PUGET SOUND

COMPREHENSIVE CHINOOK MANAGEMENT PLAN:

HARVEST MANAGEMENT COMPONENT

Puget Sound Indian Tribes

And

The Washington Department of Fish and Wildlife

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PILB

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Executive Summary

This Harvest Management Plan states objectives that will guide the Washington co-managers in planning annual harvest regimes, as they affect listed Puget Sound chinook, for the 2003 management year. These objectives comprise total or Southern U.S. exploitation rate ceilings, and / or spawning escapement goals, for each of fifteen management units. This Plan describes the technical derivation of these objectives, and how these guidelines are applied to annual harvest planning.

The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, but it considers the total harvest impacts of all fisheries, including those in Alaska and British Columbia, to assure that conservation requirements for all Puget Sound management units are achieved. Accounting of total fishery-related mortality includes incidental harvest in fisheries directed at other salmon species, and non-landed chinook mortality.

The fundamental intent of the Plan is to enable harvest of strong, productive chinook stocks and to minimize harvest of weak or critically depressed stocks. However, the Puget Sound ESU currently includes many weak populations. Providing adequate conservation of weak stocks will necessitate foregoing some harvestable surplus of strong stocks.

The recovery exploitation rate (RER) objectives stated for certain management units (Table 1) are ceilings, not annual target rates. The objective for annual, pre-season fishery planning is to develop a fishing regime that will exert exploitation rates that do not exceed the objectives for each management unit. For the immediate future, annual target rates that emerge from pre-season planning will, for many management units, fall well below their respective ceiling rates. While management units are recovering, annual harvest objectives will intentionally be conservative, even for relatively strong and productive populations.

To insure that the diversity of genetic traits and ecological adaptation expressed by all populations in the ESU are protected, critical abundance thresholds are specified. (Table 1). This threshold is intentionally set above the level at which a population may become demographically unstable, or subject to loss of genetic integrity. If abundance (i.e., escapement) is forecast to fall to or below this threshold, harvest impacts will be further constrained, so that escapement will exceed the threshold or a lower exploitation rate is achieved.

Recovery exploitation rates are based on the most current and best available information on the recent and current productivity of each management unit. Quantification of recent productivity (i.e., recruitment and survival) is subject to uncertainty and bias. The implementation of harvest regimes is subject to management error. The derivation of RER's considers specifically these sources of uncertainty and error, and averts the consequent risk that harvest rates will exceed appropriate levels. The productivity of

each management unit will be periodically re-assessed, and harvest objectives modified as necessary, so they reflect current status.

Table 1. Management objectives for Puget Sound chinook: Recovery exploitation rates, expressed either as total, southern U.S. (SUS), or pre-terminal southern US (PT SUS) rates, escapement goals, and critical abundance thresholds.

Management Unit	RER	Escapement Goal	Critical Abundance Threshold
Nooksack North Fork South Fork	Under development		 1,000 [1] 1,000 [1]
Skagit summer / fall Upper Skagit summer Sauk summer Lower Skagit fall	52%		4,800 2,200 400 900
Skagit spring Upper Sauk Cascade Siuattle	42%		576 N/A N/A N/A
Stillaguamish North Fork summer South Fork & MS fall	25%		650 [1] 500 [1] N/A
Snohomish Skykomish Snoqualmie	24%		2,800 1,745 [1] 521 [1]
Lake Washington Cedar River	15% PT SUS	 1,200	 200 [1]
Green	15% PT SUS	5,800	1,800
White River spring	20%		200
Puyallup fall South Prairie Creek	50%	 500	500
Nisqually		1,100	
Skokomish	15% PT SUS	3,650 aggregate, 1,650 natural	1,300 aggregate 800 natural
Mid-Hood Canal	15% PT SUS	750	400
Dungeness	10% SUS		500
Elwha	10% SUS		1,000
Western JDF	10% SUS		500

[1] natural-origin spawners

This Plan will be submitted to the National Marine Fisheries Service (NMFS), for evaluation under the conservation standards of the Endangered Species Act. Criteria for exemption of state / tribal resource management plans from prohibition of the 'take' of

listed species, are contained under Limit 6 of the salmon 4(d) Rule (ref). In brief, the 4(d) standard is that such activities shall not significantly reduce the likelihood of survival and recovery of the ESU. While recovery criteria for the Puget Sound ESU are being developed, this harvest plan will assure that all component populations are protected, and that the harvest of all units is implemented in manner more conservative than required by the ESA.

1. Objectives and Principles

This Harvest Management Plan consists of management guidelines for planning annual harvest regimes, as they affect Puget Sound chinook, for the 2003 – 2004 management year and beyond. The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, and considers the total harvest impacts of all fisheries on Puget Sound chinook, including those in Alaska, British Columbia, and Oregon. The Plan's objectives can be stated succinctly as intent to:

> *Manage harvest of strong salmon stocks to ensure that fishery-related mortality will not impede recovery of the productivity, abundance, and diversity of natural Puget Sound chinook salmon populations to levels consistent with treaty-reserved fishing rights, and cultural and ecological values*

This Plan will constrain harvest to the extent necessary to enable recovery of natural chinook populations in the Puget Sound evolutionarily significant unit (ESU). It includes explicit measures to conserve and recover productivity, abundance, and diversity among all the populations that make up the ESU. The ultimate goal is to rebuild natural productivity so that natural chinook populations will be sufficiently abundant and resilient to perform their natural ecological function in freshwater and marine systems, provide related cultural values to society, and sustain commercial, recreational, ceremonial, and subsistence harvest. .

The co-managers and the Puget Sound Shared Strategy have adopted abundance and productivity goals for each population, which are the endpoint for all aspects of recovery planning, which will include components for management of harvest and hatchery production, and conservation and restoration of freshwater and marine habitat.

In order to achieve recovery, the Harvest Management Plan adopts fundamental objectives and guiding principles. The Plan will:

- **Conserve the productivity, abundance, and diversity** of all the populations that make up the ESU.

- **Manage risk.**. The development and implemention of the fishery mortality limits in this Plan incorporate measures to manage the risks, and compensate for the uncertainty associated with quantifying and forecasting the abundance and productivity of populations, and projecting the dynamics of those populations under various exploitation rates. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the plan commits the co-managers to ongoing monitoring, research, and analysis, to better quantify and determine the significance of risk factors, and to modify the plan as necessary to minimize such risks.

- **Meet ESA jeopardy standards**. The ESA standard, as interpreted by the NMFS, is that activities, such as harvest regulated by this plan, may be exempted from the prohibition of take, prescribed in Section 9, only if they do not "appreciably reduce the likelihood of survival and recovery" of the ESU (50 CFR 223 vol 65(1):173). This plan meets that standard, not just for the ESU as a whole, but in several respects sets a more rigorous standard by conserving the abundance, diversity, and productivity of each component population of natural chinook within the ESU.

- **Provide opportunity for harvest surplus production from other species and populations,** subject to achieving the preceding conservation objectives. Continued harvest of sockeye, pink, and coho salmon, as well as the abundant hatchery production of chinook from Puget Sound and the Columbia River, is of central importance to the Northwest Indian tribes and non-Indian fishers. This plan eliminates chinook fisheries that target depressed runs, but permits some incidental catches from these runs in fisheries aimed at other runs with harvestable surpluses. The level of incidental catches is constrained within specific guidelines.

- **Account for all sources of fishery-related mortality**, whether landed or non-landed, incidental or directed, commercial or recreational, and occurring in the U.S. (including Alaska) or Canada, when assessing total exploitation rates.

- **Follow the principles of the Puget Sound Salmon Management Plan** (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers.

- **Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Chinook Chapter of Annex IV to the Pacific Salmon Treaty.**

- **Protect Indian treaty rights**. The exercise of fishing rights by individual tribes is limited to 'usual and accustomed' areas which were specifically described by subproceedings of *U.S. v. Washington* according to their historical use of salmon resources.

This Harvest Plan affects, primarily, management of Treaty Indian and non-Indian commercial and recreational salmon fisheries in Puget Sound, including net fisheries directed at steelhead. The geographic scope of the Plan encompasses fishing areas south of the Canadian border in the Strait of Juan de Fuca (east of Cape Flattery), and Georgia Strait. The Secretary of Commerce, through the Pacific Fisheries Management Council, is responsible for management of ocean salmon fisheries (i.e. troll and recreational) along the Oregon / Washington coast (i.e. in Areas 1 – 4B, from May through September). As participants in the PFMC / North of Falcon process, the Washington co-managers consider the impacts of these ocean fisheries on Puget Sound chinook, and may modify

them to achieve management objectives for Puget Sound chinook (PSSMP Section 1.3). Fisheries mortality in Alaska, Oregon, and British Columbia is also accounted in order to assess, as accurately as possible, total fishing mortality of Puget Sound chinook. Mortality of Puget Sound chinook in other Washington commercial and recreational fisheries, e.g. those directed at rockfish, halibut, shellfish, or trout, is not directly accounted.

Natural chinook abundance and productivity in Puget Sound is generally depressed, and for some populations, at critically low levels. Therefore, harvest of these populations must be limited, as part of a comprehensive recovery plan that addresses impacts from harvest, hatchery practices, and degraded habitat. Managing salmon fisheries in Washington to achieve this low impact on Puget Sound natural populations requires accounting of all sources of fishery-related mortality in all fisheries. This is not a trivial task since directed, incidental, and non-landed mortality must all be taken into account, and since Puget Sound chinook salmon are affected by fisheries in a large geographical area extending from southeast Alaska to the Oregon coast. However, since the 1980s research has focused on assessing fishing mortality across the entire range of Puget Sound chinook, so a large body of data and sophisticated computer models are available to quantify harvest rates and catch distribution.

The management regime must be guided by the principles of the Puget Sound Salmon Management Plan (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers. The PSSMP is the framework for planning and managing harvest so that treaty rights will be upheld and equitable sharing of harvest opportunity and benefits are realized. The fishing rights of individual tribes are geographically limited to 'usual and accustomed' areas that were specifically described by subproceedings of *U.S. v. Washington*. This chinook harvest plan is based on the principles of the PSSMP that assure that the rights of all tribes are addressed. Allocation of the non-Indian share of harvest among commercial and recreational users is a policy decision made by the Washington Department of Fish and Wildlife.

The 1999 Chinook Chapter to Annex IV of the Pacific Salmon Treaty also limits harvest in many of the fisheries that impact Puget Sound chinook. The abundance-based chinook management framework contained in the Chapter apply fishery-specific constraints to achieve reduced harvest rates when escapement goals for indicator stocks are not achieved (see section V.B.1). This Plan states how the annual fishing regime developed by the co-managers will comply with the PST agreement. Nearly all of the fisheries implemented under this plan will be directed at the harvest of species other than chinook or directed at strong chinook runs from other regions or strong hatchery chinook runs from Puget Sound. Therefore, nearly all of the anticipated harvest-related mortality to natural Puget Sound chinook will be incidental to fisheries directed at other stocks or species. Consequently, a wide range of management plans and agreements had to be taken into account in developing this plan.

Harvest-related mortality must be assessed in the context of other constraints on chinook survival. Non-harvest mortality is several orders of magnitude greater than the impact of harvest. If an adult female lays 5,000 eggs, and only two to six of those survive to adulthood, the non-harvest mortality rate exceeds 99.9%. Consequently, small improvement in the rate of survival to adulthood dwarf the potential effect from reduction of harvest. Increasing productivity, i.e. the recruitment per female spawner, is essential to recovery. Listing of the Puget Sound ESU has engendered a broad effort, shared by federal, tribal, state, and local governments and the private sector, to protect and restore habitat. Therefore, harvest must be managed so as not to impede recovery, as the capacity and productivity of habitat increases

This plan is based on limits to the cumulative annual fishery-related mortality to each Puget Sound chinook population. The limits are expressed either as an exploitation rate ceiling, which is the maximum fraction of the total abundance that can be subject to fishery-related mortality, or as a spawning escapement floor, which is the minimum abundance allowed to return to the natural spawning areas. In many cases, populations are aggregated into harvest management units because of the scale at which data that describe catch distribution are available. However, in every case, the fishery mortality limits apply to individual populations, and the effect of this plan on individual populations is the standard by which the guidelines were developed and will be the standard by which the plan's performance will be ultimately evaluated.

