collect genetic samples from naturally spawning Chinook salmon in the Basin.
- The Tribe will collect mark and tag recovery data during annual spawning ground surveys to estimate the stray rate of hatchery-origin Chinook salmon to natural spawning areas and estimate the abundance of both hatchery and natural-origin spawners in the Basin.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Nisqually River

Geography

This basin includes the Nisqually River drainage and McAllister Creek, a short stream that flows independently into the Puget Sound. The basin, which is in Water Resource Inventory Area (WRIA) 11, has approximately 715 linear miles of river and tributary streams. The Nisqually River is the principal drainage. It originates from the Nisqually Glacier on Mount Rainier and flows 72 miles to the Puget Sound. Compared to other Puget Sound rivers, the Nisqually River is predominantly a main stem river without extensive tributaries. The upper 30 miles of main stem habitat and 300 miles of tributary habitat have numerous cascades and rapids with pool and riffle sections characteristic of Cascade salmon streams. This area is now inaccessible to anadromous salmon because of the construction of the Alder and LaGrande dams built for hydroelectric power generation by the City of Tacoma. Below the Alder-LaGrande Dam complex the river gradient lessens and salmon habitat consists of extensive deep riffles, glides, and pools. At river mile 25, a fish ladder provides passage over a dam that diverts water through the Yelm Power Canal, which empties back into the river near river mile 11. Below the Alder-LaGrande Dam complex, the Mashel River, which is 20 miles long and has an additional 67 linear miles of tributary streams, provides the largest amount of tributary salmon habitat. Numerous small, low gradient spring-fed tributaries also enter the Nisqually River below the LaGrande Dam. McAllister Creek is an independent low gradient, spring-fed stream that flows 6 miles to the Nisqually River delta.

Natural Production

The Nisqually River historically supported strong native populations of Chinook salmon. These may have included early-returning and late-returning runs. The combination of dam building, high harvest rates, loss of important marine habitat and introduction of hatchery fish from outside of the basin during the last century led to replacement of the native runs by fall Chinook salmon of mixed origin. Natural spawning currently occurs throughout the main stem up to river mile 40 and in the Mashel River and Ohop Creek. Natural spawning abundance is difficult to assess, because of glacial turbidity of the river prevents visual observations of spawning fish or redds. McAllister Creek has probably never supported a self-sustaining population of Chinook salmon because its spawning habitat was too small.

Genetic data suggest that fall Chinook salmon returning to the Nisqually River are primarily Green River hatchery lineage, although hatchery records indicate that at least nine different Puget Sound hatchery stocks have been used in the system. The earliest recorded releases occurred in 1943. The total number of releases since then has exceeded 65 million fish. From 1975 to 1990 over 71% of these fish were released into different parts of the river away from the hatchery facilities.

Stock Status

The co-managers considered the integrated hatchery-wild population as healthy (WDF et al., 1993). The status of natural production in the Nisqually River is unknown. All naturally produced fish in the Nisqually River are protected under the ESA as threatened species.

Chinook Hatchery Programs

Facilities and Programs
The Nisqually Tribe operates two facilities on the Nisqually River. Clear Creek Hatchery is located on a right bank tributary at river mile 6 and Kalama Creek Hatchery is located on left bank tributary at river mile 9. Both facilities have the capacity to collect, spawn, incubate and rear fish. WDFW's McAllister Creek hatchery has recently been closed.

Table 19. Proposed annual releases of Chinook salmon in the Nisqually River basin.

Number Released (by life stage) Fingerling/Fry	Yearling	Brood Lineage	Production strategy	Release Site	Sponsor
	0 (200,000)	Green River	Integrated harvest	McAllister Creek	WDFW
3,500,000		Green River	Integrated harvest	Clear Creek Hatchery	Nisqually Tribe
500,000		Green River	Integrated harvest	Kalama Creek	Nisqually Tribe
0 (1,000,000)	0 (250,000)	Green River	Integrated harvest	McAllister Creek Hatchery	WDFW
4,000,000	**0**		TOTAL		

Objectives: The purpose of the Nisqually tribal programs is to produce fish for tribal, commercial, and recreational harvest and to support long-term natural production objectives.

Stock: Nisqually River fall Chinook salmon.

Production Goals: The goals are to release 4.0 million fingerling Chinook salmon from tribal facilities (Table 19).

Production Strategy: Integrated harvest.

Operations: The Nisqually Tribe collects and spawns fall Chinook salmon entering the adult collection ponds at Clear Creek and Kalama Creek hatcheries. No natural broodstock is purposely collected and the likelihood of natural origin recruits straying into the hatchery creeks is low. Hatchery broodstock is collected to represent the entire run returning to the facilities and fertilization takes place using a modified factorial mating strategy to maximize the genetic diversity of the hatchery stock. Migrant zero-age smolts are released from both facilities in a full volitional release during May and June.

Operational Commitments

The Nisqually River is a Category 2 watershed. No known indigenous stock of Chinook salmon remains in the Nisqually River. However, further evaluation is underway to determine final status. The management objective is to recover self-sustaining summer/fall Chinook production in Nisqually River. This will include: 1) completing any additional genetic analysis regarding the potential for native fish presence; 2) marking hatchery fish to determine stray rate and natural production potential; 3) testing potential of natural production in Nisqually River; 4) reviewing hatchery programs in determining role in natural stock management; and 5) implementing necessary hatchery strategies that will support re-establishment of a self-sustaining population.

<u>McAllister:</u> The hatchery was closed in 2002 based on concerns related to fish survival, population diversity, domestication, (HSRG recommendation February 2002) and budgetary considerations.

Nisqually (Clear Creek, Kalama Creek hatcheries): The Nisqually Hatchery stock is derived from Green River hatchery stocks that have had a long history of culture. The proportion of natural-origin spawners in the river is small relative to the hatchery component. Few, if any, natural-origin spawners are included in the brood stock. Brood stock is collected from fish that swim into the ladders at Clear Creek and Kalama Creek Hatcheries. Because hatchery fish are unmarked, incidental take of natural-origin spawners may occur. The composite population size is large and over 3000 fish are spawned each year.

Nisqually tribal Chinook programs

- The Tribe will use local Chinook brood stock volunteering to the Clear Creek or Kalama Creek hatchery traps to affect the Tribe's hatchery programs. Collection of brood stock at the hatchery traps will limit direct and incidental take effects on listed Chinook salmon.
- The Tribe will monitor and document the incidence of stray listed Chinook salmon encountered during fall Chinook adult capture activities at the hatcheries. Monitoring will allow for the estimation of listed fish take levels attributable to the brood stock collection operations.
- The Tribe will limit, as the current management intent, annual production of fall Chinook for on-station release in May or June from Clear Creek Hatchery to a maximum of 3,000,000 sub-yearlings, and to a maximum of 1,000,000 sub-yearlings from Kalama Creek Hatchery. Limiting juvenile production to current levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- The Tribe and WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings released from the hatchery each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- The Tribe will apply coded-wire tags to a representative proportion of the total annual sub-yearling production to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The Tribe will monitor Chinook salmon escapement in the Nisqually River Basin to estimate the number of fish spawning naturally in the river each year.
- The Tribe and WDFW will collect genetic samples from naturally spawning Chinook salmon in the mainstem Nisqually River and its tributaries.
- The Tribe will coordinate with WDFW and NMFS to complete a genetic analysis, based on samples collected from naturally spawning Chinook salmon in the Nisqually Basin that will improve scientific understanding regarding the presence and status of any remnant native stock.
- The Tribe will collect mark and tag recovery data during annual spawning ground surveys to estimate the stray rate of hatchery-origin Chinook salmon to natural spawning areas and the abundance of both hatchery and natural-origin spawners in the Basin. This information will improve knowledge regarding the natural production potential and levels in the Basin.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Deschutes River and Independent Tributaries

Geography

This area includes the Deschutes River and the many small, lowland tributaries of the southern Puget Sound. Although biogeographically, the Nisqually River is the dominant river of the southern end of the Puget Sound, we are treating these streams separately because they historically did not support self-sustaining natural populations of Chinook salmon but many currently have spawners supported artificially by hatchery production.

The Deschutes River is the largest of these streams. It flows nearly 50 miles from its origin in the foothills of the Cascades, providing over 256 linear miles of drainage, before emptying into the Puget Sound at Capitol Lake. Prior to 1954, a series of natural waterfalls (Tumwater Falls), located near the mouth of the Deschutes River between R.M. 1.0 and 1.25 (80 foot gradient) prevented access of Chinook salmon and other anadromous fishes to upstream areas. In 1954, the Washington Department of Fisheries (WDF) completed three fish ladders, circumventing the falls. The majority of tributaries in south Puget Sound are smaller independent systems. At least 28 of these are used by one or more species of salmon. Most of these are short, low or moderate gradient streams originating from natural springs, ground water runoff, swampy beaver ponds or lakes that drain into small estuarine inlets and bays, creating rich production areas for the invertebrates and fish on which salmon prey.

Natural Production

Historically, no self-sustaining Chinook salmon populations existed in these streams. Tumwater Falls prevented access to potential suitable habitat in the Deschutes River. Passage of Chinook salmon above the falls, which has been haphazard, may have resulted in natural production, but the extent of it is unknown. Self-sustaining Chinook populations in small, independent watersheds were unlikely to have existed, because of low flows and lack of suitable spawning habitat. Historical production from these streams may have depended on adequate numbers of straying adults from the Deschutes or Puyallup rivers. Current natural production from these areas derives from strays of thousands hatchery produced juveniles released in many locations. Production of aquatic invertebrates and mixing of fresh and saltwater in these rich areas provides excellent rearing habitat for juvenile Chinook salmon. The contribution of this natural production to the total number of adults returning to the southern Puget Sound is unknown.

Stock Status

No known historical or extant self-sustaining populations of Chinook salmon use this area.

Chinook Hatchery Programs

WDFW collects brood stock, sets production goals, and rears and releases Chinook salmon at different facilities throughout this area. Hatchery management gives brood stocks the name of the facility where they were collected. These different locations, production goals, and brood stock names may create the impression that these are different programs, but they are actually part of a single, but complex arrangement to produce Chinook salmon for harvest in the southern end of the Puget Sound. We consider these a single program because all these programs are based on the same isolated-harvest production strategy, fish may be transferred between facilities for rearing at different life stages, and different facilities often rely on other facilities for eggs if too few eggs are otherwise available.

Facilities and Programs

WDFW uses at least seven different facilities in three different complexes of hatcheries to collect, raise, rear or release Chinook salmon in this area. These include Tumwater Falls Holding Ponds and Trap, Percival Cove net pens, Chambers Creek, Hupp Springs Hatchery, Minter Creek Hatchery, Coulter Creek Hatchery and Garrison Springs Hatchery. South Sound and Fox Island net pens Chinook programs have recently been terminated and WDFW's McAllister Creek Hatchery has recently been closed.

South Puget Sound Complex

Facilities in the South Puget Sound complex are located near the southern terminus of the Puget Sound where the Deschutes River flows into Capitol Lake. Facilities that raise Chinook salmon in this complex are Tumwater Falls Holding Pond and Trap, Percival Cove and Capitol Lake. The Tumwater Falls Holding Ponds and Trap is located at the top of the third fishway at Tumwater Falls Park. Spawning and rearing take place at this facility, but it lacks incubation facilities so incubation takes place at other facilities. Percival Cove freshwater net pens are located adjacent on Capitol Lake in a cove formed by the backwaters of Percival Creek as it enters the lake. It has been used to rear and release Chinook salmon since 1971, but water quality has deteriorated with increasing amounts of urban and agricultural runoff, nutrient loads, and silt into Percival Creek and the Deschutes River. When too few brood stock are collected at Tumwater Falls, returning adults are seined at Percival Cove. The southern basin of Capitol Lake has been used as a natural rearing area where fingerlings are planted during the spring and fed until they choose to emigrate to the estuary.

Lakewood Complex

These hatcheries are located on or near Chambers Creek, a small stream that flows into Chambers Bay between the Puyallup River and Nisqually River in Water Resource Inventory Area (WRIA) 11. Facilities in this complex that produce Chinook salmon include Garrison Springs Hatchery, Chambers Creek Hatchery, and Lakewood Hatchery. An adult trap facility is located at the mouth of Chambers Creek. Garrison Springs Hatchery serves as an intermittent rearing facility for different rearing programs, which either lack rearing space or that need to take advantage of warmer water conditions. The annual release goal for this facility is 820,000 fingerlings. In addition, yearling Chinook salmon raised at South Tacoma Hatchery (200,000), and Chambers Creek Hatchery (100,000) are released at Chambers Creek into Chambers Bay.

Minter Creek Complex

These hatcheries are located in the northwest part of the southern Puget Sound region on or near the Kitsap Peninsula and Case and Carr inlets. Facilities in this complex that produce Chinook salmon include Minter Creek Hatchery, Coulter Creek Hatchery, and Hupp Springs Hatchery. Minter Creek and Hupp Springs Hatcheries are located on Minter Creek, a small, lowland stream on the Kitsap Peninsula that flows into Carr Inlet. Originally established as a research station in 1937, Minter Creek Hatchery was switched to a production hatchery in the 1960s. In addition to producing 1.8 million fingerling fall Chinook salmon for release into Minter Creek, the hatchery also rears fall Chinook salmon for release by volunteer enhancement groups at different locations throughout the South Sound. Hupp Springs Hatchery, which is used primarily for White River spring Chinook salmon, is described in more detail in the Puyallup and White Rivers section of this document. Coulter Creek Hatchery is located on Coulter Creek, a small, lowland stream that flows into the head of Case Inlet. Coulter Creek Hatchery has no incubation facilities and currently does not release Chinook but is used to support the Tumwater Falls program. Previous production was 1.0 million.

Objectives: The purpose of the WDFW programs is to produce fish for tribal, commercial, and recreational harvest.

Stock: All hatchery fish are of Green River lineage. The usual hatchery management practice is to identify different hatchery “stocks” by where the adults were collected. Genetically, these are the same group.

Production Goals: See Table 20.

Table 20. Proposed annual releases of Chinook salmon from facilities associated with the Deschutes River and independent streams in southern Puget Sound. Numbers in parentheses show previous release goals.

Fingerling/Fry	Yearling	Brood Lineage	Production Type	Release Site	Sponsor
820,000	300,000	Green River	Isolated harvest	Chambers Bay	WDFW
3,800,000	250,000	Green River	Isolated harvest	Capitol Lake	WDFW
	0 (145,000)	Green River	Isolated harvest	South Sound Net Pens	WDFW
	0 (240,000)	Green River	Isolated harvest	Fox Island Net Pens	WDFW
0 (1,000,000)		Green River	Isolated harvest	Coulter Creek	WDFW
10,000		Green River	Isolated harvest	Case Inlet	RFEG 5
10,000		Green River	Isolated harvest	Henderson Inlet	RFEG 5
15,000		Green River	Isolated harvest	Rosedale Pond	RFEG 5
1,800,000	0 (50,000)	Green River	Isolated harvest	Minter Creek	WDFW
6,455,000	**550,000**		TOTAL		

Hatchery Strategy: Programs in this region are based on an isolated harvest strategy. It is considered an isolated harvest strategy because they occur in areas where no self-sustaining natural populations have existed, which minimizes genetic interactions with natural populations. The effectiveness of this strategy for release sites near the Puyallup and Nisqually Rivers is unknown.

Operations

Tumwater Falls: The program started in 1953 with fingerling releases of Green River Hatchery-origin fingerlings. The yearling program started in 1988. Since 1992, only adult returns to the Tumwater Falls Hatchery have been used for the fingerling and yearling program. Broodstock are collected at two locations: a trap at Percival Cove to capture all Chinook entering Percival Creek and a fish ladder that bypasses Tumwater Falls on the Deschutes River leading fish to two holding ponds. There are no incubation facilities at Tumwater Falls so all eggs are transferred to other stations for hatching and early rearing.

Subyearling program at Tumwater Falls

Collection and spawning of approximately 2,390 adults needed for the fingerling release of 3,800,000 takes place between August and the end of October. Eggs are incubated and hatched at Minter Creek Hatchery. There are no incubation facilities at Tumwater Falls. Rearing, prior to transfer to the Tumwater Falls facility, takes place at Coulter Creek and Wallace River hatcheries. At the Tumwater Falls complex, 500,000 fingerlings are reared at the Percival Cove net pen and the remainder of the fish are transferred to the Tumwater Falls ponds in groups of 350,000 per pond. They are acclimated from 7-14 days, released at approximately 100 fish per pound (fpp), and then another group of 350,000 is brought in. This process takes place between April 1 and June 1.

Yearling program at Percival Cove

The yearling program began with a release of Deschutes (Tumwater falls returns) stock in 1988. Since 1992, only adult returns to the Tumwater Falls trap have been used for the yearling program. Broodstock are collected at two locations: a trap at Percival Cove to capture all Chinook entering Percival Creek and a fish ladder that bypasses Tumwater Falls leads fish to two holding ponds. Collection and spawning of approximately 110 adults needed for the yearling release of 200,000 takes place between August and the end of October. After eggs are eyed-up at the Minter Creek Hatchery, they are shipped to the McKernan Hatchery for hatching and early rearing. The fish then are transferred to the Percival Cove net pen where they are reared and released in April at 8 fish per pound (fpp).

WDFW continues to mass mark 100% of the fall Chinook in this program to allow for monitoring and evaluation of this hatchery operation. Also, a portion of the fingerling and yearling programs will have coded-wire tags applied to allow for evaluation of fishery contribution, survival rates and straying levels to other Puget Sound watersheds

Minter Creek: The facility started operations in the 1950s with the stock originating from Soos Creek near Auburn, Washington. Broodstock Chinook (1,400 adults) are trapped between August and the end of September with spawning taking place during September and October. The combined egg take goal for the facility is approximately 2.5 million eggs which includes 2.0 million eggs for the Minter Creek program (1.8 million on-station release), 200,000 for the Gorst Creek yearling program and 80,000 for the educational/enhancement co-op projects. In addition, 60,000 unfed fry are needed by the National Marine Fisheries Service (NMFS) at their Manchester Lab facility (they are not released). Eggs are incubated mostly with well water in Heath trays at a temperature of 49° F. Fry are placed in ponds in late December through January and reared to May for an on-station release at 80 fish per pound (fpp). WDFW continues to mass mark the on-station release.

Chambers Creek: The Chambers Creek program consists of yearling releases of fall Chinook at the Lakewood (200,000) and Chambers Creek (100,000) facilities. Releases at Lakewood began in May of 1999 and at Chambers Creek in April of 1998. The egg requirements for the above facilities are taken from the Garrison Springs fall Chinook egg take goal of 1,350,000. No adult collection or incubation takes place at the Lakewood or Chambers Creek Hatcheries. Fry are transferred from Garrison Springs to the two facilities and reared on spring and well water at temperatures ranging between 52 and 58° F. Fish are released at six fish per pound (fpp) between April and May. WDFW continues to mass mark (adipose fin clip only) 100% of the fall Chinook yearlings.

Garrison Springs: The program began in 1976 with the predominate stock(s) to support it originally coming from the South Sound (e.g., Minter Creek, Soos Creek, Voights Creek, Deschutes River and Garrison Springs). From 1990 to the present, the stock used is the adults returning to the Chambers Creek trap. To cover the program's egg take goal of 1,350,000, 870 adults are needed. This includes the yearling program at the Chambers Creek and Lakewood hatcheries. Broodstock are collected and spawned between the months of August and October. Eggs are eyed-up at Garrison Springs using freestyle (barrels) and vertical Heath incubators. For final incubation to hatching, vertical incubators are used. Fry are placed in ponds between mid-

December and the end of January. They are reared to April/May then are transferred and released at 50 fish per pound (fpp) at two sites: 600,000 at the Chambers Creek trap (RM 0.5); and 250,000 planted into Lake Steilacoom (RM 5.5) where they can rear and migrate out on their own. Since Garrison Springs has no release outlet to Chambers Creek it is necessary to transfer fish to the above locations for release. WDFW continues to mass mark 100% of the fingerling program. It will also apply coded-wire tags to a portion of the fingerling program to allow for evaluation of fishery contribution, survival rates and straying levels to other Puget Sound watersheds.

Operational Commitments

These watersheds are, in general, small independent steams, with the exception of Deschutes River, the largest tributary in the system. No historical evidence exists that these watersheds supported sustainable Chinook populations. In particular, an impassable falls near the mouth of the Deschutes River prevented the natural establishment of any anadromous species. Therefore, watersheds within this region will not undergo recovery efforts. Rather, the Deschutes River and the many independent tributaries will be managed for maximizing anadromous and resident fish production of all species that utilize the habitat. There will be no attempt to limit or segregate hatchery or wild fish in these circumstances. The primary concern within these watersheds is to protect and, where appropriate, improve habitat for fish production. However, there is also the need to review hatchery releases to determine hatchery/wild interactions in other Puget Sound watersheds where natural production is a primary concern.

Minter Creek Hatchery fall Chinook

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Minter Creek Hatchery to affect this program. The intent is to collect localized hatchery-origin broodstock at this location. WDFW should reverse, over time, the problem of progressively earlier run timing in the fall Chinook stock to avoid compromising its ability to contribute to harvest and to achieve a better separation between the timing of the fall Chinook and the spring Chinook. (HSRG Recommendation, February 2002)
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Minter Creek Hatchery to a total, maximum of 1,800,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Minter Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Garrison Springs Hatchery Fall Chinook Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Chambers Creek Trap to affect this program. The intent is to collect localized hatchery-origin broodstock at this location. (HSRG Recommendation, February 2002)
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Garrison Springs Hatchery to a total, maximum of 850,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU. The program size should also mesh with the facilities available to minimize the need for periodic fish transfers between facilities. (HSRG Recommendation, February 2002) WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Garrison Springs Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds. (HSRG Recommendation, February, 2002)
- The HSRG has recommended that WDFW develop a facility, in the lower Chambers Creek basin, to improve acclimation, rearing and release options for the fingerling and yearling programs. (HSRG Recommendation, February 2002)
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Chambers Creek Hatchery Fall Chinook Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Chambers Creek Trap to affect this program. The intent is to collect localized hatchery-origin broodstock at this location. (HSRG Recommendation, February, 2002)
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Chambers Creek Hatchery to a total, maximum of 300,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU. The program size should also mesh with the facilities available to minimize the need for periodic fish transfers between facilities. (HSRG Recommendation, February 2002)
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to the yearling fall Chinook production at Chambers Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds. (HSRG Recommendation, February 2002)
- The HSRG has recommended that WDFW develop a facility, in the lower Chambers Creek basin, to improve acclimation, rearing and release options for the fingerling and yearling programs. (HSRG Recommendation, February 2002)

- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Tumwater Falls fall Chinook program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Tumwater Falls Hatchery to affect this program. The intent is to collect localized hatchery-origin broodstock at this location.
- WDFW and the Squaxin Tribe will reach agreement as to whether or not to continue an experiment to test the relative reproductivity of hatchery fish spawning in the wild by passing excess adult fall Chinook upstream and allowing them to spawn naturally. The HSRG has recommended that WDFW obtain a memorandum of understanding (MOU) from NMFS addressing the potential Endangered Species Act status of Chinook spawning naturally above Tumwater Falls.
- WDFW should develop long-term plans for rearing and release facilities that eliminate the need for net pen rearing and out-of-basin transfers. (HSRG Recommendation, February, 2002) This will require investment in new facilities in the Deschutes River basin. WDFW concurs and has implemented a phased scoping and design study to identify options and capital costs to implement this recommendation. In the interim, Chinook rearing has been initiated at Coulter Creek, to reduce the number of Chinook started at the Wallace River hatchery.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Tumwater Falls Hatchery to a total, maximum of 3,800,000 fingerlings or sub-yearlings and 250,000 yearlings (Percival Cove Net Pens). Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, apply an identifiable mark to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Tumwater Falls Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The above research and monitoring will be regularly evaluated by the co-managers with the intent of adjusting as appropriate the HGMPs consistent with stock recovery and fishing objectives.

Fox Island Net Pen and South Sound Net Pen Fall Chinook Program

- WDFW will eliminate this program to assure that the genetic integrity of the Puyallup, White, and Nisqually stocks is not compromised. (These programs have been eliminated).

Hood Canal Region

Geography

The enclosed waters of Hood Canal form a natural geographic unit. The slow mixing of cold marine waters in the deep canal with warmer, shallow bays and shelves with large amounts of freshwater from streams draining the Kitsap Peninsula and the Olympic Mountains creates a rich, diverse environment for fish and shellfish. On the eastern side of Hood Canal, lowland streams with moderate gradients flow into Hood Canal from natural springs, ground water runoff, swampy beaver ponds or lakes. The Union, Dewatto, and Tahuya Rivers, which are part of Water Resource Inventory Area (WRIA) 15, are the largest of these. Together they provide approximately 130 miles of stream. On the western side of Hood Canal, major watersheds include the Skokomish, Hamma Hamma, Duckabush, Dosewallips, and Quilcene Rivers. These rivers, which comprise WRIA 16 and 17, drain the slopes of the Olympic Mountains and are steep with cascades or waterfalls that limit access of anadromous fish.

The Skokomish River, the largest of these rivers, provides 340 miles of stream drainage. Its two large branches, the North Fork and South Fork, flow for 33 and 28 miles, respectively, from the southern Olympic Mountains where they converge to form nine miles of main stem river before entering the Hood Canal through a large delta. The upper sections of the two branches drop steeply before they lessen to more moderate gradients and finally spill through deep canyons to the valley floor. The South Fork has waterfalls that are impassable to fish at river mile 21. The North Fork is inaccessible above lower Cushman Dam. The North Fork also had a natural lake (Lake Cushman), which expanded when the North Fork was dammed for hydroelectric power generation. Currently most of the flow of the North Fork is diverted through a tunnel at Lower Cushman Dam and discharged directly into Hood Canal.

The Hamma Hamma River has 18 miles of mainstem and 93 total miles of stream drainage. Most of the river is steep and cascades and a large waterfall between river miles 2-3 prevent migration of salmon farther upstream. To the north, the Duckabush River drops through mountainous, undeveloped terrain of the Olympic National Park for 24 miles. Like the Hamma Hamma River, most of the river is steep. Waterfalls block upstream migration of anadromous fish at river mile 7, although cascades 2-3 miles lower down may prevent migration of some species and partially restrict others. The Dosewallips River is narrow and steep as it falls 28 miles from its origins in Olympic National Park. Anadromous fish can move through 22 miles of the mainstem, but canyon walls and waterfalls block access to most tributaries.

The Big Quilcene and Little Quilcene Rivers are the main drainages into the northwestern Hood Canal. Like the other rivers on this side of Hood Canal, these rivers arise in the Olympic Mountains and tumble through rugged, steep-walled valleys before their gradients lessen and the valleys broaden out. The Big Quilcene is accessible to anadromous fish for nine of its 19 miles and the Little Quilcene is accessible for seven of its 12 miles.

Natural Production

In Hood Canal, most natural Chinook spawning occurs in the Skokomish River. Smaller spawning aggregations occur in the Hamma Hamma, Dosewallips, Duckabush, and Quilcene Rivers. Small numbers of Chinook spawners have occasionally been observed in the Union, Dewatto and Tahuya Rivers also. Except for the Skokomish River, it is unknown whether these smaller streams historically supported self-sustaining populations of Chinook salmon. Indigenous populations have largely disappeared from Hood Canal because of high harvest rates, loss of spawning habitat, and releases of Green River lineage hatchery fish. Many of the fish spawning in these smaller rivers may have originated from hatcheries, but few data exist on the proportions of hatchery and wild fish. In eastern Hood Canal streams especially, the habitat is not characteristic of streams where sustainable Chinook salmon populations usually exist.

The Skokomish River supported diverse runs of spring Chinook salmon. Early-returning "spring" run salmon used the South Fork until the 1950s, when abundances declined. Later-returning Chinook salmon continue to use the first 5 miles of the South Fork and 13 miles of the North Fork when flows and habitat are suitable. Currently, these adults spawn from mid-September through October and juveniles generally migrate to the estuary during the spring and early summer of their first year of life as fingerlings (Lestelle and Weller, 1994). In addition, a small, self-sustaining population of resident Chinook salmon exists in Lake Cushman, upstream of the dams. Adults, which have spent their entire life in freshwater, migrate upstream of the lake into the North Fork and spawn between river mile 28-30 during November. The origin of this population is unknown. They may represent a unique, but fortuitous, adaptation to ancient Lake Cushman that was present before the impoundment, or they may be the results of recent introductions into the lake (Kolb and Tweit, pers. comm.,1993; Tweit, pers. comm., 1993). Genetic analyses only show that the population has low genetic variability (Marshall, pers. Comm.,1995), which suggests that it had persistently low abundance or started from a small number of founders.

Stock Status

The co-managers considered the status of the composite Hood Canal Chinook salmon hatchery-wild aggregation as healthy based on the stable returns to the Skokomish River, although the escapement has not consistently achieved the goal of 1650 fish to that river (Figure 15). For the purposes of the review, the co-managers aggregated geographically distinct groups of spawners because of the belief that indigenous populations had disappeared or were genetically mixed with Green River lineage hatchery fish. Although the co-managers did not identify discrete stocks of Chinook salmon within Hood Canal, but they did recognize that returns to smaller river systems were depressed. They noted that if the indigenous spring run continues to occur in the South Fork, "it is at very low abundance" (WDFW and WWTIT, 1994). The co-managers have not yet described the status of the resident population in Lake Cushman. Under the ESA, all naturally produced fish all protected as "threatened," including the resident population in Lake Cushman.

Chinook Hatchery Programs

Facilities and Programs
The State and tribes have operated five facilities for Chinook salmon in the Hood Canal region. In addition, Long Live The Kings (a private group) and the University of Washington operate small facilities for Chinook salmon conservation and research. George Adams Hatchery is a WDFW facility located on Purdy Creek, a tributary of the Skokomish River. Hoodsport Hatchery (sometimes called Hood Canal Hatchery) is a WDFW facility located in the town of Hoodsport at Finch Creek, an independent tributary to Hood Canal. These two hatcheries produce most of the Chinook salmon currently released in Hood Canal.

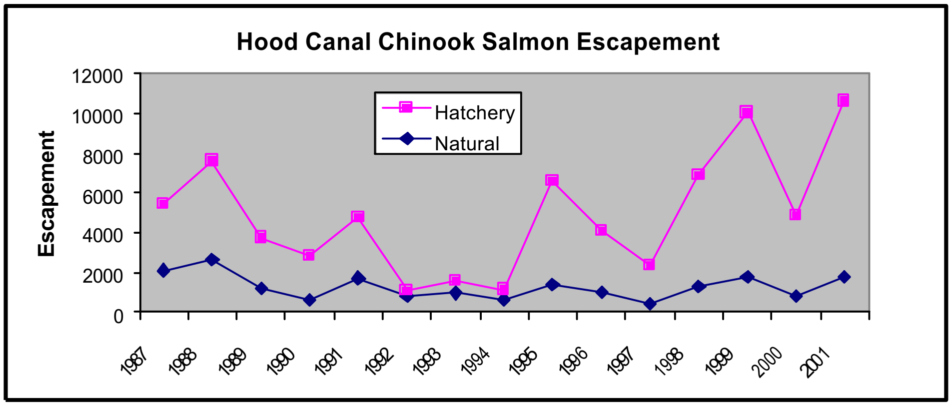

Figure 15. Annual estimated escapements of natural and hatchery Chinook salmon in Hood Canal..

Three hatcheries in Hood Canal once produced Chinook salmon for Hood Canal but no longer do so. McKernan Hatchery is a satellite facility to George Adams Hatchery that is located two miles west of George Adams Hatchery on Weaver Creek, a tributary of the Skokomish River. It no longer produces Chinook salmon for Hood Canal, although it occasionally holds Chinook salmon for release in South Puget Sound. Other facilities that have discontinued Chinook salmon production are Enetai Hatchery, which is operated by the Skokomish Tribe on Enetai Creek just north of the Skokomish River, and Sund Rock Net Pens, which was a satellite facility to Hoodsport Hatchery. They were located along the shoreline of Hood Canal approximately two miles north of the Hoodsport Hatchery.