The development and implementation of the fishery mortality limits in this plan incorporate measures to manage the risks and compensate for the uncertainty associated with quantifying and forecasting the abundance and productivity of populations and projecting the dynamics of those populations under various exploitation rates. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the plan commits the co-managers to ongoing monitoring, research and analysis, to better quantify and determine the significance of risk factors, and to modify the plan as necessary to minimize such risks.

The 2001 version of this plan (PSIT and WDFW 2001) responded to the conservation standards of Section 4(d) of the Endangered Species Act (ESA), after Puget Sound chinook were listed as threatened. However, management objectives and tools have been evolving since the early-1990's in response to the declining status of Puget Sound stocks. Concern over the declining status of Puget Sound and Columbia River chinook has motivated conservation initiatives in the arena of the Pacific Salmon Treaty, and of the Pacific Fisheries Management Council. Efforts continue within these forums to address the current status of Puget Sound chinook. This Plan as well will continue to evolve as necessary to address changing management requirements and the needs of this fishery resource.

The ESA conservation standard, as interpreted by the NMFS, is that activities that involve take of listed chinook, such as harvest regulated by this plan, may be exempted from the prohibition of take, prescribed in Section 9, only if they do not "appreciably

reduce the likelihood of survival and recovery" (50 CFR 223 vol 65(1):173) of the ESU as compared with the alternative of not going forward with the action. The co-managers assert that this plan meets that standard, and in several respects sets a more rigorous standard for conserving the abundance, diversity and spatial structure of Puget Sound chinook.

2. Population Structure – Aggregation for Management

This section of the Plan describes the population structure of the Puget Sound chinook ESU, and how, in some river basins, populations of similar run timing are aggregated for the purposes of harvest management.

Population Structure

Puget Sound chinook comprise an evolutionarily distinct unit (ESU) defined by the geographic distribution of their freshwater life stages, life history, and genetic characteristics (Myers et al 1998). This ESU is not, however, one single breeding population, but is comprised of several independent core as well as local populations. The methods used to delineate these distinct populations were described by the Puget Sound Technical Recovery Team (2001). The central intent of this Plan is to manage fishery-related risk, in order to conserve genetic and ecological diversity throughout the ESU, and to apply this standard to all its composite populations. The Chinook Status Review (Myers et al 1998) designated the ESU to include populations originating from river basins beginning at the Elwha River, in the Strait of Juan de Fuca, continuing east and south through Puget Sound, and north to the Nooksack River. This plan also includes chinook originating in streams in the western Strait of Juan de Fuca.

Puget Sound chinook populations are classified, according to their migration timing, as spring, summer, or fall chinook, but specific return timing toward their natal streams, entry into freshwater, and spawning period varies significantly within each of these 'races'. Run timing is an adaptive trait that has evolved in response to specific environmental and habitat conditions in each watershed. Fall chinook are native to or produced naturally in the majority of systems , including the Hoko, Elwha, lower Skagit, Snohomish, Cedar, Green, Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers, and in tributaries to northern Lake Washington. Summer runs originate in the Elwha, Dungeness, upper Skagit, Sauk, Stillaguamish, and Skykomish rivers. Spring (or 'early') chinook are produced in the South and North Forks of the Nooksack River, the Sauk River, Suiattle River, and Cascade River in the Skagit basin, and the White River in the Puyallup basin.

Puget Sound chinook populations were formerly identified in the Salmon and Steelhead Stock Inventory (WDF et al 1993); the 2001 Harvest Plan was generally based on the SASSI designation. This Plan generally adopts the more recent population delineation (Puget Sound TRT 2001) that is being developed by the NMFS as part of recovery planning, with the exception the Plan designates mid-Hood Canal production in the Hamma Hamma River, the Duckabush River, and the Dosewallips River as a management unit, composed of three local sub-populations. The TRT did not delineate these as three distinct populations, because of uncertainty about the status of natural production in these systems. This version of the Plan omits some populations that were included in the SASSI , either because recent assessment concludes that they are extinct, or that they exist only due to artificial production in the drainage, or as strays from other natural populations or hatchery programs. These include fall chinook in the Samish

River, Gorst Creek and other Sinclair Inlet systems, White River, Deschutes River, and several other independent tributaries in South Puget Sound, which are only present due to local hatchery programs. Spring chinook in the Snohomish, Nisqually, Skokomish, and Elwha systems are extinct; spring chinook are no longer produced at Quilcene National Fish Hatchery.

The freshwater life history of most Puget Sound chinook populations primarily involves short freshwater ('ocean-type') residence following emergence (i.e. juvenile fish transform into smolts and emigrate to the marine environment during their first year). A small (less than 5 percent) proportion of juvenile fall chinook, and a larger and variable proportion of juvenile spring and summer chinook rear in freshwater for 12 to 18 months before emigrating, but expression of this 'stream-type' life history is believed to be influenced more by environmental factors than genotype (Myers et al 1998).

The oceanic migration of Puget Sound chinook typically extends up from the Washington coast as far north as southeast Alaska, with a large, for some stocks a majority, of their harvest taken in the southern waters of British Columbia. Adult chinook generally become sexually mature at the age of three to six years, although a small proportion of males ('jacks') may mature precociously, at age-two. Adult Puget Sound chinook are predominantly age-3 and age-4.

Freshwater life history and maturation rates for Puget Sound chinook populations were reviewed extensively in the Status Review (Myers et al 1998).

Puget Sound chinook are genetically distinct and uniquely adapted to the local freshwater and marine environments of this region. Retention of their unique characteristics depends on maintaining healthy and diverse populations. A central objective of the co-managers' harvest management plan is to assure that the abundance of each population is conserved, at a level sufficient to protect its genetic integrity.

The most recent allozyme-based analysis of the genetic structure of the Puget Sound ESU indicates six distinct population aggregates – North and South Fork Nooksack River early, Skagit / Stillaguamish / Snohomish rivers, south Puget Sound and Hood Canal summer / falls, White River springs, and Elwha River (TRT 2001). Adult returns to South Sound and Hood Canal are influenced by large-scale hatchery production that utilized common original broodstock (primarily from the Green River), so their apparent genetic similarity may not have been true of indigenous populations. However analysis of samples collected from 33 spawning sites indicate that, with few exceptions, allele frequencies are significantly different, and that isolation of spawning has maintained differentiation, even among similar-timed populations within a watershed.

Life history traits were also useful in delineating natural population structure within Puget Sound. In order to determine the current population structure, the TRT (2001) examined juvenile freshwater life history, age of maturation, spawn timing, and physiographic characteristics of watersheds. . Chinook also spawn naturally in other areas which may or may not have supported self-sustaining populations historically.

Occurrence in these areas is thought be a consequence of straying from nearby natural systems or returns from hatchery programs. The most notable examples are in South Puget Sound, e.g. streams draining into Sinclair Inlet, and the Deschutes River entering Budd Inlet.

Management Units

A population is a biological unit. A management unit, in contrast, is an operational unit, whose boundaries depend on the fisheries acting on that unit. Salmon management units can range in size from something as large as the West Coast Vancouver Island (WCVI) coho run, which was managed as one unit in the WCVI troll fishery, to something as small as the males that return to a particular hatchery release site.

Prior to the conclusion of *U.S. v Washington* in 1974, almost all fisheries on Puget Sound salmon were conducted in marine waters, with no explicit management units or escapement goals. The Boldt Decision, however, encouraged the development of significant tribal fisheries at the mouths of Puget Sound rivers, and required the development of spawning escapement goals for each management unit. This left the co-managers (and the court) with the task of defining what the management units would be. It was now possible, with significant fisheries at the mouths of rivers, to manage for separate escapement goals for units returning to areas as small as a separate river system. However, unless there were differences in run timing between groups of fish, it was not possible to manage separately for finer units without perpetually wasting large numbers of harvestable fish. Therefore, the court-ordered PSSMP prescribed that management units would not be established for units smaller than a system that flows into saltwater, unless component populations exhibit a difference in migration timing, or as otherwise agreed by the co-managers. With this understanding, the co-managers defined the natural chinook management units in Puget Sound (Table 2), conforming, with the exception of the Mid-Hood Canal unit, to the TRT population delineation. The default escapement goal for these natural management units was maximum sustained harvest (MSH) escapement.

For the next several years, the management units were the smallest units considered in management of fisheries in Puget Sound. Then, in the early 1990's, the co-managers undertook the Wild Salmonid Restoration Initiative. As part of this initiative, they published a list, known as SASSI, of all the identified or hypothesized separate salmon populations in Washington, and their status. For chinook, some of these populations were the same as the existing management units, and some were smaller components of management units. Guided by this list, the co-managers then developed a Wild Salmonid Policy (WDFW et al 1997), which was intended to review and revise as necessary the existing management objectives. Although the Wild Salmonid Policy was not adopted by all the tribes, there was agreement to accept the genetic diversity performance standard that stated that:

> *"No stocks will go extinct as a result of human impacts, except in the unique circumstance where exotic species or stocks may be removed as part of a specific genetic or ecological conservation plan."*

Table 2. Management units for natural chinook in Puget Sound.

Management Unit	Component Populations (category)
Nooksack Early	North Fork Nooksack River (1 South Fork Nooksack River (1)
Skagit Summer / Fall	Upper Skagit River Summer (1) Lower Sauk River Summer (1) Lower Skagit River Fall (1)
Skagit Spring	Upper Sauk River (1) Siuattle River (1) Upper Cascade River (1)
Stillaguamish Summer/Fall	North Fork Stillaguamish River Summer (1) South Fork & mainstem Stillaguamish River Fall (1)
Snohomish Summer/Fall	Skykomish River (1) Snoqualmie River (1)
Lake Washington	Cedar River (1) North Lake Washington Tributaries (2)
Green	Green River Fall (1)
White	White River Spring (1)
Puyallup	Puyallup River Fall (2)
Nisqually	Nisqually River Fall (2)
Skokomish	North and South Fork Skokomish River Fall (2)
Mid-Hood Canal [1]	Hamma Hamma River (2) Duckabush River (2) Dosewallips River (2)
Dungeness	Dungeness River Summer (1)
Elwha	Elwha River Summer (1)
Western Strait of Juan de Fuca [2]	Hoko River (1)

[1] The existence of three distinct populations is uncertain.
[2] The western Strait of Juan de Fuca management unit is not part of the listed Puget Sound ESU.

More recently, population management has shifted its focus to give additional consideration to component populations within management units. However, this meant that management units were no longer the smallest units considered in management of Puget Sound fisheries. It did *not* mean that separate populations must be managed for the same objective as the management units (i.e., MSH escapement). It means that each separate population is managed to avoid its extinction.

Of the 15 management units covered in this plan (Table 2), six contain more than one population. For these management units, this plan describes management measures intended to conserve the viability of the weakest population within that management unit (see Chapter 6, and the management unit profiles for Skagit, Stillaguamish, and

Snohomish in Appendix A) while rebuilding the management units to their recovery goals. For the other nine management units, the populations are the same as the management units, so there is no difference between managing for the management unit, or managing for the component population.

The data to inform management of individual populations varies widely. For some populations, the only directly applicable data are spawning escapement estimates. In such cases, estimates of migratory pathways, entry patterns, age composition and maturation trends, age at recruitment, catch distribution and contributions must be inferred from the most closely related population for which such information is available. Obtaining the information to test and evaluate these inferences and assumptions is one of the key data needs identified in Chapter 7 of this Plan.

This Plan provides a focus to give additional consideration to local populations within management units. However this focus does not require that each local population be managed for the same objective as the management unit as a whole (e.g., MSH escapement). It does require that each local population be managed to avoid threats to its viability.

3. Status of Management Units and Derivation of Exploitation Rate Ceilings.

In this plan, each management unit is classified according to its category and its abundance. The category determines the priority placed on recovery of that unit; the abundance determines the allowable harvest, depending on the category.

Management Unit Categories

Puget Sound chinook management units have been categorized according to the presence of naturally-produced, native populations, the proportional contribution of artificial production, and the origin of hatchery broodstock.

- Category 1 units consist of native stocks that are predominantly naturally produced, or enhanced to a greater or lesser extent by programs using native broodstock.

- Category 2 units are predominantly of hatchery origin, in some cases comprised of non-native broodstock, but where remnant native populations may still exist, and where habitat is capable of supporting self-sustaining natural production.

- Category 3 units are designated where production occurs only because of returns to a hatchery program, or due to straying from adjacent natural populations or hatchery programs. This Plan does not state harvest objectives for Category III units.