Two additional hatcheries produce Chinook salmon in Hood Canal. The Long Live The Kings Lilliwaup Hatchery is located on Lilliwaup Creek, an independent tributary to Hood Canal, approximate five miles north of Hoodsport, and is operated by Long Live The Kings in conjunction with WDFW and the U.S. Fish and Wildlife Service. Chinook salmon reared at Lilliwaup Hatchery are not released into the Lilliwaup River but are transferred to Rick's Pond on the Skokomish River where they are acclimated before release. The University of Washington operates Big Beef Creek Hatchery on Big Beef Creek on the eastern shore of Hood Canal, northeast of the Dosewallips River.

Objectives: Objectives of the hatchery Chinook salmon programs in Hood Canal are to

1. Produce fish for tribal, commercial, and recreational harvest and for education and research.
2. Aid in recovery and reestablishment of natural populations.
3. Provide mitigation for Tacoma City Light hydroelectric projects.

These objectives represent a change from past practices, when management was focused primarily on producing fish for fisheries and protection of natural populations was of secondary importance. To meet the new objectives, the co-managers are identifying different management objectives for different areas of the Hood Canal based on the potential of watershed to support natural self-sustaining populations. Management of hatcheries will change to be consistent with these goals. The two categories for new management are: 1) watersheds believed to have a history of sustainable natural populations that will be managed to recover or re-establish locally adapted and sustainable, natural populations as habitat becomes available for sustainable natural production; and 2) watersheds believed not to historically support sustainable populations that will not be managed for sustainable, natural populations. The major areas are described below.

Western Hood Canal: This area includes the Dosewallips, Duckabush and Hamma Hamma watersheds. The management objective is to develop sustainable, locally adapted, natural Chinook salmon populations. Natural Chinook salmon populations within these systems are at low abundance. Management efforts will focus on increasing natural population numbers and meeting specified minimum escapement rates or numbers. Supplementation projects using local hatchery brood stock have recently been implemented in the Hamma Hamma (110,000 annual fingerling release in the tributary, John Creek) watersheds, but are not currently planned in the Duckabush or Dosewallips watersheds. Historically, the proportion of natural origin spawners has been small relative to hatchery origin fish and few natural origin fish have been incorporated into broodstocks. In the Hamma Hamma, co-managers are evaluating the use of natural origin and George Adams hatchery fish as a source for supplementation efforts and to better understand the risks and benefits of using natural origin versus hatchery fish. The Hamma Hamma project is intended to help rebuild the Chinook salmon populations, and is a cooperative efforts between the Hood Canal Salmon Enhancement Group, Long Live the Kings, U.S. Fish and Wildlife Service, National Marine Fisheries Service, the tribes and WDFW.

Skokomish River: Skokomish River Chinook salmon are a special case. The immediate and short-term objective for Skokomish River is to manage Chinook salmon as a composite population (natural and artificially produced Chinook salmon).

Historically, the Skokomish River supported the largest natural Chinook salmon production of any stream in Hood Canal. However, habitat degradation, including dams, severely reduced the productivity and productive capacity of the system and the ability of the Skokomish Tribe to pursue their treaty right to fish. Consequently, hatchery production was developed at WDFW's George Adams and McKernan Hatcheries to mitigate the impacts of habitat loss on natural Chinook salmon production. The co-managers will manage the composite population to achieve a suitable level of natural escapement and hatchery production that will continue mitigating the effects of habitat loss and provide the Skokomish Tribe its treaty fishing opportunity. In the meantime, habitat recovery and protection measures will be sought to improve natural production. Over time, alternative management strategies will be explored that may lead to sustainable natural production, and may reduce effects on the natural population from the operation of the hatcheries.

Eastern Hood Canal: This area includes the Union, Tahuya and Dewatto watersheds where existing supplementation projects use local hatchery brood stocks. Other streams of East Hood Canal (WRIA 15) and South Hood Canal (WRIA 14) are not candidates for having sustainable, natural Chinook salmon populations. Habitat characteristics of the Union, Tahuya and Dewatto watersheds do not represent conditions where sustainable Chinook salmon populations usually exist, although low numbers of Chinook salmon are observed there. The few Chinook salmon that currently use the Union, Tahuya, and Dewatto watersheds may be the result of historical hatchery releases, straying from releases from other areas, and production from the more recent supplementation programs. This assumption needs to be examined, but if it is found that these streams did not historically support sustainable populations, no natural escapement objectives will be specified.

Stock: Green River/Hood Canal-derived fall Chinook salmon

Production Goals:
Approximately seven million pre-yearling and 375,000 yearling hatchery Chinook salmon will be released annually into the waters of Hood Canal region. Hood Canal Salmon Management Plan identifies hatchery production goals, which are negotiated by WDFW and the tribes under *U.S. vs. Washington.* Recently, the Skokomish Tribe, WDFW, and voluntary enhancement groups have eliminated or reduced hatchery releases by more than one million fish since the ESA listing of Chinook salmon in the Hood Canal (Table 21).

Production Strategy: Programs in this region are based on an integrated harvest strategy.

Operations:
WDFW collects most of the eggs for hatchery production at George Adams and Hoodsport Hatcheries, where many of these fish will ultimately be released. George Adams Hatchery also provides eggs for the most of the smaller facilities that rear and release Chinook salmon in other areas, including those operated by the Hood Canal Salmon Enhancement Group, Long Live the Kings (a private non-profit organization), volunteer cooperatives, and schools. Hoodsport Hatchery supplements the egg collection when needed and it was the egg source for net pens located at Sund Rock, Hood Canal Marina and Pleasant Harbor (the latter two being voluntary cooperative projects). Some Chinook salmon eggs are also collected at the University of Washington facility on Big Beef Creek to meet its needs. At one time it was common to transfer eggs from South Sound (Deschutes River) hatchery programs, which also used Green River lineage Chinook salmon, to compensate for shortfalls in Hood Canal. This practice was halted in the early 1990s and fish eggs are no longer moved across regions for release.

Operational Commitments

<u>George Adams Fall Chinook</u>

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the George Adams Hatchery to affect this program.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at George Adams Hatchery to a total, maximum of 3,800,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at George Adams Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the Skokomish River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each year. This monitoring will allow for assessment of the status of the target population.

Table 21. Proposed annual releases of Chinook salmon in the Hood Canal. Numbers in parentheses show pre-listing release goals.

Fingerling/ Fry	Yearling	Brood Lineage	Production Strategy	Release Site	Sponsor
3,800,000		Green River	Integrated Harvest	Purdy Creek	WDFW
	125,000	Green River	Integrated Harvest	Skokomish River (Rick's Pond)	WDFW (Endicott)
0 (210,000)		Green River	Integrated Harvest	Skokomish River (Enetai Hatchery)	Skokomish Tribe
0 (320,000)		Green River	Integrated Harvest	Enetai Creek (Enetai Hatchery)	Skokomish Tribe
40,000		Green River	Integrated Harvest	Skokomish River	RFEG-6 / LLTK
0 (30,000)		Green River	Integrated Harvest	Duckabush River (15.0355)	RFEG-6 / LLTK
110,000 (75,000)		Green River & Hamma Hamma natural origin	Integrated Recovery	Hamma Hamma River (John Creek)	RFEG-6 / LLTK
0 (45,000)		Green River	Integrated Harvest	Tahuya River tributary	RFEG-6
0 (30,000)		Green River	Integrated Harvest	Dewatto River tributary	RFEG-6
0 (65,000)		Green River	Integrated Harvest	Union River tributaries	RFEG-6
500 (25,000)		Green River	Integrated Harvest	Independent tributary south of Union River (14.012x)	WDFW Cooperative (Grimm)
500 (50,000)		Green River	Integrated Harvest	Independent tributary south of Union River (14.012x)	WDFW Cooperative (Koopman)
500 (50,000)		Green River	Integrated Harvest	Independent tributary south of Union River (14.01xx)	WDFW Cooperative (Adams-Hood Canal schools)
500 (5,000)		Green River	Integrated Harvest	Independent tributary south of Union River (14.01xx)	WDFW Cooperative (Schmitz)
500 (5,000)		Green River	Integrated Harvest	Independent tributary (Jump-Off-Joe Creek) 15.0369)	WDFW Cooperative (Edgewater Beach)
500 (1,000)		Green River	Integrated Harvest	Independent tributary (15.0xxx)	WDFW Cooperative (Sand Hill Elem.)
200,000		Green River	Integrated Harvest	Independent tributary (Big Beef Creek)	University of Washington
3,000,000	250,000	Green River	Integrated Harvest	Finch Creek (Hoodsport Hatchery)	WDFW
	0 (12,500)	Green River	Integrated Harvest	Hood Canal Marina	WDFW cooperative
	0 (15,000)	Green River	Integrated Harvest	Pleasant Harbor	WDFW cooperative
	0 (150,000)	Green River	Integrated Harvest	Sund Rock	WDFW
7,153,000 **(7,986,000)**	**375,000** **(552,500)**		TOTAL		

Skokomish River (RFEG) Fall Chinook Program (Rick's Pond)

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the George Adams Hatchery to affect this program.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Rick's Pond to a total, maximum of 30,000 fingerlings or sub-yearlings and120,000 yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the yearling fall Chinook production at Rick's Pond to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- WDFW will monitor Chinook salmon escapement to the Skokomish River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population.

Hoodsport Hatchery Fall Chinook Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Hoodsport Hatchery to affect this program. The intent is to collect localized hatchery-origin broodstock at this location.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Hoodsport Hatchery to a total, maximum of 3,000,000 fingerlings or sub-yearlings and 250,000 yearlings. Limiting juvenile production to current levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling and yearling fall Chinook production at Hoodsport Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.

Hamma Hamma River Fall Chinook Program

- WDFW and the Hood Canal Salmon Enhancement Group will collect broodstock fall Chinook adults from the Hamma Hamma River. Broodstock will consist of only enough adults to obtain a 60,000 eggtake goal (approximately 21 pairs) in conjunction with the broodstock from George Adams Hatchery. The collection of localized hatchery-origin broodstock at this location will limit direct and incidental take effects on listed Chinook salmon.
- WDFW and the Hood Canal Salmon Enhancement Group will limit, as the management intent, annual production of fall Chinook for release into the Hamma Hamma River to a total, maximum of 110,000 fingerlings or sub-yearlings during April-May at 80 fpp.

Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.

- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it 100% of the fall Chinook salmon sub-yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will monitor Chinook salmon escapement to the Hamma Hamma River sites to estimate the number of tagged, untagged, and marked fish escaping to the river each years. This monitoring will allow for assessment of the status of the target population.

Big Beef Creek Hatchery Fall Chinook Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Big Beef Creek Hatchery to affect this program. The intent is to collect localized hatchery-origin broodstock at this location.
- WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Big Beef Creek Hatchery to a total, maximum of 200,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain, and not forestall, potential future options for the recovery of the listed Chinook ESU.
- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to 100% of the fall Chinook salmon sub-yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.
- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook production at Big Beef Creek Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.

EFFECTS OF ACTIONS

Review of Potential Adverse Effects

The scientific literature indicates that hatcheries may have adverse effects on wild Chinook populations as well as potential benefits. These impacts may be reduced or eliminated by improved management and hatchery practices developed and tested by adaptive management. These include: 1) demographic impacts, which directly affect the physical condition, abundance, distribution, and survival of wild fish; 2) genetic impacts, which affect the loss of diversity within and among populations and reproductive success in the wild; and 3) ecological impacts, such as loss of habitat, competition, predation, and disease. These potential impacts arise from a variety of interacting sources, including the physical layout and operation of the hatchery facility, hatchery practices (how fish are collected, mated, reared, and released), and management decisions about how hatcheries are used. Not all impacts occur everywhere and often the potential adverse effects of one kind arise because of actions taken to minimize impacts of another kind. These potential effects are reviewed in the scientific literature (e.g. Busack and Currens, 1995, Campton, 1995), in NMFS consultation documents (NMFS, 2001), the biological assessment of federally funded Puget Sound tribal hatchery programs by the Bureau of Indian Affairs (BIA, 1999), and brief descriptions are also included here.

Impacts of Hatchery Facilities

Hatchery facilities can have demographic impacts on wild fish. The operation of hatchery facilities can directly affect abundance and survival of wild fish through physical injury or mortality resulting from fish being impinged at water intake locations. Hatcheries facilities may indirectly affect wild fish by altering water quality and quantity in the stream where the hatchery is located. Water withdrawals from wild Chinook spawning and rearing areas for hatchery operations can diminish stream flow in the area of the stream below the water intake to where the outflow from the hatchery rejoins the stream. If flow is diminished enough, it can impede migration and affect spawning behavior of fish in the stream. Water withdrawals may also affect other stream-dwelling organisms on which wild fish feed, leading to decreased growth and displacement. Hatchery effluents may change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra, 1991). When listed fish are being raised in hatcheries, catastrophic facility failures can lead to large mortalities. These impacts can be addressed by modernizing and upgrading hatchery facilities to prevent impingement at water intake locations, scaling water use and discharge to allow migration of fish, treating effluents, and installing safeguards for catastrophic facility failures.

Impacts of Brood Stock Collection

Brood stock collection may have a negative demographic impact on wild salmon. Where hatcheries collect threatened or endangered fish for recovery programs, they purposefully "take" wild fish to increase the overall abundance of fish in the population. If the hatchery program returns less fish to spawn than the wild component of the population, the hatchery program may be mining brood stock and increasing the overall risk of extinction. Hatcheries that collect returning hatchery fish for brood stock may also incidentally collect wild listed fish, if methods to distinguish wild fish from hatchery fish are unavailable. In addition, weirs or barriers that may be used to trap brood stock may blocks or hinder upstream migration of naturally spawning fish, leading to delaying upstream migration, displaced spawning, increased stress, or injury from handling or attempting to pass the weir. These impacts can be addressed by prioritizing brood stock collection to protect against brood stock mining, adopting methods to distinguish wild fish from hatchery fish, improving hatchery facilities, and handling fish in ways that reduce stress and injury.

Genetic Effects

Genetic effects include the loss of among-population diversity and any related outbreeding depression, domestication, and loss of within-population diversity. Loss of among-population genetic diversity is associated with straying of out-of-watershed origin Chinook salmon with wild fish spawning areas or human transfers of non-local hatchery brood stock into a watershed with distinct populations and subsequent interbreeding. This can lead to loss of important adaptive differences between populations from different environments, reducing the ability of the species to respond to rapid environmental change, and reduced reproductive success. In contrast, loss of within-population genetic diversity (the amount of genetic information in a population) is largely associated with reductions in abundance and mating success. Inbreeding depression, which is the reduction in fitness of individuals resulting from mating of closely related individuals, is closely associated with similar conditions. Hatchery activities such as the number and ratio of males and females spawned, mating techniques, culling or choice of eggs for removal or transfer can affect loss of genetic diversity. Domestication is the intentional or unintentional selection for adaptation to an artificial environment. Adaptation to an artificial environment, such as a hatchery, during one phase of a salmon's life history can hinder the ability of the fish to survive in the wild The sources of these effects have been extensively reviewed and described in the genetic literature (Busack and Currens, 1995; Campton, 1995) and in the tribal hatchery biological assessment (BIA, 1999). These impacts can be addressed by using local brood stock sources, developing and using rearing and release procedures to minimize straying, maximizing genetic effective population size through modern brood stock spawning methods, and minimizing intentional and unintentional selection in the hatchery.

Ecological Effects

Ecological effects of hatchery fish include predation, competition, displacement (a form of competition for space), and disease. Disease effects are described in a separate section.

Predation
Hatchery-origin fish may prey upon juvenile wild Chinook at several stages of their life history. Newly released hatchery Chinook smolts have the potential to prey on wild 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 wild Chinook of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas where they commingle. Hatchery Chinook planted as non-migrant fry or fingerlings, and progeny of naturally spawning hatchery fish also have the potential to prey upon wild-origin Chinook in freshwater and marine areas where they occur.

Hatchery production may also have an indirect effect on predation. Large concentrations of migrating hatchery fish may attract predators (birds, fish, and seals) and consequently contribute indirectly to predation of wild fish (Steward and Bjornn, 1990). The presence of large numbers of hatchery fish may also alter wild Chinook behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (NMFS, 1995). Alternatively, a mass of hatchery fish migrating through an area may overwhelm predators, providing a beneficial, protective effect to co-occurring wild fish.

Competition
Resource competition posed by the release of hatchery-origin Chinook into environments where wild Chinook salmon are present may lead to negative effects on the productivity and survival of wild populations. Adverse effects of competition may result from direct interactions, where a hatchery-origin fish interferes with access to resources or through indirect means, as in when use of a resource by hatchery fish reduces the amount available for wild fish (SIWG, 1984). Hatchery smolts may compete with wild fish for food and space in areas where they interact during downstream migration. Adult hatchery Chinook salmon spawning in the wild may also compete with wild fish for holding areas, mates, and spawning sites. Hatchery-origin smolts and sub-adults may also compete with wild fish in estuarine and marine areas. In marine waters, the food may be the main limiting resource that leads to competition between and hatchery-origin Chinook salmon (Fresh et al.,1981; SIWG, 1984; West, 1997). The early marine life stage, when Chinook salmon 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). Because of the difficulties in studying salmonids in marine habitats, it has thus far not been possible to define the nature and extent of competitive interactions between wild and hatchery-origin Chinook salmon (SIWG, 1984). However, since 1995, SSC has been gathering data on the incidence of hatchery and wild Chinook in marine habitats.

Displacement
The large volumes of juvenile hatchery salmon released may displace rearing wild Chinook juveniles from stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al., 1994). The relative size of affected wild Chinook when compared to hatchery fish, as well as the abundance of hatchery fish encountered, also will determine the degree to which wild fish are displaced (Steward and Bjornn 1990). Wild 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 non-migratory hatchery fish have taken up residency before wild fry emerge from redds.

These impacts can be reduced by developing and using rearing and release strategies that minimize competition and predation between wild and hatchery origin fish. Adaptive management and research play an important role in this new field of fish culture.

Disease

Pathogens are not unique to hatcheries. The pathogens responsible for fish diseases are present in both hatchery and natural populations. Consequently, determining the primary source of the pathogen affecting wild fish can be problematic (Williams and Amend, 1976, Hastein and Lindstad, 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because higher rearing densities of fish in the hatcheries may stress fish and lower immune responses. Under natural, low-density conditions, most pathogens do not lead to disease outbreaks. 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). 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 released and throughout migration corridors where hatchery and wild fish may interact. These impacts can be addressed by the rearing fish at lower densities, continuing the well-developed monitoring, diagnostic, and treatment programs already in place, and maintaining risk management guidelines.

Tools and Procedures

The co-managers use a variety of tools and processes to minimize the potential adverse effects of hatcheries. These stem from the co-managers' General Principles for operating hatcheries and include development of hatchery and genetic management plans (HGMPs), risk assessments for each of the potential adverse effects (BRAP), Section 7 consultations with NMFS on tribal hatcheries, and independent scientific review of hatcheries by the Hatchery Scientific Review Group (HSRG).

The General Principles adopted by WDFW and the tribes for operating hatcheries (see Introduction, page 2) address the potential sources and adverse effects as well as the benefits of hatcheries. A brief comparison of the relationship between the co-managers' General Principles and potential effects of hatcheries shows the consistency (Table 22). The National Marine Fisheries Service, for example, in considering the potential adverse effects of hatcheries classifies them into five categories, including: 1) hatchery operational effects (e.g., impingement on water intake screens, water withdrawals, effluent discharge); 2) brood stock collection effects ("take" of listed fish, brood stock mining); 3) genetic effects (loss of within and among-population diversity, inbreeding, domestication); 4) ecological effects (predation, competition, displacement, disease); and 5) monitoring, evaluation, and research effects on listed fish (NMFS, 2001). Each of these is addressed by the General Principles. Table 22 also illustrates how the co-managers link hatchery and genetic management plans, risk assessments, Section 7 consultations, and independent scientif review of hatcheries to identify and address effects.

Summary of Effects

General Principles

The Final Endangered Species Act (ESA) 4(d) Rule for Puget Sound Chinook Salmon Evolutionary Significant Unit (ESU) states that the prohibition of paragraph (s) of the rule (50 CFR 223.203(a) do not apply to activities associated with artificial propagation programs provided that the certain elements of the rule are met.

The following principles that guide this plan are consistent with those identified within the 4(d) Rule. There are 42 HGMPs that are included within this ESU. These HGMPs are submitted concurrently with this document and describe the detail for each program. In relation to the general principles within this document, responses to each item will be directed towards the ESU rather than specific programs. Refer to Table 4 for a summary of the various programs (HGMP) including release numbers, recovery category and program type.

Hatchery programs need clearly stated goals, performance objectives and performance indicators.

Within each HGMP, the goal of the program is identified in section 1.7, performance standards and indicators are addressed in sections 1.9 and 1.10.

Priorities for brood stock collection of listed fish depend on the status of the donor population, relative to critical or viable population thresholds. **Highest priority for brood stock collection of listed populations below the viable threshold is conservation. Brood stock collection for other priorities depends on meeting the conservation goals and not appreciably slowing recovery to viable levels.**

Sections 6 and 7 of each HGMP describe the origin, identity, and collection procedures for the brood stock used in each program. Although critical and viable population thresholds have not been developed, the plan identifies only five programs for which brood stock will be collected from natural spawning areas: Elwha Chinook, Marblemount Fall Chinook, Marblemount Summer Chinook, Stillaguamish Summer Chinook, and Hamma Hamma Chinook. Each of these is either a Recovery or Research programs, and survival in each program from green egg to release is approaching 90%.

All other programs rely upon brood stock returning to a WDFW or tribal facility. The origin of these fish has often been uncertain because all hatchery production was not marked. That uncertainty will be addressed by marking of all hatchery production. Results from the marking will be used to evaluate the benefits and risks posed by the use of natural origin broodstock returning to the facilities and to recommend appropriate modifications to the HGMPs.

Hatchery programs need protocols to analyze risks associated with fish health, brood stock collection, spawning, rearing, and release of juveniles; disposition of adults; and catastrophes within the hatchery.

Chinook hatchery programs in Puget Sound are operated in compliance with the " Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998). Fish are regularly inspected by fish health professionals and appropriate treatments are prescribed. Brood stock are screened for pathogens and eggs are treated to control fungus and pathogens.

Brood stock collection procedures are explained in the HGMPs and vary according to the particular program. Brood stock is to be collected throughout the run. Representative brood stock is collected randomly without regard to size, sex or age. Various and multiple methods are used to ensure that appropriate brood stock is being collected. For example, return timing used with on-site reading of coded-wire tags, is used to ensure appropriate broods stock utilization for the Nooksack spring Chinook program. Additionally, data is being collected at hatcheries regarding brood stock collection that will help identify changes in the hatchery and natural populations.

Brood stock spawning protocols vary depending on the size of the brood stock population and the intent of the program. Generally, the larger the brood stock population, the more flexible the spawning protocols. For example, with a brood stock population of thousands of fish, pooling the eggs of multiple females and combining it with the pooled sperm of an equal number of males, may be appropriate. In cases where there are a few hundred or less brood stock, a factorial or 1:1 mating spawning protocol may be necessary to prevent adverse genetic effects. Spawning protocols are detailed in "Spawning Guidelines for Washington Department of Fish and Wildlife Hatcheries" (Seidel, 1983).

Rearing and release of juvenile hatchery Chinook at WDFW facilities in Puget Sound follow the guidelines in "Fish Hatchery Management" (Piper et. al., 1982). Eggs are incubated at particular flows and juveniles are reared at particular loadings and densities designed to ensure that the hatchery releases a healthy, smolted fish at the time and size desired. Release time and size is dependent on the intent of the hatchery program. For conservation programs, the intent may be to have the hatchery fish mimic the naturally-produced fish in outmigration time and size to reduce domestication effects. For harvest-oriented programs, release the fish at a time and size that maximizes survival while minimizing impacts to listed fish.

Each hatchery program has a plan for disposition of hatchery adults. Again, the plans vary depending on the number of excess adults, the intent of the hatchery program and the status of the natural stock. For most Puget Sound Chinook programs, excess adults are returned to the river to spawn naturally and distribute themselves for nutrient enhancement. In instances where there is an upstream escapement goal and it has been met or where there is not suitable habitat for the Chinook to spawn and rear, these fish may be killed and donated to food banks, sold to a contract buyer or dispersed throughout the watershed for nutrient enhancement.

Catastrophic risk management strategies at Puget Sound hatchery facilities are in place to prevent large-scale fish loss from equipment failure, water loss, flooding and other such events. In most cases hatchery personnel live at the hatchery facility and can quickly respond to water or power failures. Incubation rooms and rearing ponds are equipped with alarms and hatchery facilities have back-up generators. This is the case for all facilities propagating listed fish.

Hatchery programs need to assess and manage ecological and genetic risks to natural populations.

Section 2 within the HGMPs discusses program effects of ESA-listed salmon populations. Section 2.2 provides description, status and projected take actions and levels for ESA-listed natural populations in the target area. These descriptions are specific to the watershed and commingling natural stocks. The "Collective Effects of Chinook Programs" section of this report describes the potential risks of competitive interactions in estuarine and marine waters, and the actions to address those risks.

A variety of tools have been used to evaluate the ecological and genetic risks posed by the programs, and to develop remedial actions if necessary. Results from this assessment are summarized below:

<u>Loss of Among-Population Diversity.</u> Institution in the early 1990s of fish health transfer policies and development of local brood stocks (Figure 3) substantially reduced the risk of a loss in population diversity. Further review of the programs during the development of this plan led to additional actions, including:

1) terminating net pen programs at Fidalgo, Oak Harbor, Roche Harbor, San Juan, Mukilteo, Langley, Ballard, Elliot Bay, Des Moines, Fox Island, Hood Canal Marina, Pleasant Harbor, and Sund Rocks;
2) terminating the McAllister Creek Hatchery program;
3) reducing the Samish Fingerling Fall Chinook program from 5.2 to 4.0 million;
4) reducing the Wallace Yearling Summer production from 520,000 to 250,000; and
5) reducing Hood Canal fingerling/fry production by 830,000.

Results from the marking and tagging identified in this plan will be used to evaluate if additional actions are required.

Loss of Within-Population Diversity. The likelihood of negative effects from loss of within-population diversity is unknown, but it has been substantially reduced by practices in place since the 1980s. There is no evidence of inbreeding depression in hatcheries that would affect listed fish. Genetic data do not show strong evidence of a decrease in heterozygosity that might indicate past losses of within-population diversity, although interpretation is confounded by the effects of gene flow. Risk from current practices will vary from program to program, but are minimized in this plan by maintaining the implementation of brood stock selection and spawning protocols. The WDFW HOPPS (Fuss and Ashbrook, 1995) documents details procedures used at WDFW hatcheries to avoid genetic effects and how each facility has performed in meeting genetic stock reduction objectives.

Negative Effects from Domestication. The effects of domestication on naturally reproducing, listed Chinook salmon in the Puget Sound are unknown. Although an emerging body of literature indicates that domestication may occur in cultured salmon, no controlled studies are available to predict the magnitude or likelihood of effects on wild fish. In programs directly culturing listed fish, such as the Elwha, Dungeness, Nooksack, Stillaguamish, and White Rivers, domestication may be occurring, but the benefits of using artificial production to prevent extinction outweigh the risks of domestication. It is highly likely, however, that established hatchery populations have undergone some level of domestication. In watersheds where integrated-harvest programs are using established brood stocks and where the majority of the fish are produced in the hatchery, the risks of domestication may also be high but the impacts are unknown. Actions required by this plan to reduce the risk of domestication include:

1) reducing the Kendall Creek Spring Chinook production from 1.6 to 0.70 million;
2) terminating the net pen programs discussed above;
3) terminating the McAllister Creek Hatchery program; and
4) reducing the Wallace Yearling Summer production from 520,000 to 250,000.

Results from the marking and tagging identified in this plan, and studies of the effects of domestication by WDFW and the tribes, will be used to evaluate if additional actions are required.

Negative Effects from Predation. The Species Interaction Work Group (SIWG, 1984), an expert panel administered by NMFS and formed to develop Washington salmonid enhancement project guidelines through the Salmon and Steelhead Conservation and Enhancement Act of 1980, reported that there is an unknown risk that predation by hatchery Chinook will have a significant negative impact on the productivity of wild Chinook juveniles where they interact in freshwater migration areas. Although rating the risk to wild fish as unknown, the SIWG (1984) noted that predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to wild fish.

The SIWG indicated a high risk of a significant predation impact by hatchery Chinook occurring during wild Chinook early marine life (SIWG 1984). However, little to no empirical evidence of predation by hatchery-origin Chinook smolts or sub-adults on other juvenile salmonids, including wild Chinook, in Puget Sound has been found (Miller et al.,1977; Bax et al., 1978; Fresh et al., 1979; Cardwell and Fresh, 1980). In a recent literature review of Chinook salmon food habits and feeding ecology in Pacific Northwest marine waters, Buckley (1999) concluded that cannibalism and intra-generic predation by Chinook salmon are rare events. Cardwell and Fresh (1979) suggest likely reasons for apparent low predation rates on salmon juveniles, including Chinook, by larger Chinook and other marine predators. 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.

Actions required by this plan to reduce the risk of predation include:

1) terminating the net pen programs discussed above;
2) terminating the McAllister Creek Yearling program;
3) reducing the Wallace Yearling Summer production from 520,000 to 250,000;
4) releasing yearling Chinook salmon at a time, size, and/or physiological condition that provides a low likelihood of residualism and promotes rapid migration through the estuary; and
5) conducting studies on the incidence and effects of predation in fresh and marine waters.

Results from the studies will be used to evaluate if additional actions are required.

Negative Effects from Competition. SIWG (1984) reported a high risk of significant ecological resource competition between hatchery and natural-origin Chinook salmon juveniles where they interact in freshwater, and in estuarine areas where wild fish spend their early marine life. Competition may also occur in marine waters, although it is extremely difficult to document. Freshwater impacts from competition are assumed to be greatest in the spawning and nursery areas and at release locations where fish densities are highest (NMFS, 1995). These impacts likely diminish as hatchery smolts disperse, but resource competition may continue to occur at some unknown, but lower level as smolts move downstream. Smolt-only release practices employed by hatcheries in the region probably significantly reduces the duration of interaction, and therefore the potential negative effects of competitive interactions between newly-released hatchery fish and indigenous juvenile Chinook populations in freshwater. 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 wild fish, and that hatchery fish will be unlikely to out-compete wild fish. Actions implemented in this plan to reduce the risk posed by competition include:

1) releasing fish at a time, size, and physiologically condition that provides a low likelihood of residualization and promotes rapid migration through the estuary to marine waters. Programs typically release subyearling Chinook salmon that are in the 40 to 90 fpp (77 to 100mm fl) during the months of May and June. Fish released at this time and size are fully smolted, are unlikely to residualize, and are expected to move rapidly through estuarine areas;
2) releasing subyearling fish that are a larger size than natural-origin Chinook salmon of the same brood year to reduce the potential for diet overlap with any co-occuring natural origin fish in marine waters. Recent studies by WDFW (Seiler, 2001; Seiler et al., 2001; and H. Fuss pers. comm.) demonstrate that the majority of natural origin Chinook salmon produced in the Skagit, Cedar, and Deschutes rivers emigrate at a size less than 200 fpp, or 60 mm fl. The WDFW and tribal programs release sub-yearling Chinook salmon that are in the 40 to 90 fpp (77 to 100 mm fl) size range.
3) limiting the total releases of Chinook salmon in Puget Sound and reducing or minimizing releases affecting key stocks. The Chinook salmon programs proposed in this plan constitute a 37% reduction in production relative to 1990 (see Figure 3), including a 35% reduction in yearling production.