Conservation of Category 1 populations is the first priority of this HMP, because they comprise genetically and ecologically essential and unique components of the ESU. The harvest management objectives for these units incorporate a very low tolerance for risk with regard to their component populations. They include populations in the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Green, White, Dungeness, Elwha, and Hoko rivers (Table 2). Hatchery supplementation is considered to be essential to protecting the genetic and demographic integrity of populations in the Nooksack, Stillaguamish, White, Dungeness, and Elwha rivers, and is listed under the ESA.

Natural populations in the North Lake Washington tributaries, and the Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers have been heavily influenced by artificial production based on non-local stocks, and are, therefore, Category 2 management units. The effects of this influence still persist, even in cases where artificial production may have been redesigned, scaled back, or terminated. Some Puget Sound stocks, most notably from the Green River, have been produced and released into these systems, and into the Snohomish system.

In the past, of these hatchery programs, frequently using non-local stocks, were managed without informed consideration of the risk to native, natural populations, particularly when viewed in the light of current understanding of the ecological and genetic interactions of natural and hatchery production. Their primary motivation was to enhance fisheries. Hatchery production was seen as a solution to increasing demand for fishing opportunity, particularly following the resolution of *U.S. v. Washington*, and resulting from rapidly increasing urban populations around Puget Sound. This approach was also perceived as a relatively feasible method to mitigate for severe and continuing habitat losses, including those from hydropower development, irrigation and other withdrawals, agricultural and forest practices, to name a few. The policy was to fully utilize this increased hatchery production, and manage harvest primarily to achieve sufficient escapement to meet the broodstock requirements of the hatchery programs. The potential for increasing or restoring natural production in these systems was already known to be compromised by degraded habitat. The resulting high exploitation rates were not sustainable by the native, natural chinook populations.

This Plan emphasizes conservation of these Category 2 populations, in order to assure their continued viability. In some cases, large-scale hatchery enhancement programs operate in these systems, and hatchery returns continue to contribute significantly to natural spawning. Regardless of the genetic identity of the naturally spawning chinook in these systems, there is renewed focus on quantifying their abundance and productivity, and overt constraint of harvest pressure to increase natural escapement. Where hatchery programs have been implemented specifically as mitigation for habitat loss, e.g. in the Nisqually River and Skokomish River, and thus intended to replace the associated lost fishing opportunity, harvest may take priority over increasing escapement beyond the level of assuring viability, at least until functional habitat is restored, or the productive capacity of habitat is quantified. Assuring the viability of these populations now preserves future options to manage for higher natural-origin production later, should those populations be deemed essential to a recovered ESU.

Specific harvest objectives are not established for Category 3 populations in this Plan, so their status is not discussed here in detail. Returns to many of these systems, however, is related to harvest management that is directed at hatchery production. Hatchery programs have been established on systems where there is no evidence of historical native chinook production. In these areas, terminal harvest is frequently managed to remove a very high proportion of returning chinook, in excess of the broodstock required to perpetuate the program. However, the harvest may fall short of this objective, resulting in excess adults spawning naturally, or intentionally passed above barriers to enable spawning. Straying into adjacent streams is also likely under this condition. While natural production occurs in these systems, habitat is not suitable to enable sustained production without the continued infusion of hatchery returns or strays.

Abundance Designations

This plan classifies Puget Sound chinook management units into two abundance classifications: those that usually have harvestable surpluses, and those that usually don't.

Within the classification of those that don't have harvestable surpluses, the management units and their component populations (for MU's with more than one component population) are further subdivided into those whose abundance exceeds a Critical Abundance Threshold, and those whose abundance is less than their Critical Abundance Threshold. These abundance classifications are used to set the maximum allowable fishery-related mortality (see Application to Management section).

Abundances with Harvestable Surpluses

Consistent with the PSSMP, the co-managers will establish the MSH escapement level as the threshold for determining whether a MU has harvestable surplus, unless a different level is agreed to. Depending on the current quality of the habitat affecting the MU, this MSH escapement level will be either the MSH escapement under current habitat conditions, or the MSH escapement under recovered habitat conditions. After factoring in expected Alaskan catches, Canadian catches, and incidental, test, and ceremonial and subsistence catches in southern U.S. fisheries, if an MU is expected to have a spawning escapement greater than the applicable MSH escapement level, that MU will be classified as an MU with harvestable surplus

Methods for Calculating the Threshold for Harvestable Abundance

The first step in calculating the threshold for harvestable abundance is to calculate the productivity of the MU under current habitat conditions. The method used to calculate the productivity depends on the data available for that MU. Some MU's have data on spawning escapement, juvenile production, habitat measurements, CWT distribution, and adult recruitment; other units may have data only on escapement and terminal run size; and other units may have only index escapement counts and terminal catches. The method used for each MU is described in its Management Unit Profile (Appendix A). Once the current productivity and capacity are calculated, the current MSH escapement level can be estimated from standard spawner-recruit calculations (Ricker 1975).

The next step is to calculate the productivity and capacity under "recovered" habitat conditions. The co-managers are developing recovery goals for all Puget Sound chinook populations, as a cooperative analysis by the co-managers' technical staff, the NMFS Technical Recovery Team, and the Shared Strategy Forum, in order to establish benchmarks against which recovery progress can be measured. These goals take the form of recruitment functions that would be expected under realistically achievable improvements in the productivity of existing habitat. They are defined, not as point estimates of total abundance or spawning escapement, but in terms of the productivity and recruitment expected at different levels of spawning escapement (i.e., as spawner-recruit functions). Habitat-based production models, such as the Ecosystem Diagnosis and Treatment model (Lestelle et al 1996), supplemented by current research, were used to estimate historical, current, and "properly functioning" levels of productivity and capacity for each system. From these estimates of productivity and capacity, the MSH escapement level under recovered habitat conditions could be estimated.

For MU's whose habitat is relatively less degraded, such that the MSH escapement level under recovered habitat conditions is still realistically achievable even under current habitat conditions, and there are aggressive efforts in place to improve the limiting habitat types, the threshold for harvestable abundance will be the MSH escapement level under recovered habitat conditions. This is a conservative standard that, until habitat recovery is achieved, will cost the fishermen otherwise harvestable fish, but it will also allow increased utilization of habitat while habitat recovery occurs. It should also be noted that simply achieving the MSH escapement level under recovered conditions does not mean that recovery has been achieved for the MU. Recovery for the MU will be achieved only when both the spawning escapement and the resulting adult recruitment regularly achieve the recovery standard. And while achievement of the recovery spawning escapement level is partly the responsibility of harvest management, achievement of the recruitment standard, once the escapement level has been achieved, is entirely due to the quality and quantity of the habitat.

For the other MU's, which have severely degraded habitat (this is most of the ESU), the threshold for harvestable abundance will be the MSH escapement level under current habitat conditions. Establishing the current MSH escapement level as the threshold above which there is a harvestable surplus is also a conservative standard that assigns harvest management its rightful share of the burden of conservation, assures long-term increases in abundance, and does not impede recovery. As habitat conditions improve, this threshold can be increased toward the MSH escapement level under recovered habitat conditions.

Abundances without Harvestable Surpluses

A MU that is expected to have a spawning escapement below its threshold for harvestable abundance is classified as a MU without harvestable surplus. Under this plan, no commercial or sport fisheries in Puget Sound can be conducted that target on MU's without harvestable surplus (see Application to Management section). Moreover, incidental impacts on each MU must be less than a MU-specific ceiling exploitation rate (also called "recovery exploitation rate", or RER). This ceiling is further reduced if the abundance of any MU, or a component population of a MU, is below a specified Critical Abundance Threshold (CAT).

Derivation of the Ceiling Recovery Exploitation Rates

Recovery Exploitation Rates, if used as the target rate every year, would not impede recovery. Calculating these rates would ideally involve developing a spawner-recruit relationship for each unit from data on escapement, age composition, CWT distribution, environmental parameters, and management error.

For units without such data, the ceiling rates were set by using data on observed minimum rates, PST ceilings, or data from units that do have the requisite data for a spawner-recruit analysis (see MU Profiles). For these management units, total or southern U.S. (SUS, i.e., Washington and Oregon fisheries) exploitation rate ceilings are

generally established at the low level of the late 1990's, which resulted in stable or increasing spawning escapement. Where very low or zero terminal harvest impact occurs, these ceilings are usually SUS exploitation rates between 10 and 20 percent. Since this plan eliminates fisheries targeted at MU's without harvestable abundance, these ceilings allow the spawning escapements for these units to benefit from the recent reductions in Canadian and U.S. fisheries, in some cases even providing terminal runs that exceed the threshold for harvestable abundance.

For units with the requisite data, the RER's (Table 3) were chosen to meet specific risk criteria. If the RER was the annual target, the following criteria would be met:

- A very low probability (less than five percentage points higher than under zero harvest) of abundance declining to a calculated point of instability; and either

- A high probability (at least 80%) of the spawning escapement increasing in 25 years to a specified threshold (see MU Profiles in Appendix A for details)

- The percentage of escapements less than this threshold level at the end of 25 years differs from a zero harvest regime by less than 10 percentage points.

The RER is the rate that achieves these risk criteria while maximizing long-term harvest. Calculating this rate, given the dynamic variations in abundance of a population over a multi-generation time period, required simulation of recruitment and mortality over that period, under the range of expected productivity, environmental, and fishery conditions. We therefore developed simulation models that incorporated initial brood escapement, maturation schedule, population-specific spawner – recruit parameters, natural mortality during freshwater and marine life stages, environmental variables, fishing mortality, and error inputs, and then ran these models to determine the applicable RER.

For this exercise, initial escapement was set at recently observed levels, or at an average of recent years. The recruitment function was derived from a set of spawner – recruit pairs compiled over the last ten to twenty brood years. Recruits from a single brood year escapement – defined as either the age-2 unfished abundance, or as the adult equivalent recruitment -- were estimated by cohort reconstruction, and a computer program developed by the PSC Chinook Technical Committee estimated age-specific fishing rates from tag recovery data.

We fit Ricker (Ricker 1954, cited in Ricker 1975), Beverton – Holt (Beverton and Holt 1957), or 'hockey –stick' spawner-recruit functions to the spawer – recruit pairs. Because survival is influenced by a very complex array of environmental and ecological factors, recruitment typically varies widely at any given level of escapement. To reduce this variation and estimate more precisely the spawner-recruit parameters, in cases where recruit abundance is significantly correlated to an environmental index factor such as river discharge, temperature, or coastal marine productivity, we added freshwater and marine survival terms to the function. We fit the recruitment function by conventional statistical methods, or by using the dynamic model (NMFS 20001).

To run the simulation model, we varied the input environmental factors that appear to affect chinook survival. For some systems (e.g. the Skagit River), 0^+ chinook smolt production has been strongly correlated to magnitude of peak flow during the incubation season (Seiler et al 2000). Similar smolt monitoring is underway in several other systems in Puget Sound (NWIFC 2002). Marine survival, which occurs prior to fish reaching the size when they become vulnerable to fishing, has been routinely indexed by the PSC Chinook Technical Committee, using CWT-based cohort reconstruction. In running the simulation models, we selected flow and marine survival values from a range typical of recent conditions. This range may be intentionally constrained to represent poor marine survival conditions, such as were common during the late 1980's and early 1990's, or a broader range that includes favorable conditions, such as those that have improved survival in the late 1990's. For some populations, rather than randomly selecting the value of the marine survival parameter, it was programmed to vary cyclically, as has been theorized about ocean conditions in the North Pacific (Mantua et al 1997).

We also factored management error into the simulation. Management error, for the purposes of this discussion, is broadly defined as the discrepancy between the pre-season expected value of the total exploitation rate and the rate actually achieved in a given management year for a given population. The pre-season and post-season values were estimated by the Fisheries Regulation Assessment Model (FRAM) that is currently used for Puget Sound chinook fishery planning Pre-season FRAM runs incorporate the forecast abundance of all chinook stocks (from the Columbia River, Washington, and British Columbia) and anticipated chinook catch in more than 70 commercial and recreational fisheries, including those in Alaska and British Columbia. Management error includes forecast error, the differences between anticipated and actual chinook catch, and annual variation in the catch distribution of the populations under consideration. It may be estimated for each of the Puget Sound management units for which FRAM computes fisheries-related mortality. Values for the management error parameter introduced into the simulation were selected randomly from the gamma distribution of values obtained by combining error estimates for many Puget Sound stocks, from 1990 – 1996 (J. Guttman, pers comm. December 10, 1997; K. Nason, pers comm., May 12, 1998 – technical memoranda to the Model Evaluation Subgroup).