4) conducting studies on the incidence and effects of competition in fresh and marine waters.

Results from the studies will be used to evaluate if additional actions are required.

Disease Effects. The risk of disease transmission to wild Chinook in the Puget Sound region is low. Transmission of hatchery-origin diseases from hatchery to wild fish in areas where they co-occur is an unlikely event. Although hatchery populations can be considered to be reservoirs for disease pathogens because of their elevated exposure to high rearing densities and stress, there is little evidence to suggest that diseases are routinely transmitted from hatchery to wild fish (Steward and Bjornn, 1990). Actions identified in this plan include:

1) implementation of fish health policies and procedures (PNFHPC, 1989; Co-managers 1991; WDFW 1996);
2) maintenance of state-of-the-art fish health monitoring, facility disinfecting, and disease management procedures presently applied in the operation of Puget Sound hatcheries.

Hatchery programs need to coordinate with fishery management programs to maximize benefits and minimize biological risks

This follows the limits on the prohibitions within section 9(a)(1) of the ESA (16 U.S.C. 1538(a)(1). Limit 4 refers to fishery management actions, which must be approved by NMFS as a fisheries Management and Evaluation Plan. In accordance to Limit 4, the Puget Sound Comprehensive Chinook Management Plan, Harvest Management Component (WDFW et. al., 2001) was developed. This plan defined harvest objectives for Chinook salmon originating in Washington waters from the mouth of the Strait of Juan de Fuca eastwards (Puget Sound). The goals and objectives of this plan guide the management of Puget Sound Chinook as they transit various management jurisdictions. The major feature of this plan identified recovery exploitation rates ceilings and low abundance thresholds for each natural Chinook stock. The basic management strategy is to keep exploitation rates, including the exploitation directed at hatchery runs, at or below a unit-specific ceiling rate, as long as the unit's spawning escapement is expected to be above the low abundance threshold.

This plan was approved for a two-year interim term (2001-2002) by NMFS. An updated plan will be available for 2003.

In addition to this overall plan Section 3 of the HGMPs describes the relationship of the specific hatchery program to other management objectives. Section 3.3 describes harvest objectives specific to the stock and management units.

Hatchery programs must have adequate facilities and maintenance to rear fish, maintain fish health and diversity, and minimize domestication in fish of naturally spawned brood stock.

Listed Chinook are propagated at the following facilities: Kendall Creek Hatchery (Nooksack spring Chinook), Harvey Creek Hatchery and Whitehorse Rearing Ponds (Stillaguamish summer Chinook), Minter Creek, Hupp Springs and White River Hatcheries (White River spring Chinook), Dungeness Hatchery, Hurd Creek Hatchery and Greywolf Acclimation Pond (Dungeness spring Chinook) and Elwha, Hurd Creek and Sol Duc Hatcheries (Elwha summer/fall Chinook).

All of these hatcheries have adequate brood stock holding areas, incubation capacity, water and pond space to properly rear listed Chinook. These facilities were selected, and in some cases, re-programmed to accommodate listed fish. Multiple facilities are used for some programs to ensure that the listed fish are receiving the proper care. Adequate personnel, alarms and back-up systems are in place to ensure against possible catastrophic incidents. These facilities exhibit high egg-to-smolt survival and low pre-spawning mortality indicating well-designed and properly operating programs. The result of these programs to date has been to successfully increase adult returns. The exception to this is Dungeness spring Chinook where it is too early to assess the impact of the hatchery program.

Fish health protocols are followed and monitoring by fish health professionals occurs on a regular basis. Appropriate treatments are prescribed as necessary.

This information is described in the HGMPs in sections 4 (Water Source), 5 (Facilities), 6 (Brood Stock (Origin and Identity), 7 (Brood Stock Collection), 8 (Mating), 9 (Incubation and Rearing), and 10 (Release). Each facility is discussed specifically in relation to the program.

Hatchery programs should be based on adaptive management that includes having adequate monitoring and evaluation, to determine whether the program is meeting its objectives, and a process for making revisions to the program based on evaluating the monitoring data.

With over a century of change and extensive human occupation throughout Washington, especially the Puget Sound region, it is obvious that we cannot revert back to the pristine watershed conditions that once existed. Artificial production has become an integral part of salmon management and is often the only realistic means of providing harvest opportunities. However, cultured production continues to be a source of controversy, with three primary concerns: 1) gene flow between hatchery and wild fish; 2) mixed-stock fisheries that can overfish wild stocks; and 3) competition and predation impacts on wild fish.

This plan requires a major investment in monitoring and research, including marking 36 million and tagging 5 million fish. This is a major commitment by the WDFW and the tribes? a commitment for transforming hatcheries from one of the all-H (habitat, hydro, harvest, and hatcheries) risk factors to an integrated, productive, recovery tool.

Hatchery program must be consistent with the plans and conditions identified by Federal Courts with jurisdiction over tribal harvest allocations

The HGMP is consistent with standing court orders and court-approved state-tribal agreements pertaining to fisheries management and tribal rights to fish in usual and accustomed fish grounds and to a meaningful harvest. The Puget Sound Salmon Management Plan (PSSMP, 1985) and the Hood Canal Salmon Management Plan (HCSMP, 1986) are federal court orders that currently control both the harvest management rules and hatchery production schedules for salmon under the *U.S. v. Washington* (1974) management framework. All HGMPs, and the overarching documents specific to the various regions were developed by the state and tribal Co-managers within these court-approved fisheries and hatchery management frameworks. Co-managers acknowledge that it may be necessary to modify these plans in order to implement revised joint state-tribal management recommendations included and agreed to in the Summer Chum Salmon

Conservation Initiative (SCSCI). However, the provisions of the PSSMP will remain in effect until modified through court order by mutual agreement.

Hatchery programs will monitor the "take" of listed salmon occurring in the program.

Within each HGMP, the level of take of listed fish is specifically addressed in Section 12.9. In most cases, the level of take is a best estimate, based on the present hatchery operations and release strategies. As operations and production strategies change, the level of take will be reviewed relative to these changes. Additional information regarding the effects of the hatchery program is discussed in Section 2, especially 2.2 and 2.3..

Table 22. Potential adverse effects associated with hatcheries addressed by the co-managers' General Principles and the application of different tools used to assess the effects.

Co-managers General Principles	Sources of Potential Effects Addressed	Hatchery and Genetic Management Plans	Benefit-Risk Assessment Procedure	Section 7 consultation	Hatchery Scientific Review Group*
• Goals, objectives, performance standards	Inappropriate management decisions	Sections 1.6, 1.7, 1.8, 1.9, 1.10	Uses HGMP	Yes	Yes—Important focus of review
• Priorities for brood stock collection	Brood stock mining, minimizing "take"	Sections 6.2.1 and 6.2.2	Genetic Hazard, Demographic Hazard	Yes	Yes
• Protocols to manage risks associated with hatchery operations	Loss of genetic variation, disease, demographic losses from catastrophic facility failures	Sections 7, 8, 9, and 10; Sections 7.8 and 5.8	Uses HGMP and supplemental information	Yes	Yes
• Assess and manage ecological and genetic risks to natural populations	Loss of genetic variation, reproductive success, competition, predation	Sections 4.2, 5.8, 6.2.4, 6.3, 7.2, 7.9, 8, 9.1.7, 9.2.10, 10.11, 11.2	Genetic Hazard 1-3; Ecological Hazard 1-3; Demographic Hazard 1-2; Facility Effect Hazard 1-3.	Yes	Yes
• Coordination with fishery management programs	Genetic effects, demographic effects	Sections 3.1, 3.2, and 3.3	Uses HGMP	Yes	Yes
• Adequate facilities	Catastrophic facility failures, disease, domestication	Section 4, 5, 7.6, 9.2.9, and 9.2.10	Genetic Hazard 2; Ecological Hazard 1; Facility Effect Hazard 1.	Yes	Yes—Important focus of review
• Adaptive management and monitoring & evaluation	Inappropriate management decisions; monitoring, evaluation, and research effects	Sections 1.9, 1.10, and 11	Intent is to use risk assessment results to identify areas for monitoring, evaluation and research	Yes	Yes
• Monitor "take" of listed fish	All of the above	To be included	Not directly addressed	To be done	No

* HSRG has not completed reviews of all Puget Sound programs yet. These will be completed by 2003.

Collective Effects

The production from multiple hatchery programs often rear with juveniles from natural populations in the estuaries, nearshore, and marine areas of Puget Sound. While significant gaps exist in our understanding of Chinook salmon in these life stages, studies have begun to provide us with a broad understanding of migration patterns, food habits, and growth rates (see Healey (1991) for an extensive review of the literature):

- Estuaries provide subyearling Chinook with an important link between the freshwater and marine phases of the life cycle (Healey, 1980b; 1982b; Simenstad et al., 1982; Levy and Northcote 1981,1982). Yearling migrants, in contrast, appear to move quickly through the estuary (Healey, 1980b; 1982b; 1983; Levy and Northcote, 1981; Simenstad et al., 1982; Hayman et al., 1996).
- Seasonal and inter-estuarine variations in the growth rate of juvenile Chinook salmon have been correlated with food availability (Healey, 1982; Neilson et al., 1985) and population abundance (Reimers, 1971; Neilson et al., 1985).
- Subyearling Chinook are typically most abundance in estuaries in April and May before moving to bays and nearshore areas in June and July (Fresh et al., 1979; Hayman et al., 1996).
- Juvenile Chinook remain in Puget Sound in large numbers through the first fall after entering marine waters, but most appear to leave Puget Sound before the following spring (Hartt and Dell, 1986; Beamish et al., 1998).

The correlation of abundance, growth rate, and food availability in estuaries, and the prolonged residence of Chinook salmon in Puget Sound have raised questions about the potential effects of competitive interactions between hatchery and natural origin Chinook during these life stages. Concentrations of hatchery origin fish, particularly in the estuary, could result in a short-term deficit of food, resulting in reduced growth and survival of natural fish. However, because it is difficult to study salmonids in marine habitats, it has been problematic to define if, where, and when food limitations for Chinook salmon in Puget Sound occur, and whether competitive interactions between wild and hatchery origin Chinook salmon exist (SIWG, 1984).

The Puget Sound Tribes, WDFW, and the HSRG are now conducting studies to evaluate competitive interactions in marine waters (Duffy et al., 2001). Data collected through the studies will be used to adjust, if necessary, release numbers, release timing, or characteristics of the programs.

In the interim period, hatchery programs will apply measures based on the best available science to reduce the risks posed by competition between hatchery and natural origin Chinook salmon in marine waters:

1) Release fish at a time, size, and physiologically condition that provides a low likelihood of residualization and promotes rapid migration through the estuary to marine waters. Programs typically release subyearling Chinook salmon that are in the 40 to 90 fpp (77 to 100mm fl) during the months of May and June. Fish released at this time and size are fully smolted, are unlikely to residualize, and are expected to move rapidly through estuarine areas.
2) Release subyearling fish that are a larger size than natural-origin Chinook salmon of the same brood year to reduce the potential for diet overlap with any co-occuring natural origin fish in marine waters. Recent studies by WDFW (Seiler, 2001; Seiler, et al. 2001; and H. Fuss pers. comm.) demonstrate that the majority of natural origin Chinook

salmon produced in the Skagit, Cedar, and Deschutes rivers emigrate at a size less than 200 fpp, or 60 mm fl. The WDFW and tribal programs release sub-yearling Chinook salmon that are in the 40 to 90 fpp (77 to 100 mm fl) size range.

3) Place a cap on the total releases of Chinook salmon in Puget Sound and reduce or minimize releases affecting key stocks. The Chinook salmon programs proposed in this plan constitute a 37% reduction in production relative to 1990 (see Figure 3), including a 35% reduction in yearling production.

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APPENDIX A: ARTIFICIAL PRODUCTION GUIDELINES

Table A.1. Guidelines for Integrated-Recovery Programs.

Issue	Guidelines
Natural Population Status	➢ Population should be at significant risk of extinction.
SCALE OF PROJECT	➢ Total production should ▪ be within the freshwater capacity of the system ▪ be large enough to avoid significant loss of genetic variation or increase in inbreeding ▪ take into account unavoidable mortality
INITIATING A PROJECT	➢ Projects should be initiated and continued only if: ▪ The project is estimated to provide a net benefit to the population targeted for recovery; ▪ The project is part of an overall recovery strategy where the causes for the natural population's decline will be corrected in the foreseeable future. A recovery project based on artificial propagation should not be used as a substitute for addressing the causes of a population's decline.
Changing or Terminating the Project	➢ Change or terminate if the project no longer provides a net benefit to the target population.
Measures of Success	➢ Depending on project goals, successful integrated-recovery projects will ▪ Increase the total abundance of the composite natural/hatchery population. ▪ Result in a trend in the number of natural origin recruits (adult progeny of fish that spawned in the wild) that is estimated to be greater than would have been the case without the project; ▪ Produce adult hatchery fish that are similar to wild fish in terms of size, age, morphology, behavior and geographic and temporal spawning distribution; ▪ Maintain the genetic diversity within the management unit or watershed.
Choice of Brood Stock	Recovery Projects targeting an existing natural population ➢ Except in extreme circumstances, use only the target population or returning project fish derived from the target population for brood stock Reintroduction Projects ➢ Choose the donor stock that has the greatest similarity to the stock that was historically present based on (a) genetic lineage, (b) life history patterns, (c) ecology of the originating environment. ▪ First priority is a hatchery population that was recently derived from the extirpated population, or a neighboring population that best meets the similarity requirements. If suitable neighboring populations are depleted, take small numbers of brood stock from several neighboring populations meeting the similarity criteria so as to minimize impacts. ▪ If neighboring populations are not available, use either non-neighboring hatchery or natural populations that best meet the similarity criteria.

Issue	Guidelines
Collection of Brood Stock	➢ Broodstock should be collected in a number and manner that minimizes genetic differences between hatchery and natural components of the population and that minimizes genetic changes to the whole population over time. ▪ Collect proportionally with respect to age, sex, and run-timing over the entire spawning run. ▪ Include all ages. Jacks and precocious parr should be included in proportion to their natural occurrence, taking into account any known differences in fertility and mating success between males of different ages. ➢ Minimize use of hatchery-reared fish for broodstock. ➢ Collected in a manner that minimizes prespawning mortality. ➢ Collect sufficient broodstock to avoid substantial reductions in effective populations size due to genetic amplification effects (see Part 2 - effective population size)
Brood Stock Spawning	➢ Randomize all the matings of fish on a given day. ➢ Do not pool milt prior to fertilization. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining effective population size (see Part 2 - effective population size). ➢ Consider the use of spawning channels or similar methods of allowing the fish to choose their own mates.
Rearing of Fish	➢ Produce fish that are qualitatively similar to natural fish in size, morphology, behavior, physiological status, health and other ecological attributes, while sufficiently increasing survival at all life history stages in the hatchery environment. Emphasize increasing survival when threats to population abundance (extinction) are greatest; increase emphasis on similarity to natural fish as threats to extinction decrease. ▪ Minimize dependence of chemical treatments to maintain fish health. ▪ Rearing should be for the shortest period possible, that also sufficiently enhances post-release survival and that allows the fish to be become imprinted. ▪ Size at release should enhance post-release survival and minimize negative ecological interactions. ➢ Prevent the introduction, spread, or amplification of fish pathogens (*Co-Managers' Fish Disease Control Policy*). ➢ Fish management ▪ Pool fish so that any differences in rearing conditions will affect all families equally. ▪ Culling should be as random as possible. ▪ Limit the number of times fish must be moved during rearing.
Release of Fish	➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Design release strategies to integrate hatchery-reared fish with wild fish of the same life history stage. ➢ When fish are likely to remain in the release area (for example, presmolts or residuals), disperse fish at several locations.

Issue	Guidelines
Release of Fish (cont.)	➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient portion of the fish such that proportion of natural and hatchery fish can be estimated accurately.
Management of Returning Adults	➢ <u>Proportion of project fish spawning naturally with the target population</u>: *If the project meets all other guidelines and is estimated to provide a net benefit to the target natural population* (see Part 2), there is no restriction on the proportion of hatchery fish *of this stock* on the spawning grounds of the target population for the first three generations. After three generations, restrictions should be considered after a detailed program review and risk analysis. ➢ <u>Control of straying to non-target populations</u>: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically distinct populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species and that capture the returning adults as an egg source, or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds where this stock did not historically occur, unless it is a reintroduction project. ➢ Return hatchery-spawned carcasses to local streams for nutrient supplementation following written a application to the co-managers and meeting fish health guidelines.

Table A.2. Guidelines for Integrated-Harvest Projects

Issue	Guidelines
Natural Population Status	➢ Not at significant risk of extinction
Scale of Project	➢ Total hatchery production should be based on meeting harvest objectives, legal agreements, or treaty obligations while keeping within genetic and ecological guidelines. ➢ Duration of project is unrestricted when guidelines are met. ➢ The total abundance of the target population should not exceed the carrying capacity of its habitat.
Changing or Terminating the Project	➢ If population is believed to be at significant risk, terminate or change to integrated-recovery project. ➢ If number of hatchery fish spawning in the target population cannot be limited to acceptable levels (see below), reevaluate the project.
Measures of Success	➢ Successful integrated-harvest projects will ▪ produce fish for harvest; ▪ maintain the number of natural origin recruits (NORs) above the critical/low threshold; ▪ produce adult hatchery fish that are similar to wild fish in terms of size, age, morphology, behavior and geographic and temporal spawning distribution; ▪ maintain the genetic diversity within the watershed and ESU.
Choice of Brood Stock	➢ Use only natural or hatchery origin returns from the target population.
Collection of Brood Stock	➢ Collect in a number and manner that minimizes genetic differences between hatchery and natural components of the population and that minimizes genetic changes to the whole population over time. ▪ Collect numbers of brood stock proportionally with respect to age, sex, and run timing over the entire spawning run. ▪ Include all ages. Jacks and precocious parr should be included in proportion to their natural occurrence. ▪ Ideally, a substantial proportion of the brood stock each generation should be natural origin fish. ➢ Brood stock should be collected to minimize prespawning mortality. ➢ Limit the number of fish collected for brood stock so that the number remaining to spawn naturally will meet minimum population size recommendations or escapement goals. (If it is impossible to meet this guideline, consider whether the objective of this project would be better met by an integrated-recovery project or an isolated-harvest project.)

Issue	Guidelines
Brood Stock Spawning	➢ Randomize all the matings of fish that are ready for spawning on a given day. ➢ Do not pool milt prior to fertilization. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining the variance effective population size.
Rearing of Fish	➢ Produce fish that are as similar to natural fish as possible in size, morphology, behavior, physiological status, health and other ecological attributes, balanced against the propagation goals of the project. ▪ Minimize dependence of chemical treatments to maintain fish health. ▪ Length of rearing should be the shortest period possible, balanced to ensure sufficient post-release survival and imprinting on the water where they are to return. ▪ Size at release should enhance post-release survival and minimize any negative ecological interactions that may be due to differences from wild fish. ➢ Prevent the introduction, spread, or amplification of fish pathogens in accordance with the *Co-Managers Fish Disease Control Policy*. ➢ Fish management ▪ Pool fish so that any differences in rearing conditions will affect all families equally. ▪ Culling should be as random as possible. ▪ Limit the number of times fish must be moved during rearing.
Release of Fish	➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient proportion of the fish released such that stray rates and the proportion of project fish in the target population can be accurately estimated.

Issue	Guidelines
Management of Returning Adults	➢ Proportion of project fish spawning naturally with the target population: If a project meets all other guidelines, the proportion of hatchery fish *of this stock* on the spawning grounds of the target population should be small (less than about 15% of the total abundance). ➢ Control of straying to non-target populations: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population and/or to the hatchery, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically dissimilar populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species capture returning adults as an egg source or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks. ➢ The use of fish weirs or racks should be considered if necessary to control the proportion of natural spawners that are hatchery fish.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds, unless they are the most suitable stock for a restoration project or unless they are being used in an isolated harvest project. ➢ Return hatchery -spawned carcasses to local streams for nutrient supplementation following a written application to the co-managers and meeting fish health guidelines.

Table A.3. Guidelines for Isolated-Harvest Projects.

Issue	Guidelines
Population Status	➢ Not applicable, as long as harvest or hatchery operations do not have a significant negative impact on natural populations.
Scale of Project	➢ Total hatchery propagation should be based on meeting harvest objectives, legal agreements, or treaty obligations while keeping within genetic and ecological guidelines. ➢ Duration of project is unrestricted as long as guidelines are met.
Changing or Terminating the Project	➢ If the guidelines on limiting genetic and ecological risks to natural populations cannot be met, change or terminate the project.
Measures of Success	➢ Successful isolated-harvest projects will ▪ Produce fish for harvest; ▪ Limit genetic and ecological impacts to natural populations to acceptable levels.
Choice of Brood Stock	➢ Any brood stock that has the desired life history traits to make the project successful. Where possible, these should be from local stocks.
Collection of Brood Stock	➢ Brood stock must be obtained without significant risks to natural populations.
Brood Stock Spawning	➢ Matings should be designed to accomplish project objectives.
Rearing of Fish	➢ Use appropriate aquacultural practices to maximize survival at all life history stages in the hatchery environment and returns of fish to the fishery. ➢ Fish size at release should enhance post-release survival and minimize any negative ecological interactions with wild fish. ➢ Prevent the introduction, spread, or amplification of fish pathogens in accordance with the *Co-Managers Fish Disease Control Policy*.
Release of Fish	➢ Design release strategies to allow fish to return to the desired areas at the desired times while minimizing straying and harmful ecological interactions. Strategies may include ▪ Locating hatchery or release facility to limit ecological interactions and improve isolation; ▪ Using only on-station releases of fish; ▪ Using volitional releases. ➢ Mark a sufficient proportion of the fish such that stray rates can be measured accurately.

Issue	Guidelines
Management of Returning Adults	➢ <u>Proportion of project fish intended for spawning in the wild</u>: None. ➢ <u>Control of straying to natural populations</u>: Gene flow from project fish to native, natural populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically distinct populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than the proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species and that capture the returning adults as an egg source or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds where this stock did not historically occur unless it is for another isolated harvest project or unless this is the most appropriate stock for a reintroduction project. ➢ Hatchery -spawned carcasses may be returned to local streams for nutrient supplementation where appropriate. Plantings of carcasses should be based on a written application to the co-managers and must meet fish health guidelines for carcass distributions.

Table A.4. Guidelines for Isolated-Recovery Projects.

These guidelines are primarily aimed at captive brood stock projects. Most other recovery projects are probably more appropriately treated under the 'integrated' category.

Issue	Guidelines
Population Status	➢ Population at very high risk of extinction.
Scale of Project	➢ Total production should be based on the number of fish needed to ▪ prevent extinction, ▪ adequately represent genetic variation for life history traits of the wild population, ▪ minimize genetic change during captivity, ▪ reestablish the fish in the wild. ➢ Duration should be a short as possible (ideally, 1-3 generations or less).
Changing or Terminating the Project	➢ If risk of immediate extinction lessens because causes of decline are being corrected, terminate or change to an integrated-recovery project.
Measures of Success	➢ Successful projects will ▪ Prevent extinction ▪ Maintain fish with minimal genetic change from the original source population; ▪ Reintroduce fish that are phenotypically similar to wild fish of the same age in development, morphology, physiological state, and behavior. ▪ Increase the number of fish reproducing successfully in the wild.
Choice of Brood Stock and collection	➢ Use as brood stock only fish from the population targeted for recovery. ➢ Collect as representative a sample from the population as possible and collect sufficient numbers of fish to meet minimal guidelines on maintaining a sufficiently large genetic effective population size.
Brood Stock Spawning	➢ Spawn all available adults ➢ Retrieve all possible eggs from mature females, either by multiple live spawning while minimizing stress to the fish or by careful attention to ripeness and handling. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining the variance effective population size. If brood stock sizes must be very small due to low natural population abundance, use spawning protocols that will maximize genetic effective size, such as ▪ factorial matings ▪ use of cryopreserved sperm ▪ induced spawning ▪ fertilizing with milt from a second male ~ 60 seconds after initial fertilization ("backup male").

Issue	Guidelines
Brood Stock Spawning (cont.)	➢ Weigh benefits of using cryopreserving sperm or sperm extender against potential loss of viability, especially when the number of available eggs is very low.
Rearing of Fish	➢ Use rearing conditions that maximizing survival at all life history stages in the hatchery environment, while producing fish that are qualitatively similar to natural fish in size, morphology, behavior, physiological status, health and other ecological attributes that are important for fitness. Emphasize maximizing survival when threats to population abundance (extinction) are greatest; emphasize similarity to natural fish when preparing for reintroduction (see below). ➢ As much as possible, mimic wild rearing conditions (light, cover, substrate, flow, temperature, densities) for fish to be released in the wild. ➢ Facilities for freshwater rearing should have access to pathogen and predator free water. ➢ Transfer of fish to seawater for rearing or release should be done so as to not compromise the ability of the fish to adapt to seawater. ➢ Seawater-based rearing facilities should be able to withstand the effects of storms, harmful phytoplankton, predation, poaching, and disease.
Release of Fish	➢ Release fish at a life stage where probability of survival is greatest. ➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Design release strategies to integrate hatchery-reared fish with wild fish of the same life history stage, if any remain in the stream. ➢ When fish are likely to remain in the release area (for example, presmolts or residuals), disperse fish at several locations. ➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient proportion of the fish such that stray rates can be accurately estimated.
Management of Returning Adults	➢ <u>Proportion of project fish spawning naturally with the target population</u>: If the project meets all other guidelines and is estimated to provide a net benefit to the target population (see Part 2), there is no restriction on the proportion of hatchery fish *of this stock* on the spawning grounds during the reintroduction phase of the project. ➢ <u>2. Control of straying to non-target populations</u>: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population and/or to the hatchery, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically dissimilar populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population.

Issue	Guidelines
Other Disposition of Fish	➢ Where isolated recovery projects produce more fish than are needed for future brood stock or release into the wild, the extra fish will be culled randomly and disposed of in a manner that is agreeable to the co-managers and that does not jeopardize the project or other recovery projects.

APPENDIX B. MONITORING ACTIVITIES

This section summarizes monitoring associated with hatchery production. It is not intended to be a complete description of all the monitoring that provides important information for making decisions about hatcheries undertaken by the co-managers. The co-managers describe monitoring of the contribution of hatchery fish to different fisheries or the proportion the hatchery and wild fish escaping to spawning grounds, for example, in harvest resource management plans. In addition, individual hatchery programs may monitor additional aspects of fish culture, fish performance, and environmental quality that are not included here. Descriptions of these are available in HGMPs.

Marking, Release, and Sampling of Hatchery Fish

Kinds of Marks

The ability to distinguish hatchery fish from naturally produced fish is a prerequisite for monitoring hatchery fish once they leave the hatchery. The co-managers maintain extensive marking programs for hatchery fish. The programs rely on three main kinds of marks: adipose fin clips, coded-wire tags (CWT), and otolith marks. Clipping the adipose fin of juvenile salmon (sometimes called mass marking) provides a quick method of identifying whether a fish originated in a hatchery but provides no other information. Marking a fish with a coded-wire tag is more difficult and expensive but it also provides specific information about where, when, and under what conditions the fish was raised and released. Otolith marks provide hatchery and production group specific information but are more difficult to read and are less commonly used. There has been little formal effort to coordinate otolith marks or sampling among programs or species. Finally, at least one stock of hatchery fish in the Puget Sound—Tulalip fall chum salmon—has a genetic mark, which allows managers to monitor not only the presence of hatchery fish but also their progeny.

The CWT system provides most of the scientific monitoring data for hatchery coho salmon and Chinook salmon. The CWT system is an extensive, cooperative, international program. A selected sample of hatcheries from British Columbia, Washington, and Oregon applies CWTs to statistical sample of their fish (e.g., Figure 16, Table 23, Table 24). Most CWT fish also have adipose fin clips to allow surveyors to identify whether a fish has a CWT that should be de-coded. A few programs have double index tags (DIT). This involves tagging paired groups of fish from a hatchery with CWT but one group has an adipose fin clip and the other does not. Data from CWT fish are collected during ocean fisheries, recreational fisheries, hatcheries, and spawning ground surveys and maintained in public databases by the Pacific States Marine Fisheries Commission.

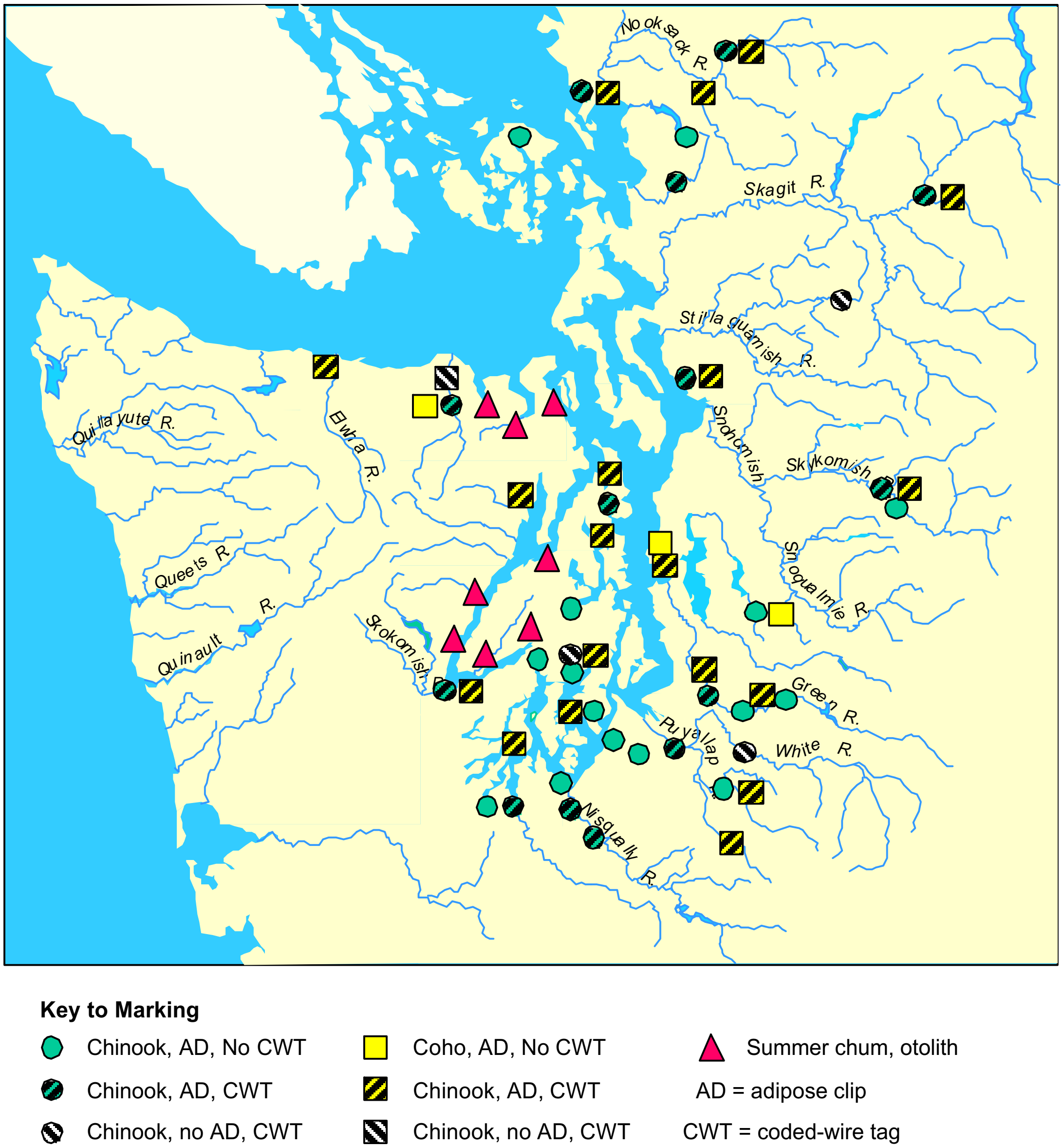

Figure 16. Locations of fish marking programs in the Puget Sound based on 2001 releases.