Finally, we varied the underlying spawner-recruit parameters at the beginning of each iteration, by sampling from a (usually log-normal) distribution generated by fitting the observed data. Varying the recruitment parameter(s) according to actual data from recent brood years is assumed to represent uncertainty in the parameter estimates, as well as the annual variation in productivity that might be experienced in the next 25 years.

Two thousand to five thousand 25-year simulations were run for a range (usually 0% to 80%) of total fishing exploitation rates. For each fishing rate, the simulation produced a set of 50,000 to 125,000 annual spawning escapements, for which summary statistics could rigorously describe the probabilities (risk) of the population attaining a recovery threshold or declining to a point of instability. The RER for the management unit in

question was selected as that which maximized harvest and exceeded both criteria defined above.

RER's have been derived for the Nooksack early, Skagit summer/fall, Skagit Spring, Stillaguamish summer/fall, and Snohomish summer/fall management units. Details of the risk analysis for each unit are presented in Management Unit Profiles (Appendix A).

Derivation of Critical Abundance Thresholds

The critical abundance threshold (CAT) is defined as a level of escapement, for a specific population, below which there is a significant increase in the risk of extinction, demographic instability, or irreversible damage to genetic integrity. The exact point (level of brood escapement) at which this risk escalates has not been identified for any population, but genetic and demographic theory, represented by current scientific endeavor, draws its boundaries. The critical abundance threshold (Table 3) for management is set well above this point, so that harvest mortality can be constrained, severely if necessary, to avoid the population escapement actually falling to the range of instability.

At low spawner abundance, ecological and behavioral factors can cause a dramatic decline in productivity. Low spawner density can affect spawning success by reducing the opportunity for mate selection, or outright inability to find suitable mates. Depensatory predation can significantly reduce smolt production. However, the level at which these factors exert their effect will differ markedly between populations.

As with the RER derivations, the methods used to calculate the CAT varied according to the data available for each population. There are no direct measurements of the point of instability, but in some cases, a usable surrogate was empirical observations of the lowest recorded escapement that more than replaced itself on the next cycle. In other cases, where spawner-recruit and management error data were sufficient, we could calculate a threshold at which the probability of falling below the point of instability was acceptably low. And in still other cases, where specific data were lacking, we could use literature values that estimated genetic thresholds for minimum effective population sizes (e.g., Franklin 1980; Waples 1990; Lande 1995; NMFS 2000).

For example, for Skagit summer and fall populations, the thresholds were calculated as the forecast escapement level for which there is a 95 percent probability that actual escapement will be above the point of instability (i.e., 5 percent of the replacement escapement level). This calculation accounted for the difference between forecast and actual escapement in recent years, and the variance around recruitment parameters. For the Stillaguamish management unit, escapement of 500 was identified as the critical threshold, because this level has resulted in recruitment rates of 2 – 5 adults per spawner. For other Puget Sound populations the critical threshold was identified with reference to the literature, or more subjectively, at 200 to 1,000 annual escapement (see MU Profiles).

Table 3. Critical abundance thresholds and the range of expected Minimum Fishery Regime (MFR) exploitation rates for Puget Sound chinook management units.

Management Unit	Recovery Exploitation Rate	Critical Abundance Threshold	Range of MFR Exploitation Rates
Nooksack North Fork South Fork	Under development	 1,000 [1] 1,000 [1]	5% - 9% SUS
Skagit summer / fall Upper Skagit summer Sauk summer Lower Skagit fall	52%	4,800 2200 400 900	33% - 25% total
Skagit spring Upper Sauk Cascade Siuattle	42%	576 N/A N/A N/A	21% - 27% total
Stillaguamish North Fork Summer South Fk & MS Fall	25%	650 [1] 500 [1] N/A	12% - 16% total
Snohomish Skykomish Snoqualmie	24%	2,800 [1] 521 [1]1745 [1]	18% - 26 % total
Lake Washington Cedar River	15% PT SUS	 200 [1]	9% - 15% PT SUS
Green	15% PT SUS	1,800	7% - 15% PT SUS
White River spring	17%	200	12% - 14% total
Puyallup fall	50%	500	36% - 46% total
Nisqually	Terminal fishery managed to achieve 1,100 natural spawners		
Skokomish	15% PT SUS	1,300 [2]	11% - 15% PT SUS
Mid-Hood Canal	15% PT SUS	400	11% - 15% PT SUS
Dungeness	10% SUS	500	5% - 10% SUS
Elwha	10% SUS	1,000	5% - 10% SUS
Western JDF	10% SUS	500	5% 10% SUS

[1] natural-origin spawners
[2] composed of 800 natural, 500 hatchery; see Management Unit Profile, Appendix A.

Derivation of the Critical Abundance Exploitation Rate Ceiling

If the spawning escapement for any population in any management unit is projected to fall at or below its critical abundance threshold, the co-managers will adopt suitable conservation measures to further constrain fishery-related mortality. Under this circumstance the fishery exploitation rate objective for that management unit is reduced to a level defined by the Minimum Fishery Regime. This new objective will be below

the RER or other objective defined above for MU's without harvestable abundance.

The Minimum Fishery Regime is a set of catch levels or regulations for all fisheries that directly or incidentally cause harvest-related mortality of Puget Sound chinook (Appendix C). It was derived pursuant to 1999 PST Chinook Annex agreements, and specifies catch levels or regulations for each regulatory area and time period. This regime is input to the FRAM model, as a set of exploitation rate scalars, with current forecasts of total abundance (i.e., abundance scalars). The total fisheries exploitation rate output by FRAM for each management unit, under this regime, becomes the new exploitation rate ceiling for any management unit falling below its critical abundance threshold. The co-managers will then examine all Washington fisheries that incur harvest-related mortality of any stocks at their critical abundance threshold, and through negotiation decide on conservation measures that will reduce total exploitation rate to or below the new ceiling rate.

The purpose of the Minimum Fishery Regime is to protect all populations against decline in abundance to a point of ecological or genetic instability, at which risk of extinction increases. Conservation of weak populations cannot be solely attained by constraint of harvest, and all factors that affect their productivity must be addressed. However, when facing an acute change in the status of any population, that requires immediate conservative action, the co-managers will implement extraordinary protective measures. These measures will still enable fishing opportunity on other salmon species, and affect fisheries with low impact on the weak populations to the least extent possible. Pre-season planning results in adoption of a set of regulations that meet the objectives for all management units, but wherever it is available, in-season assessment of abundance will be examined carefully for all units below the LAT.

There are significant incidental chinook impacts in fisheries directed at pink salmon in odd-numbered years, so the minimum fishery regime differs in odd- and even-numbered years. Incidental chinook impacts occur in the Strait of Juan de Fuca and Rosario / Georgia Strait net fisheries directed at Fraser River pink stocks, and in the Skagit and Snohomish terminal area fisheries directed at local pink salmon stocks.

The Minimum Fishery Regime rates for six of the Puget Sound management units (Skagit summer / fall and spring, Stillaguamish, Snohomish, White River, and Puyallup) are stated as a total exploitation rates, and for three units (Dungeness, Elwha, and Western Strait of Juan de Fuca) as 'southern U.S' (i.e., Washington fishery) rates. In both of these cases, the Washington co-managers will constrain Washington ocean and Puget Sound fisheries to the MFR rate, or to achieve escapement higher than the critical threshold, whichever occurs first. A 'southern U.S. pre-terminal' MFR rate is specified for the Lake Washington, Green, Skokomish, and Mid-Hood Canal units. These pre-terminal exploitation rates, which typically range from 10 to 15 percent, were derived from the highly constrained pre-terminal fishing regimes typical of the late 1990's. As detailed in the management unit profiles (Appendix A), if their status should decline to critical, pre-terminal and terminal fisheries will be constrained so as to achieve the critical abundance threshold escapement level, or the MFR rate.

The MFR exploitation rates will vary, since they are re-calculated annually based on the Minimum Fishery Regime regulations, expected harvest levels outside of Washington waters, and the current abundance forecasts for all chinook stocks in the FRAM. If the MFR rates fall significantly outside the estimated range (Table 3), the co-managers will consult with the NMFS regarding the implications for affected management units.

4. The Fisheries and Jurisdictions

Puget Sound chinook migrate along, and are contribute to fisheries, along the coast of British Columbia and Alaska, as well as the coastal waters of Washington and in Puget Sound. Their management, therefore, involves, in addition to the local jurisdictions of the Washington co-managers, the jurisdictions of the State of Alaska, the Canadian Department of Fisheries and Oceans, the Pacific Salmon Commission, and the Pacific Fisheries Management Council.

Southeast Alaska

In Southeast Alaska (SEAK) chinook are harvested in commercial, subsistence, personal use, and recreational fisheries throughout Southeast Alaska. Since 1995, the total landed chinook catch has ranged from 217,000 to 339,000 (Table 4). These fisheries are managed by the Alaska Board of Fisheries and the Department of Fish and Game, under oversight of the North Pacific Fisheries Management Council to ensure consistency of fisheries management objectives with the Magnuson – Stevens Fisheries Conservation and Management Act.

Commercial fisheries employ troll, gillnet, and purse seine gear. Commercial trolling accounts for about 68% of the chinook harvest (NMFS 2002). Approximately 6% of the catch of chinook and coho is taken outside of State waters, in the Economic Exclusive Zone (EEZ). The majority of troll catch occurs during the summer season; but 'winter' and 'spring' troll seasons are also scheduled from October through April. The summer season usually opens on July 1st, targeting chinook, then shifts to a coho-directed fishery in August. Incidental harvest of pink, chum, and sockeye salmon also occurs in the troll fishery. Gillnet and seine fisheries occur within State waters, and target pink, sockeye, and chum salmon, with substantial incidental catch of coho, and relatively low incidental catch of chinook.

Table 4. Chinook salmon harvest, all fisheries combined, in Southeast Alaska, 1995 – 2001 (PSC Preliminary 2001 Post-Season Report).

1995	231,100
1996	217,200
1997	339,200
1998	271,000
1999	251,000
2000	263,300
2001	259,600

Recreational fishing in Southeast Alaska, in recent years, has comprised more than 500,000 angler days annually. It occurs primarily in June, July, and August. A majority of the effort is associated with non-resident fishers, and is targeted at chinook salmon. Fishing is concentrated in the vicinity of the major populations centers; Ketchikan, Petersburg, Sitka, and Juneau, but it also occurs along the coast of Prince of Wales Island

and other remote areas. Fishing in the vicinity of Sitka accounts for 47% of the recreational chinook harvest (Jones and Stokes 1991).

Southeast Alaskan harvests are composed primarily of chinook from the Columbia River, Oregon coast, Washington coast, WCVI, and northern B.C. (CTC 2001) Very few Puget Sound chinook are caught in Alaska , except for Strait of Juan de Fuca stocks, which have significant exploitation rates in Southeast Alaska (up to 30% of the catch of Elwha falls, and, in some years, over 50% of the catch of Hoko and Sooes falls). Also, in some years, between 5% and 10% of the catch of Stillaguamish chinook has been taken in Southeast Alaska (Chinook TC 1999)."

More than 3,000 subsistence and personal use permits were issued in Southeast Alaska in 1996 (NMFS 2002), but only a small proportion of the subsistence harvest of salmon (33,000 in 1996) is chinook.

British Columbia

In British Columbia, troll fisheries occur on the northern coast and on the west coast of Vancouver Island (WCVI). Conservation concerns over WCVI and Fraser River chinook and coho stocks have constrained these fisheries in recent years. Commercial and test troll fisheries directed at pink salmon in northern areas, and sockeye on the WCVI and the southern Strait of Georgia incur relatively low incidental chinook mortality. Time / area restrictions, and selective gear regulations have been implemented to reduce the harvest of weak chinook and coho stocks.

Net fisheries, including gillnet and purse seine gear, in British Columbia marine inshore waters are primarily directed at sockeye, pink, and chum salmon, but also incur incidental chinook mortality. Gillnet fisheries, directed at chinook salmon, occurred in 2001 on the Northern coast, targeting abundant returns to the Skeena River (Table 5). Conservation measures have limited chinook retention in many other areas.