Chinook Salmon

Table 23. Coded-wire tag (CWT) and adipose (AD) marking and releases of 2000 brood-year Chinook salmon from Puget Sound hatcheries in 2001 (SFEC-RCWG 2003).

		CWT		No CWT		
Hatchery	Group	AD	No AD	AD	No AD	Total
Bernie Gobin	Tulalip Tribe	162,137	3,141	24,863	1,229,859	1,420,000
Clear Creek*	Nisqually Tribe	169,143	176,207	2,068,077	294,881	2,708,308
Coulter Creek	WDFW	0	0	1,088,728	14,272	1,103,000
Diru Creek	Puyallup Tribe	233,487	3,767	4,144	2,755	244,153
Dungeness	WDFW	94,431	706,201	177,869	1,106,279	2,084,780
Elwha	WDFW	0	0	0	2,583,000	2,583,000
Garrison Springs	WDFW	0	0	619,236	27,149	646,385
George Adams*	WDFW	223,009	227,460	487	3,384,664	3,835,620
Glenwood Springs	WDFW	0	0	250,000	0	250,000
Gorst Creek	Suquamish Tribe	0	0	1,275,443	13,404	1,288,847
Grovers Creek*	Suquamish Tribe	203,754	206,563	25,211	229,427	664,955
Hoodsport	WDFW	0	0	0	3,059,892	3,059,892
Hupps Springs (White River)	WDFW	0	238,765	0	3,562	242,327
Issaquah	WDFW	0	0	2,053,605	141,168	2,194,773
Kalama Creek	Nisqually Tribe	83,178	3,655	471,237	9,529	567,599
Kendall Creek*	WDFW	197,364	199,511	1,636	1,248,789	1,647,300
Keta Creek	Muckleshoot Tribe	0		587,392	0	587,392
Lummi Bay	Lummi Tribe	167,171	4,003	801,414	18,663	991,251
Marblemount	WDFW	366,150	736	1,471	0	368,357
Marblemount (springs)	WDFW	268,460	541	1,078	0	270,079
McAllister Creek	WDFW	0	0	841,476	31,424	872,900
Minter Creek	WDFW	0	0	1,789,587	55,063	1,844,650
Percival Cove Net Pens	WDFW	0	0	591,127	22,673	613,800
Samish*	WDFW	146,129	151,312	3,225,739	219,097	3,742,277
Soos Creek*	WDFW	194,248	205,861	2,945,147	50,409	3,395,665
Tumwater Falls	WDFW	109,140	11,110	2,992,044	96,906	3,209,200
Voights Creek	WDFW	0	0	1,571,505	39,935	1,611,440
Wallace River*	WDFW	205,008	215,556	776,559	26,071	1,223,194
White River	Muckleshoot Tribe	0	253,592	0	26,121	279,713
Whitehorse	WDFW	0	192,789	0	0	192,789

Table 24. Coded-wire tag (CWT) and adipose (AD) marking and releases of 1999 brood-year Chinook salmon from Puget Sound hatcheries in 2001 (SFEC-RCWG 2003).

		CWT		NO CWT		
Hatchery	Group	AD	No AD	AD	No AD	Total
Bernie Gobin	Tulalip Tribe	37,861	282	494	143	38,780
Chambers Creek	WDFW	0	0	80,289	8,722	89,011
Fox Island Net Pens	WDFW	0	0	196,367	14,783	211,150
Gorst Creek	Suquamish Tribe	0	0	110,052	0	110,052
Hoodsport	WDFW	0	0	0	247,931	247,931
Hupps Springs (White River)	WDFW	0	83,742	0	6,595	90,337
Icy Creek	WDFW	0	0	241,300	0	241,300
Lakewood	WDFW	0	0	172,122	14,234	186,356
Marblemount*	WDFW	71,246	74,251	865	1,031	147,393
McAllister Creek	WDFW	0	0	122,005	7,995	130,000
Mukilteo Net Pens	WDFW	0	0	1,900	0	1,900
Samish	WDFW	0	0	78,235	5,448	83,683
Tumwater Falls	WDFW	67,926	1,965	107,034	3,075	180,000
Wallace River	WDFW	0	0	500,000	0	500,000
Whatcom Creek	WDFW	0	0	120,980	0	120,980
White River	Muckleshoot Tribe	0	82,204	0	7,735	89,939

Developing and Maintaining Genetic Baselines

Genetic monitoring and evaluation are important elements of the oversight and stewardship responsibilities of the comanagers. Since the inception of the WDFW Genetics Laboratory in 1985, the comanagers have implemented an ambitious field sampling program to obtain the necessary tissue samples (and associated biological data) and conducted laboratory-based genetic analyses of Pacific salmon and trout. The comanagers have now collected over 26,000 samples for allozyme analysis and over 40,000 samples for DNA analysis (Table 25).

In order to federal ESA needs for relevant biological data upon which to evaluate alternative approaches, actions, and ESU status and compliance, the comanagers will continue to collect biological samples of both natural and hatchery spawning population of Pacific salmon and trout throughout Puget Sound. It is our intent to collect genetic samples (almost entirely non-lethal tissue samples for DNA analysis) from a total of approximately 200-300 fish from each of the natural-spawning and hatchery-produced populations of Pacific salmon, steelhead, and resident trout in Puget Sound over the coming five years.

Hatchery Brood Stock Selection

Each hatchery program monitors compliance with brood stock selection guidelines. Appropriate sources and methods for collecting brood stock are described in HGMPs and WDFW's Hatchery Operation Plans and Performance Summaries. During spawning, hatchery personnel monitor the number, sex, and developmental state of all brood stock.

Fish Culture and Health

Each hatchery program monitors standard fish culture variables, including environmental characteristics (e.g., water temperature and flows) and number of eggs collected, fertilization success, feeding rates, growth and survival to different developmental stages, number of fish marked, locations and dates of fish transfers between rearing locations, fish health, and number and size of fish released.

Both the state and tribes conduct rigorous fish health monitoring. At spawning, WDFW and tribal fish pathologists examine a minimum of 60 ovarian fluid samples and 60 kidney and spleen samples for viral pathogens from each group and stock of fish. During rearing, the pathologists examine a representative sample of each stock of fish monthly, before transfer, and before release and the findings are recorded on WDFW Form FH01 or in the Fish Health Database at the Northwest Indian Fisheries Commission (NWIFC). Pathologists report and control fish pathogens following the Co-managers' Fish Disease Policy. All hatcheries monitor compliance with fish disease prevention and therapeutic measures, such as disinfection of eggs with iodophor, disinfection of nets, boots, tanks, and rain gear, administering antibiotics, and control of parasites.

Screening and Passage

Hatchery intakes deliver water by either gravity or pumped induction to specific hatchery ponds or to a water collection facility. Intakes are screened to prevent wood debris, river sediments, juvenile fish, amphibians and aquatic invertebrates from entering the system. Tribal hatchery programs assess screening as part of routine maintenance. WDFW has assessed hatchery screening on a number of occasions (Shelfer, pers. comm.; Mills 2001) and is in the process of reassessing each facility in Puget Sound relative to current guidelines and criteria. Screening criteria and guidelines under which facilities may be assessed include: 1) WDFW Screening Requirements for Water Diversions (no date); RCW 77.16.220, RCW 75.20.040, RCW 75.20.061; 2) Fish Protection Screen Guidelines for Washington State (WDFW 2001); 3) NMFS Juvenile Fish Screen Criteria (1995) and 4) NMFS Juvenile Fish Screen Criteria for Pump Intakes (1996).

Table 25. Puget Sound genetic baseline collections and data for Pacific salmon, steelhead, and resident rainbow trout (1985-2003).

		Allozyme Data				DNA Data				Archived for DNA Analysis			
Species	Origin	Collections	Populations	Years	Total Fish	Collections	Populations	Years	Total Fish	Collections	Populations	Years	Total Fish
Chinook salmon	N	60	28	16	3773	17	4	7	964	77	27	18	5179
	H	45	13	12	4182	9	7	2	967	53	16	17	4980
Coho salmon	N	-	-	-	-	2	1	2	180	47	18	9	6696
	H	-	-	-	-	7	3	3	610	24	12	10	2384
Chum salmon	N	122	63	18	9395	14	12	8	897	161	65	19	12773
	H	21	10	11	2012	4	4	3	249	28	10	13	2860
Pink	N	63	27	12	4655	2	2	1	200	34	14	8	2794
	H	7	6		450	1	1	2	956	4	2	2	1006
Sockeye	N	-	-	-	-	4	4	1	253	8	4	3	651
	H	-	-	-	-	-	-	-	-	-	-	-	-
Steelhead	N	26	25	4	1543	-	-	-	-	18	10	7	751
	H	3	3	2	150	-	-	-	-	4	4	3	294
Resident	N	6	2	5	266	2	2	2	162	3	3	3	202
O. mykiss	H	5	5	1	521	4	4	3	296	4	4	6	296

Hatchery facilities may include weirs, traps, or channels to assist in the collection of returning adults for hatchery broodstock. Passage criteria and guidelines are available in several locations, including: 1) WAC 220-110-070, RCW 77.55.060, RCW 77.55.070; 2) Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (WDFW 2000); and 3) Fishway Guidelines for Washington State (WDFW 2000). Fish passage facilities were most recently reviewed by Mills (2001); WDFW is in the process of reassessing each facility in Puget Sound relative to current guidelines and criteria.

Pollution Abatement

Hatchery programs monitor water quality at their facilities to identify 1) when detrimental environmental changes in the watershed from logging, road building, or urbanization hatchery might be decreasing water quality to a point where it impacts fish culture, and 2) when discharges from hatchery might be negatively impacting water quality and require changes in fish culture. WDFW hatchery programs at facilities producing more than 20,000 pounds of fish annually monitor water quality variables to meet the requirements of the National Pollution Discharge Elimination Permit System (NPDES), which is administered by Washington Department of Ecology. Tribal programs located on reservations also monitor water quality. Tribes are currently working with the Environmental Protection Agency (EPA) to develop a starndardized process for monitoring and reporting. Variables that are usually monitored as part of the NPDES system include total suspended solids, settleable solids, upstream and downstream temperatures, upstream and downstream dissolved oxygen, water temperatures in the hatchery, and dissolved oxygen in the hatchery. Specific performance standards for WDFW hatchery programs are described in WDFW's Hatchery Operation Plans and Performance Summaries.

APPENDIX C: RESEARCH

Tribal Hatchery Research Programs

The Tribes have been using recently available funds for hatchery reform to identify and fund research to improve hatchery practices. Each year, the Northwest Indian Fisheries Commission (NWIFC) solicits proposals for research from member tribes. NWIFC biometricians, salmon ecologist, and fish geneticist work with the tribes to develop rigorous research proposals. The projects are presented, evaluated, and ranked by merit by tribal enhancement biologists and independent NWIFC scientists during a two-day workshop. Ranking is based on the description of methods (20%), assumptions (10%), costs (15%), and relevance to hatchery reform (55%). A Hatchery Reform Steering Committee evaluates the process for soliciting, improving, and selecting submitted projects for tribal hatchery reform funding annually and suggests changes.

During 2002-2003, 24 tribal projects focused on improving hatchery practices and 10 projects to improve hatchery tribal facilities received funding though the competitive ranking process in 2002-2003. Most projects focused on Chinook salmon (*Oncorhynchus tshawytscha*), which is listed under the Endangered Species Act (Figure 17). This reflected the higher priority given to projects associated with salmon recovery in the project ranking process and the importance of this species to the tribes rather than the relative need for hatchery reform for this species. The largest proportion of projects to improve hatchery practices focused on critical gaps in knowledge for choosing and modifying rearing-and-release strategies and evaluating potential interactions of hatchery and wild fish.

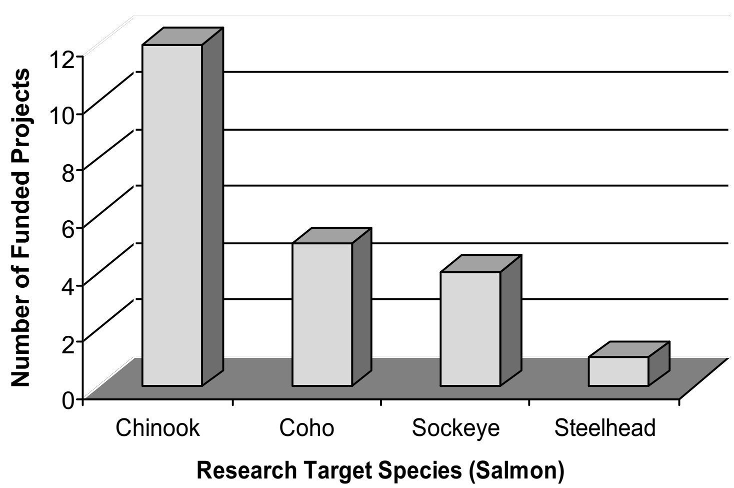

Figure 17. Number of tribal hatchery-reform research projects funded by species for 2002-2003.

Table 26. Hatchery-reform implementation projects for western Washington Treaty Tribes (2001).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	$54,716.00	$54,716.00
1-2	Stillaguamish	Determine if there have been genetic and morphological changes in North Fork Stillaguamish River summer Chinook	$49,355.00	$104,071.00
1-3	Lower Elwha	Lower Elwha enriched rearing environment study	$76,833.61	$180,904.61
1-4	Makah	Lake Ozette salmon out-migration monitoring project	$59,081.00	$239,985.61
1-5	Makah	Acoustic and radio telemetry of adult Lake Ozette sockeye, phase II	$40,000.00	$279,985.61
1-6	Stillaguamish	Smolt investigations on the mainstem Stillaguamish River	$50,213.00	$330,198.61
1-7	Puyallup	Puyallup Tribe's Chinook evaluation of Diru Creek	$16,461.58	$346,660.19
1-8	Quinault	Evaluation of Quinault hatchery steelhead smolt release strategies	$69,719.01	$416,379.20
1-9	Lummi	Lummi Bay Chinook tagging study	$28,121.00	$444,500.20
1-10	Nisqually	Chiller system for incubation water	$89,600.00	$534,100.20
1-11	Suquamish	Gorst Creek fall Chinook rearing ponds mass marking and hatchery/wild interactions monitoring and evaluation study	$89,992.00	$624,092.20
1-12	Lummi	Co-occurrence of hatchery and natural Chinook and coho in Nooksack near-shore habitats	$39,259.58	$663,351.78
		Total	**$663,351.78**	

Table 27. Hatchery-reform implementation projects for western Washington Treaty Tribes (2002).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Lower Elwha	Lower Elwha Enriched Rearing Environment Study	48,388.26	$48,388.26
1-2	Makah	Umbrella Creek Resistance Board Weir & Adult Trap Operation	17,683.00	$66,071.26
1-3	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	57,770.00	$123,841.26
1-4	Makah	Lake Ozette Sockeye Salmon Out-migration Monitoring Project	16,390.00	$140,231.26
1-5	Nisqually	Estimating Hatchery & Natural Returns of Chinook by Age to the Nisqually River	31,893.00	$172,124.26
1-6	Stillaguamish	Smolt Outmigration Study on the Stillaguamish River	47,810.00	$219,934.26
1-7	Makah	Lake Ozette Sockeye Computer-Enhanced Run Size Monitoring	24,503.00	$244,437.26
1-8	Tulalip	Survival Rate Comparison of Summer & Fall Chinook Broodstock at Tulalip Hatchery	31,653.00	$276,090.26
1-9	Nisqually	Juvenile Salmon Utilization of the Nisqually River Estuary	9,661.00	$285,751.26
1-10	Puyallup	Puyallup Tribe's Chinook Evaluation for Diru Creek	17,880.26	
1-11	Squaxin Island	Examination of Relative Return Rates & Straying of Coho Based on Broodstock & Intermediate Rearing Locations	61,200.00	
1-12	Suquamish	Increasing Post-Release Survival of Chinook Using Semi-Natural Rearing Habitat at Gorst Creek Hatchery	27,054.00	$312,805.26
1-13	Squaxin Island	Acoustic Monitoring of Tagged Juvenile Coho in South Puget Sound	49,245.39	$362,050.65
1-14	Makah	Genetic Characterization of Lake Ozette Sockeye Salmon	40,064.00	$402,114.65
		Total	$481,194.91	

Table 28. Hatchery-reform implementation projects for western Washington Treaty Tribes (2003).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	$53,844.00	$53,844.00
1-2	Puyallup	White River Spring Chinook Broodstock Identification and Hybridization Study	$38,709.00	$92,553.00
1-3	Lower Elwha	Lower Elwha Enriched Rearing Environment Study	$48,388.26	$140,941.26
1-4	Tulalip	Survival Rate Comparisons of Summer & Fall Chinook Broodstock at Tulalip Hatchery	$33,875.00	$174,816.26
1-5	Makah	Umbrella Creek Sockeye Broodstock Capture & Adult Escapement Monitoring	$27,004.00	$201,820.26
1-6	Makah	Lake Ozette Sockeye Salmon Smolt Out-Migration Monitoring Project	$12,959.00	$214,779.26
1-7	Stillaguamish	Characterization of the Hatchery & Wild Chinook Smolt Outmigration on the Stillaguamish River	$69,261.00	$284,040.26
1-8	Quinault	Evaluation of Supplemental Coho Smolt Survival	$23,898.00	$307,938.26
1-9	Makah	Hoko River Chinook Salmon Smolt Out-Migration Monitoring Project	$19,308.00	$327,246.26
1-10	Nisqually	Juvenile Salmon Utilization of the Nisqually River Estuary	$40,460.00	$367,706.26
		Total	$367,706.26	

WDFW Hatchery Research Programs

WDFW conducts extensive research on hatchery programs throughout the state of Washington that are funded by state, federal, and local sources. Research expected to be conducted during 2004 is summarized in Table 29 relative to four primary categories: 1) genetics, 2) ecological interactions, 3) program performance, and 4) population structure of hatchery and natural populations.