Recreational harvest of chinook in the Queen Charlotte Islands and on the WCVI have been similarly constrained by time / area and size regulations to conserve weak chinook stocks. Nearshore waters along the entire WCVI were closed to salmon fishing in 1999 – 2001 (2000 and 2001 Post Season Reports to PSC). Limited recreational fisheries have been implemented in the 'inside' waters of the WCVI (e.g. in Nootka Sound, Esperanza Inlet, and Tlupana Inlet). Marine recreational fisheries occur along the Central B.C. coast, Johnstone Strait, Georgia Strait, and the Strait of Juan de Fuca. Sport fisheries in inshore marine areas comprise the largest portion of the chinook harvest in southern B.C.

Table 5. Landed chinook harvest in British Columbia inshore marine fisheries in 2001 (from 2001 Post Season Report to the PSC).

Northern BC troll	13,100
WCVI troll	77,000
Georgia Strait troll	485
Northern BC net	22,035
Central BC net	4,589
Native North and Central	7,231
Johnstone Strait net	1,000
Queen Charlotte Is. Sport	27,500
WCVI outside sport	36,000
North coast sport	11,000
Central coast sport	7,736
JDF, GS, JS sport	57,526
Total	265,202

Fisheries in Northern B.C. are targeted primarily at local stocks, as well as chinook from the Columbia River, Washington and Oregon coasts, Georgia Strait, and WCVI (CTC 2001). Puget Sound chinook make up a minor portion of the catch, but a significant portion of the mortality of North Sound and Strait of Juan de Fuca spring and summer/fall chinook can occur in these fisheries (see Catch Distribution, below). WCVI fisheries, which target on Columbia River, Puget Sound, and Georgia Strait stocks, have a major impact on all Puget Sound summer/fall stocks, with a lower, but significant impact on springs. Georgia Strait fisheries target on Georgia Strait and Puget Sound chinook, and have heavy impacts on North Sound springs, North Sound summer/falls, and Hood Canal summer/falls, and significant, but lower impacts on all other Puget Sound stocks (Chinook TC 1999).

Washington Ocean Fisheries

Treaty Indian and non-Indian commercial troll fisheries directed at chinook, coho, and pink salmon, and recreational fisheries directed at chinook and coho salmon are scheduled from May through September, under co-management by the WDFW and Treaty Tribes. Annual fishing regimes are overseen by the Pacific Fisheries Management Council (PFMC), pursuant to the Magnuson – Stevens Sustainable Fisheries Act. Tribal fleets operate within the confines of their usual and accustomed fishing areas. Principles governing the co-management objectives and the allocation of harvest benefits among tribal and non-Indian users, for each river of origin, were developed under *Hoh v Baldrige* (522 F.Supp. 683 (1981)). The declining status of Columbia River origin chinook stocks has been the primary constraint on coastal fisheries, though consideration is also given to attaining allocation objectives for troll, terminal net, and recreational harvest of coastal-origin stocks from the Quillayute, Queets, Quinault, Hoh, and Grays Harbor systems. These fisheries are primarily targeted at Columbia River and Fraser chinook (CTC 2001) Puget Sound chinook make up a low percentage of the catch, with South Sound and Hood Canal stocks exploited at a slightly higher rate than North Sound and Strait of Juan de Fuca chinook.

The summer troll fishery (Table 6) has been structured, in recent years, to focus on chinook-directed fishing in May and June, and chinook/coho-directed fishing from July into mid-September, to enable full utilization of Treaty and non-Treaty chinook and coho quotas. These quotas are developed in a pre-season planning process that considers harvest impacts on all contributing stocks, and function as catch ceilings. Time / area and gear restrictions are implemented to selectively harvest the target species and stock groups. In general, the chinook harvest occurs 10 to 40 miles offshore, whereas the coho fishery occurs within 10 miles off the coast, but annual variations in the distribution of the target species may cause this pattern to vary. The majority of the chinook catch has, in recent years, been caught in Areas 3 and 4 (which, during the summer, includes the westernmost areas of the Strait of Juan de Fuca – Areas 4B). In the last five years, troll catch has ranged from 18,000 to 49,300 (Table 3).

Table 6. Commercial troll and recreational harvest of chinook in Washington Areas 1 – 4, 1990 – 2001 (from PFMC 2001 post-season review).

	Treaty Troll	NT troll	Recreational	Total
1990	40,338	31,104	30,000	172,884
1991	27,867	28,809	12,671	126,023
1992	30,388	43,628	18,427	166,459
1993	32,493	30,072	13,018	138,148
1994	5,678	0	0	11,356
1995	11,335	3	509	23,185
1996	14,949	0	177	30,075
1997	14,424	6,418	3,969	45,653
1998	14,859	5,929	2,187	43,763
1999	27,664	17,456	9,887	100,127
2000	7,770	10,269	8,478	44,556
2001	28,100	21,229	22,974	121,632

In odd-numbered years, the coastal troll fishery may also target pink salmon, the majority of which originate in the Fraser River. In the last six odd-numbered years, the annual troll harvest of pink salmon has ranged from 1,800 to 48,300.

Recreational fisheries, in Washington Ocean areas, are also conducted under specific quotas for each species, and allocations to each catch area. WDFW conducts creel surveys at each port to estimate catch and keep fishing impacts within the overall quotas. Most of the recreational effort occurs in Areas 1 and 2, adjacent to Ilwaco and Westport. Generally recreational regulations are not species directed, but certain time / area strata have had chinook non-retention imposed, as conservation concerns have increased, and to enable continued opportunity based on more abundant coho stocks. In the last five years, recreational chinook catch in Areas 1 – 4 has ranged from 2,200 to 23,000 (Table 3).

Puget Sound chinook stocks comprise less than 10 percent of coastal troll and sport catch (see below for more detailed discussion of the catch distribution of specific populations). The contribution of Puget Sound stocks is higher in northern areas on the coast. The

exploitation rate of most individual chinook management units in these coastal fisheries is, in most years, less than one percent. However, these exploitation rates vary annually in response to the varying abundance of commingled Columbia River, local coastal, and Canadian chinook stocks.

Amendment 14 to the PFMC Framework Management Plan restricts the its direct oversight of conservation (overfishing review) to those chinook stocks whose exploitation rate in PFMC fisheries have exceeded two percent, in a specified base period. However, the PFMC must also align its harvest objectives with conservation standards required for salmon ESUs, listed under the Endangered Species Act. Additionally, this Plan commits the co-managers to explicit consideration of coastal fishery impacts, to ensure that the overall conservation objectives are achieved for all Puget Sound Management Units. This requires the assessment of all impacts on each weak management unit, even in fisheries where its contribution is very low.

Puget Sound – Commercial Chinook Fisheries

Commercial salmon fisheries in Puget Sound, including the U.S. waters of the Strait of Juan de Fuca, Rosario Strait, and Georgia Strait, embayments of the Puget Sound proper, and Hood Canal, are co-managed by the tribes and WDFW under the Puget Sound Salmon Management Plan. Several tribes conduct small-scale commercial troll fisheries directed at chinook salmon in the Strait of Juan de Fuca and Rosario Strait. In the western Strait of Juan de Fuca, most of the effort occurs in winter and early spring, with annual closure from mid-April to mid-June to protect maturing spring chinook. Annual harvest has ranged from 1,000 to 2,000 in the last five years.

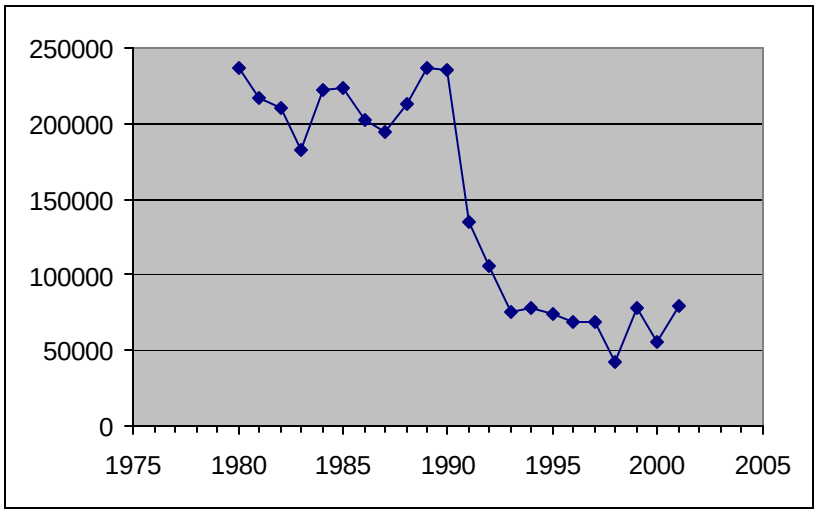
Commercial net fisheries, using set and drift gill nets, purse / roundhaul seines, beach seines, and reef nets are conducted throughout Puget Sound, and in the lower reaches of larger rivers. These fisheries are regulated, by WDFW (non-Indian fleets) and by individual tribes, with time/area and gear restrictions. In each catch area, harvest is focused on the target species or stock according to its migration timing through that area. Management periods are defined as that interval encompassing the central 80% of the migration timing of the species, in each management area. Because the migration timings of different species overlap, the actual fishing schedules may be constrained during the early and late portion of the management period to reduce impacts on non-target species. Incidental harvest of chinook also occurs in net fisheries directed at sockeye, pink, and coho salmon.

Due to current conservation concerns, chinook-directed commercial fisheries are of limited scope and are mostly directed at abundant hatchery production in terminal areas; Bellingham /Samish Bay and the Nooksack River, Tulalip Bay, Elliot Bay and the Duwamish River, Lake Washington, the Puyallup River, the Nisqually River, Budd Inlet, Chambers Bay, Sinclair Inlet, southern Hood Canal and the Skokomish River. Purse or roundhaul seine vessels operate in Bellingham Bay and Tulalip Bay, although these are primarily gillnet fisheries. A small-scale, onshore, marine set gillnet fishery is conducted in the Strait of Juan de Fuca and on the coast immediately south of Cape Flattery. Small scale gillnet test fisheries are also used in-season to acquire management and research

data in the Skagit River, Elliot Bay, Puyallup River, and Nisqually River. Typically, these involve two or three vessels making a prescribed number of sets at specific locations, one day per week, during the run's passage.

Total commercial net and troll harvest of chinook has fallen from levels in excess of 200,000 in the 1980's to an average of 64,000 for the period 1997 – 2001. (Figure 1).

Figure 1. Commercial net and troll catch of chinook in Puget Sound , 1980 – 2001 (TFT database).



Indian tribes schedule ceremonial and subsistence chinook fisheries to provide basic nutritional benefits to their members, and to maintain the intrinsic and essential cultural values imbued in traditional fishing practices and spiritual links with the natural environment. The magnitude of ceremonial and subsistence harvest of chinook is small, relative to commercial and recreational harvest, particularly where it involves critically depressed stocks.

Puget Sound - Commercial Sockeye, Pink, Coho, and Chum Fisheries

Net fisheries directed at Fraser River sockeye are conducted annually, and at Fraser River pink salmon in odd-numbered years, in the Strait of Juan de Fuca, and Rosario and Georgia Strait. Nine tribes and the WDFW issue regulations for these fisheries, with oversight by the Fraser River Panel under Pacific Salmon Treaty Annexes. Annual management plans include sharing and allocation provisions, but fishing schedules are developed based on in-season assessment of the abundance of early, early summer, summer, and late-run sockeye stocks. Sockeye harvest has exceeded 2 million in the last ten years, but the fishery has been constrained in recent years due to lower survival and pre-spawning mortality, so harvest has ranged from 20,000 to 536,000 since 1998 (Table 7). In the last six seasons (1991 – 2001) the fishery for Fraser River pink salmon in the Strait harvested from 3,700 to 40,000 fish, and in Rosario / Georgia Strait, harvested from 475,000 to over 3 million fish (Table 7). Most of the pink salmon harvest is taken by

purse seine gear. Specific regulations to reduce incidental chinook mortality, including requiring release of all live chinook from purse seine hauls, have reduced incidental contribution to less than 1% of the total catch.

Table 7. Fraser sockeye and pink salmon harvest, and incidental chinook catch, in Puget Sound, 1995 – 2001. (TFT database, 2001 data are preliminary).