Two recent appropriations have significantly enhanced the ability of WDFW to address critical questions related to the operation of artificial production programs: 1) a biennial appropriation of 1.0 million from the state legislature for implementation of HSRG recommendations; and 2) an annual federal appropriation of approximately 1.0 million for support of the HSRG process. WDFW has scored and prioritized potential research projects relative to six criteria: 1) consistency with HSRG recommendation; 2) required by HGMP or compliance with state or federal regulations; 3) status of affected natural populations; 4) opportunities for cost sharing; and 5) feasibility.

Table 29. Hatchery-reform implementation projects for WDFW in 2004.

Question	Species and/or Locations
1.0 Genetics. What are the magnitude of genetic effects of hatchery programs on wild salmonid populations.	
1.1 Inbreeding Depression. What is the magnitude of the effect in wild salmonid populations of inbreeding depression associated with hatchery programs?	No current research.
1.2 Outbreeding Depression. What is the magnitude of the effect in wild salmonid populations of outbreeding depression associated with hatchery programs?	No current research.
1.3 Domestication. What is the magnitude of the effect in wild salmonid populations of domestication associated with hatchery programs?	Deschutes River. Evaluate reproductive success and fitness maintenance of hatchery origin chinook spawning naturally in the Deschutes River. Minter Creek. Evaluate the reproductive success, fitness maintenance of hatchery and wild origin coho spawning in naturally in Minter Creek. Snow Creek. Evaluate the effectiveness of alternative artificial production strategies for restoring Snow Creek coho. Kalama River. a) Evaluate the survival from emergence to adult return of wild origin summer steelhead spawning in the Kalama River versus wild fish spawned and reared in the Kalama Falls Hatchery; and b) evaluate the survival from release to adult of hatchery (Chambers Creek origin) and wild (Kalaman River) origin fish reared at Kalama
	Yakima River. a) Monitor the reproductive behavior of hatchery and wild origin spawners in a spawning channel and evaluate the reproductive success of hatchery, wild, and hatchery x wild crosses; b) compare the survival and fecundity of adults returning from conventional and semi-natural rearing treatments; and c) measure genetic changes caused by adaptation to the hatchery environment. Tucannon River. Evaluate the effects of supplementation on wild stocks of steelhead and chinook. Wenatchee River. Evaluate the effects of supplementation on wild stocks of steelhead, chinook, and sockeye. Methow River. Evaluate the effects of supplementation on wild stocks of steelhead, chinook, and sockeye.

Question	Species and/or Locations
2.0 Ecological. What are the magnitude of the ecological effects of hatchery programs on wild salmonid populations?	
2.1 Predation. What is the magnitude of predation mortality on wild salmonid populations resulting from the presence of fish of hatchery origin?	
2.1.1 Direct Predation. What is the rate of predation of fish released from hatcheries on natural populations of salmonids.	Deschutes River. Estimate the consumption rate of chinook by steelhead and the percentage of the total chinook population consumed by steelhead. Green River. Estimate the consumption rate of chinook by coho, steelhead, and yearling chinook.
2.1.2 Indirect Predation. How are predation losses of wild salmonids affected by the presence of fish of hatchery origin.	Lake Washington. Evaluate the effects of varying numbers of hatchery and natural origin sockeye smolts on survival rates through the Lake Washington basin.
2.2 Competition. What is the magnitude of the effect of competitive pressures on wild salmonid populations resulting from the presence of hatchery fish?	
2.2.1 Competition - Freshwater Rearing.	No current research.
2.2.2 Competition - Freshwater Migration.	No current research.
2.2.3 Competition - Estuaries and Puget Sound.	No current research.
2.2.4 Competition - Ocean.	No current research.
2.2.5 Competition - Adult Spawning.	Cedar River. Evaluate the effects of the number of sockeye spawners on the survival of chinook from egg deposition to lake entry.

Question	Species and/or Locations
2.3 Behavioral Anomalies. What is the magnitude of the effect on wild salmonid populations of behaviorial anomalies (e.g., "Pied Piper"effect) resulting from the presence of hatchery fish?	No current research.
2.4 Disease. What is the magnitude of the effect on wild salmonid populations of disease related to hatchery programs?	
2.4.1 Disease - Direct. What is the magnitude of the effect on wild salmonid populations of disease transmitted from fish of hatchery origin?	No current research.
2.4.2 Disease - Indirect. What is the magnitude of the effect on wild salmonid populations of disease resulting from indirectly from the presence of hatchery origin fish (e.g., disease rate inflated because of agonistic interactions)?	No current research.
2.5 Nutrient Dynamics. What is the magnitude of the effect on wild salmonid populations of increased nutrient levels resulting from the carcasses of hatchery fish that spawned in natural areas?	No current research.

Question	Species and/or Locations
3.0 Program Performance. What is the survival rate of fish released from the hatchery? What is the percentage of natural escapement comprised of fish of hatchery origin? How can the performance of a program be improved?	Marking and tagging. See individual program descriptions. Escapement sampling and analysis. See monitoring section. Improved program performance. a) Evaluate the effect of dirt ponds on survival of steelhead at Marblemout Hatchery. b) Evaluate the effect of a low phosphorous diet on survival of coho at Issaquah Hatchery. c) Evaluate the survival benefits obtained from sorting fish to achieve a target size at release for Wallave Hatchery coho, George Adams Hatchery coho, Naselle Hatchery coho, Kalama Fall Hatchery chinook, Washougal Hatchery chinook. d) Evaluate the improvements in survival associated with increased pigmentation resulting from feeding coho at Soos Creek Hatchery with astaxanthin. e) Evaluate survival benefits of NATURES rearing of coho at Soos Creek Hatchery. f) Evaluate survival benefits of directional feeders for coho in SPS net pens. g) Evaluate relative survival of small and large coho at Marblemeount Hatchery. h) Compare genetics and life history characteristics among South Sound, Skykomish, and Minter Creek Hatchery.
	i) Evaluate rate of straying of using local (Minter Creek) and nonlocal (Skykomish) coho in South Sound net pens. j) Compare rates of straying between in-region and out-of-region incubation and rearing.
4.0 Population Structure. What is the structure of the natural populations that the hatchery program might affect?	Genetic sampling and analysis. See monitoring section.

APPENDIX D: RISK ASSESSMENT MODELING PROJECT

Overview

What Is It?
The goal of this project is to develop a risk assessment tool for hatcheries that is consistent, transparent, and scientifically defensible. The focus is on biological risks to natural production, including risk to hatchery fish that are part of a conservation strategy for natural production. Risk is the set of outcomes associated with a hazard (source of loss) that have different consequences and probabilities of occurring.

Hatcheries pose four general kinds of hazards to natural populations—genetic, ecological, demographic, and facility—with different components (Figure 18). Our objective is to develop a separate assessment tool (or module), such as a causal probabilistic network (Figure 19), for each of these components that quantifies as much as possible the risks associated with each under different conditions.

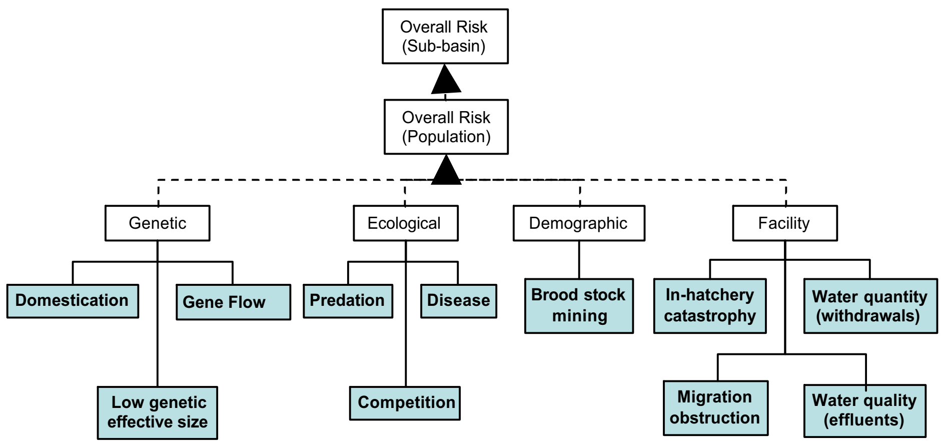

Figure 18. One possible organization of hatchery hazards. Shaded boxes are potential risk modules. Dotted lines show the roll-up of risks from all hazards to an overall risk for the population or sub-basin.

The consequences of these hazards can be measured in different ways, such as effects on abundance, fitness, or diversity. Ideally, we want to rollup the risks of each of these (i.e. take into account the interactions between the hazards) to an overall risk to the population or sub-basin, but developing this part of the tool may not be possible within the time-frame of this project.

Who Wants The Tool?
Western Washington treaty tribes, state, and federal agencies involved in managing hatcheries in the Columbia River and western Washington want an objective, transparent, rigorous tool for hatchery reform. The project was solicited by the Northwest Power Planning Council and is funded by Bonneville Power Administration.

Who Is Involved?
An important objective of this project is to represent the best available knowledge on these risks by including broad scientific participation. We have four key groups of participants. They are not mutually exclusive.

- *Principal Investigators*—Craig Busack, Ken Currens, Todd Pearsons, and Lars Mobrand are the principal investigators (PIs). They will do the bulk of the model development.
- *Advisory Group*—The advisory group consists of 10-12 scientists with 3-4 experts in each of the major kinds of hazards. Their role is to help the PIs identify the appropriate risk categories and sources of the risk the PIs wish to use (such as Figure 18), describe as influence diagrams or conceptual models the major factors influencing risk for each hazard, identify sources in the scientific literature of theoretical models that might be used, help with selection of the expert panel, and review the risk modules. Most of their participation will occur during three 2-day workshops.
- *Decision Theorists*—Two or three experts in decision theory, causal probabilistic networks, and expert elicitation help review the overall approach of the project.
- *Expert Panel*—This group includes 25-30 experts, including some members of the Advisory Group, who will be a source of expert knowledge on risk parameters when the scientific literature is inadequate. Expert elicitation will use the Internet.

When Does It Start?
The project starts in January 2004. The advisory group meets with the principal investigators in February and again in April and will receive regular updates on the project. Survey of the expert panel occurs during the summer. The advisory group meets again in September to review the final modules and report.

How Long Will It Take?
The project will completed by November 2004.

Whom Do I Contact for More Information?

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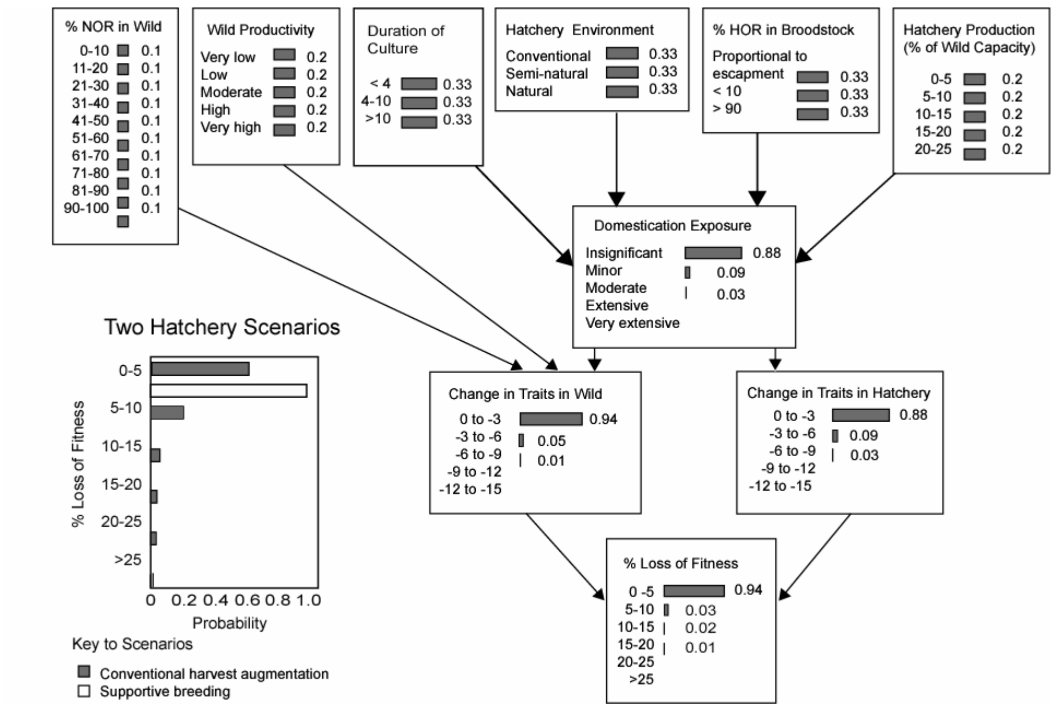

Figure 19. A causal probabilistic network for loss of fitness from domestication and risk assessment results from two hatchery scenarios (inset). The causal probabilistic network links different states of input variables (top row), dependent population variables, and risk outcomes through tables of probabilities developed from simulations, data, and expert knowledge. The histograms in the network show the initial probabilities before assessment. Inset histogram (lower left) shows probabilities for loss of fitness after assessment. The conventional harvest augmentation scenario assumed proportion of natural-origin recruits (% NORs) spawning in the wild was 41-50%; productivity in the wild was moderate; the program has been operating for 4-10 generations; the conventional hatchery environment was almost entirely artificial; more than 90% of brood stock was of hatchery origin (% HORs); and hatchery production was more than 20% of the stream's capacity. The supportive breeding scenario assumed the proportion of NORs spawning in the wild was 41-50%; wild productivity was low; the program has been going for less than 4 generations; hatchery environment was semi-natural; less than 10% of the brood stock was hatchery origin; and hatchery production was more than 20% of the stream's capacity.