		1995	1996	1997	1998	1999	2000	2001
Strait of	sockeye	41,106	30,414	12,510	26,730	20,328	44,728	34,973
Juan de Fuca	pink	48,333	8	3,723	35	4,526	91	8,583
	chinook	4,681	497	422	258	471	630	911
Rosario and	sockeye	372,789	243,936	1,354,532	509,153	69	446,757	216,324
Georgia Strait	pink	2,065,779	1	1,790,883	807	11	254	474,513
	chinook	5,321	3,934	29,592	3,668	3	801	965

Commercial and recreational fisheries directed at Puget Sound sockeye stocks occur in Elliot Bay, the Ship Canal, and Lake Washington (Cedar River sockeye), and at a smaller scale on the Skagit River (Baker River sockeye). The Cedar River stock does not achieve harvestable abundance consistently, but significant fisheries occurred in 1996 and 2000, when more than 50,000 sockeye were harvested. However, these fisheries involve low incidental chinook mortality.

Commercial and recreational fisheries directed at Puget Sound-origin pink salmon occur in terminal marine areas and freshwater in Bellingham Bay and the Nooksack River, Skagit Bay and Skagit River, and Possession Sound / Port Gardner (Snohomish River system). In the last six seasons, catch in the Nooksack system has ranged up to 17,500; in the Skagit system catch has ranged up to 525,000, and in the Snohomish system catch has ranged up to 86,100 (Table 8). Incidental chinook catch in these pink fisheries adds significantly to the total terminal-area catch of chinook.

Table 8. Commercial net fishery harvest of pink salmon from the Nooksack, Skagit, and Snohomish river systems, 1991 – 2001. 2001 data are preliminary. (TFT database).

	Bellingham Bay & Nooksack River	Skagit Bay & Skagit River	Possession Sound & Port Gardner
1991	17,447	133,672	46,039
1993	1,335	143,880	9,648
1995	7,339	524,810	48,006
1997	1,196	46,169	34,537
1999	2,484	32,339	13,055
2001	12,280	198,534	86,097

Commercial fisheries directed at coho salmon, also occur throughout Puget Sound and in some rivers. Coho are also caught incidentally in fisheries directed at chinook, sockeye, pink, and chum salmon. In the last five years total landed coho catch has ranged from 108,000 to 390,000, with 43% of the catch taken in central and south Puget Sound, and 20% taken in each of the Nooksack – Samish, and Snohomish regions (Table 9). Catch in every region increased in 2000 and 2001, relative to the late-1990's, but is still below the levels of the early 1990's, when the total harvest exceeded one million coho.

Table 9. Landed coho harvest for Puget Sound net fisheries. Regional totals include freshwater catch. Preliminary data for 2001. (TFT database).

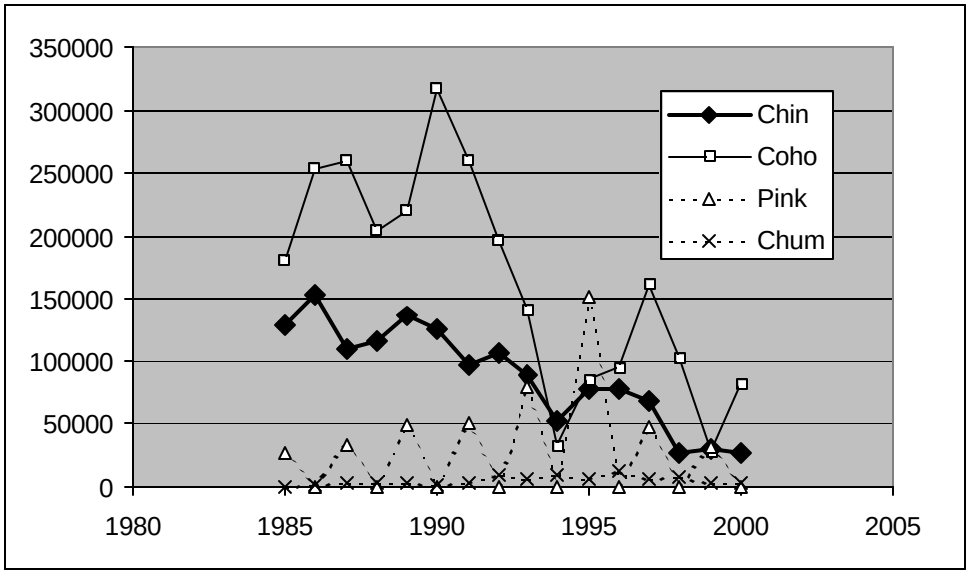
	Strait of Juan de Fuca	Georgia & Rosario Strait	Nooksack Samish	Skagit	Stillaguamish Snohomish	So Puget Sound	Hood Canal	Total
1997	1,200	10,525	15,034	1,348	25,193	78,634	9,925	141,859
1998	8,083	1,980	22,892	10,359	24,743	65,617	21,974	155,648
1999	5,586	1	50,175	7,411	18,439	21,189	4,845	107,646
2000	12,505	1,549	68,206	13,239	89,881	181,857	23,014	390,251
2001	17,671	738	76,685	20,089	75,078	143,489	12,860	346,610

Puget Sound – Recreational Fisheries

Recreational salmon fisheries in Puget Sound occur in marine and freshwater areas, under regulations promulgated by the Washington Department of Fish and Wildlife. In marine areas, the principal target species are chinook and coho salmon. Since the mid-1980's the total annual marine harvest of chinook has steadily declined to levels less than 5,000 in recent years (Figure 2). Coho harvest also declined markedly in the early 1990's, and since then has varied from three to fifteen thousand. Pink salmon fisheries are substantial only in odd-number years, and in most years since the mid-1980's harvest has been about five thousand.

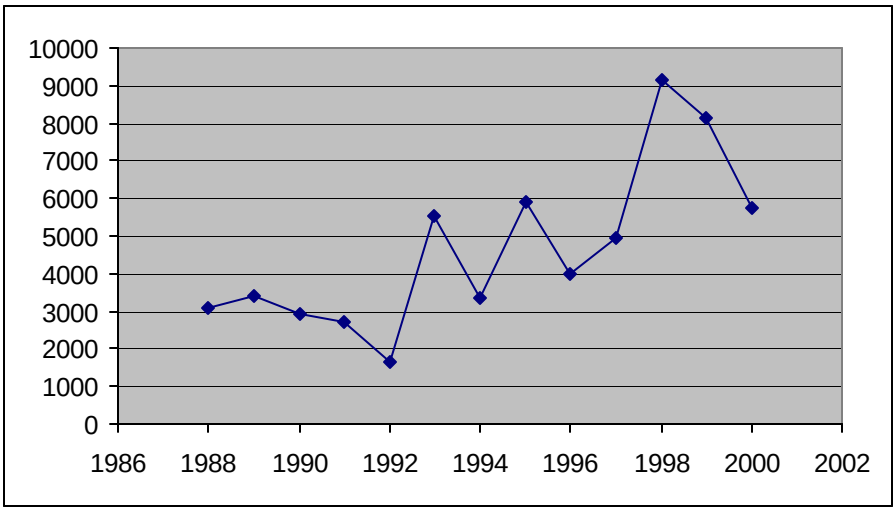
Recreational fisheries target mature chinook occur during the summer months (July – September), and continue through the fall and winter months, primarily in central Puget Sound, targeting immature chinook ('blackmouth'). Recreational chinook catch has been increasingly constrained to avoid overharvest of weak Puget Sound populations. Recreational fisheries are managed under the same harvest objectives for chinook and coho salmon that apply to commercial fisheries. WDFW has exercised their policy prerogative in allocating, in recent years, more of the non-Treaty fishing opportunity to the recreational sector.

Figure 2. Recreational salmon catch in Puget Sound marine areas.



Perhaps in response to increasingly constrained bag limits and seasons in marine areas, recreational harvest of chinook in freshwater areas of Puget Sound has shown an increasing trend since the early 1990's (Figure 3).

Figure 3. Recreational chinook harvest in Puget Sound freshwater areas (WDFW Catch Record Card estimates; excludes jacks; 1999 and 2000 are preliminary).



Non-Landed Fisheries Mortality

In all fisheries, each type of commercial and recreational gear also exerts 'non-landed' mortality on chinook. Hook-and-line fisheries are regulated by size limits and non-retention periods, and some proportion of fish below the minimum size limit, or of all chinook hooked during non-retention periods, will die from hooking trauma. A large body of relevant literature expresses a very broad range of hooking mortality rates. Rates are assumed to be higher for commercial troll than recreational gear, and higher for smaller fish. As bag limits on recreational fisheries have decreased, the magnitude of non-landed catch has risen accordingly. The Washington co-managers and the PFMC have periodically reviewed the literature, and adjusted the non-landed mortality rates associated with hook-and-line fisheries, so that fisheries simulation models used in management planning express the best available science. For hook&line gear, the release mortality (or "shaker mortality") rate refers to the percentage of fish which are brought to the boat and released, because they are below the legal size limit, or a species for which regulations preclude retention. Drop-off mortality rate is calculated as a proportion of the landed catch, but refers to fish that are hooked but escape before being brought to the boat. Current values for these rates are shown below (Table 10). A more detailed description of the basis for these rates and their application is included in Appendix B.

The various types of net gear also exert non-landed mortality. Studies to quantify rates are typically logistically difficult, so few reference data are available. Though salmon are not believed to survive gillnet entanglement, a small proportion (3% of landed catch in pre-terminal areas, 2% in terminal fisheries) drops out of the net before being retrieved. Marine mammal predation adds a significant additional loss in many areas of Puget Sound, but their effect varies from year to year, and among areas. The assumed rates do not express this variation in mammal predation, and the few available studies that exist are limited to a few areas (cite PNPTC reports) Purse seine gear has been modified, according to regulations, to reduce the catch of immature chinook, by incorporating a strip of wide-mesh net at the surface of the bunt. Nonetheless, small chinook are entrapped by seine gear, and are assumed more likely to be killed. Non-treaty seine fishers have been required to release all chinook in all areas of Puget Sound in recent years. Mortality rates vary due to a number of factors, but studies have shown that two-thirds to half of chinook survive seine capture, particularly if fish are sorted immediately or allowed to recover in a holding tank before release. Because total catch is typically small for beach seine and reef net gear, chinook may be released without harm. Research continues into net gear that reduces release mortality, with promising results from recent tests of tangle nets. In any case, non-landed mortality is accounted by managers, according to the best available information, to quantify the mortality associated with harvest.

Table 10 - Chinook incidental mortality rates applied to commercial and recreational fisheries in Washington.

Fishery	Release Mortality	Drop-off, Drop-out, etc
Ocean Recreational	14%	5%
Ocean troll - barbless hooks - barbed hooks	26% 30%	5% 5%
Puget Sound recreational	> 22" - 10% < 22" - 20%	5% 5%
Gillnet Skagit Bay	 52.4%	terminal areas - 2% pre-terminal areas - 3%
Purse Seine	immature fish- 45% mature fish - 33%	0% 0%
Beach Seine Skagit Bay pink fishery	 50%	 0%
Reef Net	0%	0%

Regulatory Jurisdictions Affecting Washington Fisheries

The Washington co-managers' planning and regulations are coordinated with other jurisdictions, in consideration of the effects of Washington fisheries on Columbia River and Canadian chinook stocks. Pursuant to *U.S. v Washington* (384 F. Supp. 312), the Puget Sound Salmon Management Plan (1985) provides fundamental principles and objectives for co-management of salmon fisheries.

The Pacific Salmon Treaty, originally signed in 1984, commits the co-managers to equitable cross-border sharing of harvest and conservation of U.S. and Canadian stocks. The Chinook Chapter of the Treaty, which is implemented by the Pacific Salmon Commission, establishes ceilings on chinook exploitation rates in southern U.S. fisheries The thrust of the original Treaty, and subsequently negotiated agreements for chinook, was to constrain harvest on both sides of the border in order to rebuild depressed stocks.

The PFMC is responsible for setting harvest levels for coastal salmon fisheries in Washington, Oregon, and California. The PFMC adopts the management objectives of the relevant local authority, provided they meet the standards of the Magnuson-Stevens Sustainable Fisheries Act. The Endangered Species Act has introduced a more conservative standard for coastal fisheries, when they significantly impact listed stocks.

Puget Sound Salmon Management Plan (U.S. v. Washington)

The Puget Sound Salmon Management Plan remains the guiding framework for jointly agreed management objectives, allocation of harvest, information exchange among the co-managers, and processes for negotiating annual harvest regimes. At its inception, the

Plan implemented the court order to provide equal access to salmon harvest opportunity to Indian tribes, but its enduring principle is to 'promote the stability and vitality of treaty and non-treaty fisheries of Puget Sound …. and improve the technical basis for …management." It defined management units (see Chapter III), and regions of origin, as the basis for harvest objectives and allocation, and defined maximum sustainable harvest (MSH) and MSH escapement as general objectives for all units. The Plan also envisioned the adaptive management process that motivated this chinook harvest plan, i.e. improved technical understanding of the productivity of populations, and assessment of the actual performance of management regimes in relation to management objectives and the status of stocks, would result in continuing modification of harvest objectives.

Pacific Salmon Treaty

In 1999, negotiations between the U.S. and Canada resulted in a new, comprehensive chinook agreement, which replaced the previous fixed-ceiling regime with a new approach based on the annual abundance of stocks. It includes increased specificity on the management of all fisheries affecting chinook, and seeks to address the conservation requirements of a larger number of depressed stocks, including some that are now listed under the ESA.

The new agreement establishes exploitation rate guidelines or quotas for fisheries subject to the PST based on the forecast abundance of key chinook stocks. This regime will be in effect for the 1999 through 2008 period. Fisheries are classified as aggregate abundance-based management regimes (AABM) or individual stock-based management regimes (ISBM). As provided in the new chinook chapter of the agreement: "an AABM fishery is an abundance-based regime that constrains catch or total adult equivalent mortality to a numerical limit computed from either a pre-season forecast or an in-season estimate of abundance, and the application of a desired harvest rate index expressed as a proportion of the 1979-1982 base period." (NMFS 2000).

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK sport, net and troll fisheries; 2) the Northern British Columbia troll (statistical areas 1-5) and the Queen Charlotte Islands sport (statistical areas 1 - 2); and 3) the WCVI troll (statistical areas 21,23-27, and 121-127) and sport, for specified areas and time periods. The estimated abundance index each year is computed by a formula specified in the agreement for each AABM fishery. Table 1 of the new chinook chapter of the agreement specifies the target catch levels for each AABM fishery as a function of that estimated abundance index.

All chinook fisheries subject to the Treaty that are not AABM fisheries are classified as ISBM fisheries, including freshwater chinook fisheries. As provided in the new agreement, "an ISBM fishery is an abundance-based regime that constrains to a numerical limit the total catch or total adult equivalent mortality rate within the fisheries of a jurisdiction for a naturally spawning chinook stock or stock group." For these fisheries the agreement specifies that Canada and the U.S. shall reduce the total adult equivalent mortality rate by 36.5% and 40% respectively, relative to the 1979-1982 base

period, for a specified list of indicator stocks. In Puget Sound these include Nooksack early, Skagit summer/fall and spring, Stillaguamish, Snohomish, Lake Washington, and Green stocks.

If such reductions do not result in the biologically-based escapement objectives for a specified list of natural-origin stocks, ISBM fishery managers must implement further reductions across their fisheries as necessary to meet those objectives or as necessary to equal, at least, the average of those reductions that occurred during 1991-1996 . Although the specified ISBM objectives must be achieved to comply with the agreement, the affected managers may choose to apply more constraints to their respective fisheries than are specifically mandated by the agreement. The annual distribution of allowable impacts is left to each country's domestic management processes.

Pacific Fisheries Management Council

The Pacific Fisheries Management Council (PFMC) provides recommendations to the Secretary of Commerce regarding management regulations and sets annual harvest levels for salmon and groundfish fisheries in the coastal marine waters of Washington, Oregon, and California, within the 200-mile EEZ of the United States. The Council was created by the Magnuson Fishery Management and Conservation Act in 1977, and re-authorized by Congress' passage of the Sustainable Fisheries (Magnuson-Stevens) Act (SFA) in 1997. The Council coordinates and oversees the ocean fishery management objectives among the three state jurisdictions by mandating regulations that prevent overfishing and maintain sustainable harvest. The Council's function is to assure that conservation objectives are achieved for all chinook and coho stocks, and that harvest is equitably shared among the various user groups.

The fundamental principles and implementation of the conservation standards are outlined in the Framework Management Plan (FMP). The Council has adopted amendments to the FMP to address specific conservation and management issues. The FMP includes specific management goals and objectives for salmon stocks, usually stated as escapement goals or exploitation or harvest rates. These objectives are based on the fundamental principle of providing optimum yield, which was re-defined to mean 'maximum sustainable yield, as reduced by relevant economic, social, or ecological factors" (PFMC 1999).

Amendment 14 to the Pacific Coast Salmon Plan included conservation objectives, expressed as the number of natural, adult spawners, for chinook stocks from Puget Sound and the Strait of Juan de Fuca. These objectives could be revised without FMP amendment according to procedures in the PSSMP.

Distribution of Fishing Mortality

A significant portion of the fishing mortality on many Puget Sound chinook stocks occurs outside the jurisdiction of this plan, in Canadian and, in some cases, Southeast Alaskan fisheries (Table 12), based on analysis of coded-wire tagged indicator stocks. More than

half of the total mortality of Stillaguamish summer, Hoko fall, Nooksack early, and Skagit spring chinook occurs in Alaska and Canada. Washington ocean troll fisheries generally account for a small proportion of the mortality of Puget Sound chinook, but their impact exceeds 5 percent of total mortality for Skokomish and South Puget Sound fall stocks. Puget Sound net and Washington sport fisheries account for the largest proportion of fishing mortality for most Puget Sound stocks

Table 11. Distribution of harvest for Puget Sound chinook, expressed as an average (1996-2000) proportion of total, annual, adult equivalent fishing exploitation rate (TCChinook 02-3 2002)

	Alaska	**B.C.**	**Washington troll**	**Puget Sound Net**	**Washington Sport**
Samish Fall	2.3%	43.0%	1.8%	40.2%	12.7%
Stillaguamish Sum	17.8%	50.3%	0.3%	2.6%	29.1%
South Puget Snd Fall	2.0%	29.6%	6.0%	21.7%	40.7%
Nisqually Fall	0.5%	14.5%	2.6%	44.9%	37.6%
Skokomish Fall	1.7%	37.4%	9.0%	7.2%	44.7%
Hoko Fall	74.2%	25.3%	0.0%	0.6%	0.0%
Nooksack Spring	1.6%	75.7%	1.5%	3.0%	18.3%
Skagit Spring	1.0%	51.4%	1.2%	7.1%	39.2%
White River Spring	0.0%	4.5%	0.6%	3.5%	91.4%

Summer fall stocks

Samish fall fingerlings: Alaskan and Canadian fisheries incur 45 percent of fishing mortality. Washington sport fisheries account for 13 percent, and Puget Sound net fisheries 40 percent of total mortality.

Stillaguamish summer fingerlings: In recent years, 68% of the harvest impact on Stillaguamish summers has occurred outside of Washington. Most of the impact of Washington fisheries has occurred in recreational fisheries.

South Puget Sound fall fingerlings: Canadian fisheries account for 30 percent of harvest mortality. Puget Sound net and sport fisheries account for 22 percent, and 41 percent of the total, respectively. For Nisqually fall fingerlings, relatively fewer impacts occur in Canada (15%), and approximately equal impacts in Puget Sound sport and net fisheries.

Skokomish fall fingerlings: Canadian fisheries account for 37 percent of fishing mortality. Washington recreational fisheries account for 45 percent of total mortality.

Hoko fall fingerlings: Fishing mortality occurs primarily in Alaskan (75 percent) and Canadian fisheries (25 percent). Very few impacts are associated with Washington fisheries.

Spring chinook stocks

Nooksack Early yearlings: The majority of the impacts (75 percent) on Nooksack Early chinook occur outside Washington, in Georgia Strait sport fisheries. Since 1996 sport fisheries in Puget Sound have accounted for about 18 percent of the harvest mortality.

Skagit Spring yearlings: Canadian fisheries account for 51 percent of fishing mortality. Washington recreational fisheries account for 39 percent of the total.

White River spring: Fishing mortality occurs primarily (91 percent) in Puget Sound recreational fisheries.

Trends in Exploitation Rates

FRAM 'validation' runs, which incorporate post-season observed catches and stock abundances, are available for management years 1983 – 2000, and provide an index of the trend in the total exploitation rate of Puget Sound chinook. For these models, post-season abundances, in terms of total recruitment, are estimated from the observed terminal run sizes by using preterminal expansion factors estimated either from CWT preterminal exploitation rates, or from fishery effort scale factors

For Category 1 MU's, fisheries management has decreased exploitation rates steadily since the 1980's . Exploitation rates on Skagit, Stillaguamish, and Snohomish units have declined 49 – 56 percent, from levels 1983 - 1987 to the last five years (Figure 4). Total exploitation rates on spring chinook have also declined: the average rate Nooksack early chinook has declined 57 percent, for White River springs 42 percent, and for Skagit springs 47 percent. (Fig 5).

Figure 4. Trend in total exploitation rate for Skagit, Stillaguamish, and Snohomish summer/fall chinook management units. (post season FRAM estimates).

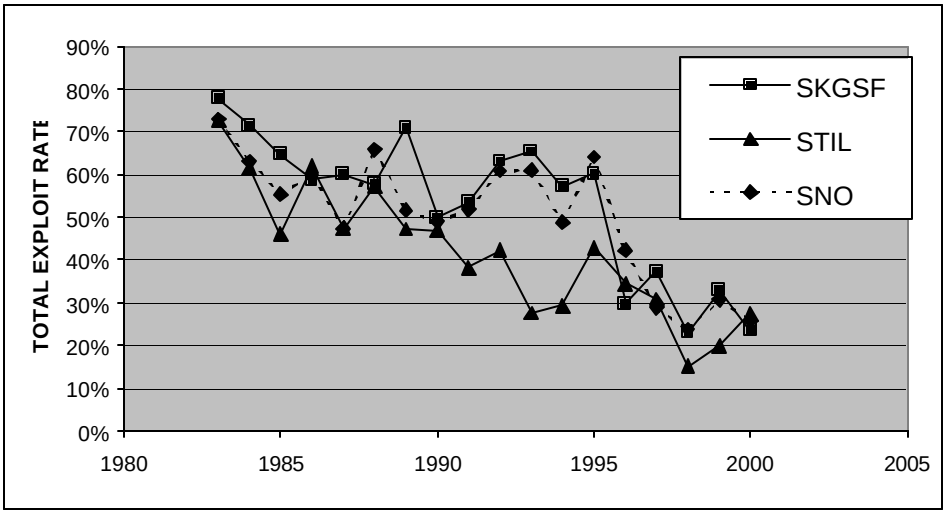
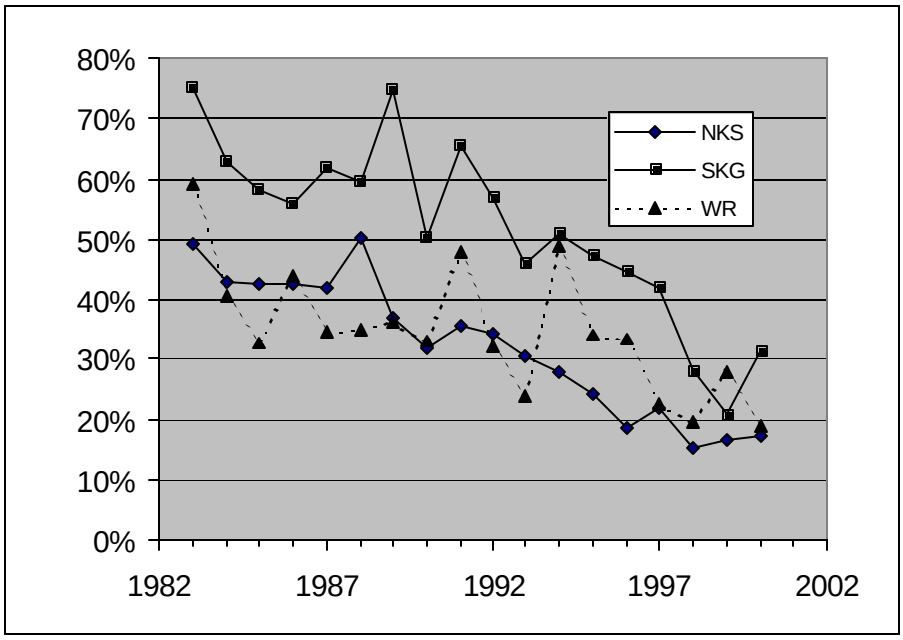
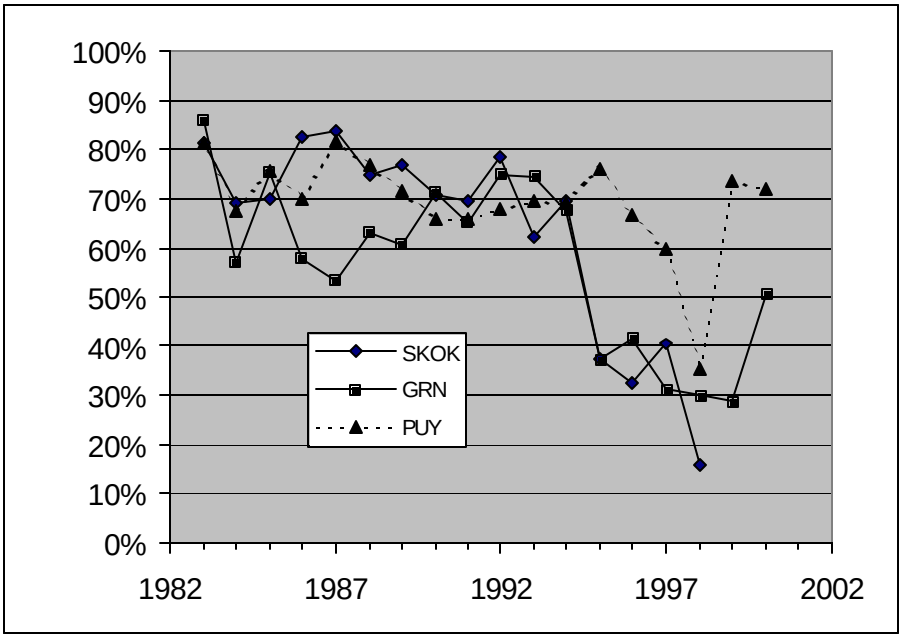


Figure 5. Trend in total exploitation rate for Nooksack, Skagit, and White spring chinook management units (post-season FRAM estimates)



Exploitation rates on Category 2 MU's also declined relative to 1985-1990 (Figure 6), but have increased in the last two years (1999 – 2000) largely because these runs have exceeded their escapement goals, allowing terminal-area harvest to increase.

Figure 6. Total AEQ fisheries exploitation rate for the Skokomish, Green, and Puyallup management units (post season FRAM estimates).



5. Application of Management to Puget Sound Fisheries

Management Intent

The co-managers' central management intent is to provide opportunity for the harvest of available surpluses from stronger stocks, while controlling impacts on weak or threatened weak populations, to avoid impeding their recovery. For the immediate future, this intent precludes fisheries that target chinook in many areas, except where conditions allow focused harvest of highly productive populations.

For the purposes of this Plan, 'directed' or 'targeted' fishing is defined as occurring where more than 50 percent of the fishery-related mortality is made up of listed, Puget Sound-origin fish. Total mortality, rather than landed catch, is specified to include all potential non-landed mortality.

Rules for Allowing Fisheries

The annual management strategy, for any given chinook management unit, shall depend on whether a harvestable surplus is forecast. This Plan prohibits targeted harvest on wild, listed populations of Puget Sound chinook, unless they have harvestable surplus. In other words, if depressed management units do not have a harvestable surplus, then harvest-related mortality will be constrained to incidental impacts. The following rules define how and where fisheries can operate:

- Fisheries may be conducted where there is reasonable expectation that more than 50 percent of the resulting fishery-related mortality will accrue to management units with harvestable surpluses.

- Within this constraint, the intent is to avoid harvests of wild chinook runs that don't have harvestable surpluses, not to find the combination of fisheries that have the highest impact without exceeding the constraint.

- While the intent is to avoid harvests of chinook from weak stocks, it is not the co-managers' intent to implement strategies that seek to achieve the absolute minimum impact on weak stocks, regardless of collateral loss of harvest opportunity on stronger chinook stocks and other species.

- Some exceptions may be provided for test fisheries that are necessary for research, and limited tribal ceremonial and subsistence fisheries, provided that these fisheries are modest in scope.

Where it is not possible to target effectively on productive natural stocks or hatchery production, without a majority of the fishery impacts coming from runs without harvestable surpluses, use of the above rules will likely necessitate foregoing harvest of much of the surplus from those more productive management units.

Rules That Limit Harvest Levels

The co-managers' will adhere to the following guidelines when assessing the appropriate levels for proposed annual fishing regimes:

- The management regime will be devised to meet the conservation standards of the weakest, least productive management unit or component population. Because these units commingle with more productive units to some extent, even in terminal fishing areas, meeting the needs of these units may result in reducing the exploitation on stronger units to significantly less than the level that meets the conservation needs of the stronger units.

- A management unit shall be considered to have a harvestable surplus if, after accounting for expected Alaskan and Canadian catches, and incidental, test, and tribal ceremonial and subsistence catches in southern U.S. fisheries, an MU is expected to have a spawning escapement greater than its threshold for harvestable abundance (see Section III), and its projected ER is less than its ER ceiling. In that case, additional fisheries (including directed) may be implemented until the exploitation rate ceiling is met, consistent with the Rules for Allowing Fisheries (above), or its expected escapement equals the threshold for harvestable abundance. Because this MU has harvestable abundance, impacts are *not* limited to incidental catches only. The array of fisheries that may be managed to harvest the surplus is broadened, and may include terminal area fisheries that target natural chinook.

- If a MU does not have harvestable surplus, then, consistent with the Rules for Allowing Fisheries (above), only incidental, test, and tribal ceremonial and subsistence harvests of that MU may be allowed in Washington areas.

- The projected exploitation rate for management units with no harvestable surplus will not be allowed to exceed their ceiling exploitation rate. It is important to note that, for units without harvestable surplus, the ceiling ER is a trigger for additional restrictions, not a quota or target harvest level. In most cases, restricting impacts to only incidental catches will result in projected ER's well under the ceiling ER. In the event that the projected ER exceeds the ceiling ER, the incidental, test, and ceremonial and subsistence harvests must be further reduced until the ceiling ER is not exceeded.

- The annual fishing regime must meet the guidelines established by the Pacific Salmon Treaty chinook agreement, such that the non-ceiling fishery index will not exceed the Treaty-mandated ceiling (see Section IV, Pacific Salmon Treaty). If the ISBM index is projected to be exceeded, U.S. fisheries must be further reduced until the mandated ceiling is achieved.

- If, after accounting for anticipated Alaskan and Canadian interceptions, test fisheries, and ceremonial and subsistence harvest, and incidental mortality in

southern U.S. fisheries, the spawning escapement for one or more management units is expected to be less than its Critical Abundance Threshold, the ceiling exploitation rate in southern U.S. fisheries for that management unit will be reduced to its Critical Abundance Exploitation Rate Ceiling (see Section 3). When that occurs, Washington fisheries will be further reduced or shaped as necessary until either the escapement is projected to exceed its LAT, or until its projected exploitation rate in southern U.S. fisheries does not exceed the Critical Abundance (MFR) ER Ceiling.

- Where analysis demonstrates that further conservation measures in fisheries will contribute significantly to recovery of a management unit, the co-managers may, at their discretion, and in concert with other specific habitat and enhancement actions, implement further reductions in fishery harvest levels.

Steps for Application to Annual Fisheries Management Planning

Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and so-called North of Cape Falcon forums. These offer the public, particularly commercial and recreational fishing interest groups, access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified early in the process. The annual steps are as follows:

Abundance forecasts are developed for Puget Sound, Washington coastal, and Columbia River chinook management units in advance of the management planning process. Forecast methods are detailed in documents available from WDFW and tribal management agencies. Preliminary abundance forecasts for Canadian chinook stocks, and expected catch ceilings in Alaska and British Columbia, are obtained through the Pacific Salmon Commission forum or directly from Canada Department of Fisheries and Oceans.

The Pacific Fishery Management Council's annual planning process begins in early March by establishing a range of allowable catch for each coastal fishery. For Washington fisheries, this involves recreational and commercial troll chinook catch quotas for Areas 1 – 4 (including Area 4B in the western Strait of Juan de Fuca).

An initial regime for Puget Sound fishing is evaluated. Recreational fisheries are initially set at levels similar to the previous year's regime. Incidental chinook harvest in pre-terminal net fisheries is projected using the performance of recent years and the anticipated fisheries for other species in the current year. Terminal area net fisheries in chinook-directed periods are scaled to harvest surplus production and achieve natural and / or hatchery escapement objectives. The fishery regimes for pre-terminal and terminal net fisheries directed at other salmon species are initially set to meet management objectives for those species.

The FRAM is used to simulate this initial regulation set for all Washington fisheries, based on forecast abundance of all chinook management units. Spawning escapement, and Washington and total exploitation rates projected by this model run are then examined for compliance with management objectives for each Puget Sound chinook management unit. Concurrently, model the Minimum Fisheries Regime, incorporating forecast abundance, and pink-directed fisheries in odd-numbered years, to calculate exploitation rate objectives for any management unit below its LAT.

The initial model runs are used to reveal the scope and magnitude of conservation concerns for any management units in critical status (i.e. where escapement falls short of their Critical Abundance Thresholds), and a more general perspective on achievement of management objectives for all other management units. As necessary, regulations governing directed and incidental chinook harvest impacts are adjusted, through technical assessment and negotiation among the co-managers, in order to arrive at a fishery regime that addresses the conservation concerns for weak stocks, ensures that exploitation rate ceilings are not exceeded and / or escapement objectives achieved for all other units, while achieving the annual harvest objectives of the co-managers.

If spawning escapement to any management unit or component population is projected to fall below the critical abundance threshold, further constraints may be imposed on fisheries with impacts on that unit. Incremental constraints are then modeled until either escapement exceeds the threshold, or the exploitation rate is lower than the ceiling rate which was identified by modeling the Minimum Fishery Regime (Appendix C).

The proposed regime is then examined for compliance with PST chinook agreements (see Compliance with PST Chinook Agreements, below). If the regime is out of compliance, further adjustments must be made until it is in compliance

Where feasible the co-managers may implement additional protective measures for any management unit to reduce risk associated with low abundance, benefit recovery, or achieve harvest allocation objectives. In doing so, they may consider the most recent information regarding the status and productivity of the management unit or population, and past performance in achieving its management objectives

Because of annual variability in abundance and productivity among the various populations, there is no single fishing regime that can be implemented from one year to the next to achieve the management objectives for all Puget Sound chinook units. The co-managers have, at their disposal, a range of management tools, including gear restrictions, time / area closures, catch or retention limits, and complete closures of specific fisheries. Combinations of these actions will be implemented in any given year as necessary to insure that management objectives are achieved.

Compliance with Pacific Salmon Treaty Chinook Agreements

In 1996, the parties to the Pacific Salmon Treaty agreed to a new abundance-based chinook management regime for individual stock-based management (ISBM) fisheries in

the United States and Canada. With respect to Puget Sound chinook, this agreement refers to the abundance status (i.e. spawning escapement) of certain indicator stock groups with respect to their identified escapement goals. The summer/fall indicator group includes the Skagit, Stillaguamish, Snohomish, Lake Washington, and Green units; the spring indicator group includes Skagit spring and Nooksack early units. Stepped reductions in ISBM fisheries will be imposed when two or more of these indicator units are projected not to meet their escapement objectives. These reductions will comply with the pass through provisions and general obligations for individual stock-based management regimes (ISBM) pursuant to the chinook chapter within the US/Canada Pacific Salmon Treaty.

Escapement projected by the FRAM, at the conclusion of pre-season planning, will be compared to PST objectives. According to the PST agreement: "the United State shall reduce by 40%, the total adult equivalent mortality rate, relative to the 1979-82 base period, in the respective ISBM fisheries that affect those stocks." The reduction shall be referred to as the "general obligation".

For those stock groups for which the general obligation is insufficient to meet the agreed escapement objectives, the jurisdiction within which the stock group originates shall implement either:

i) additional reductions as necessary to meet the agreed escapement objectives; or

ii) additional reductions, which taken together with the general obligation, are at least equivalent to the average of those reductions that occurred for the stock group during the years 1991-96.

The non-ceiling fishery index was defined by the Chinook Technical Committee (TCChinook 96-1). The PST defers to any more restrictive limit mandated by the Puget Sound chinook management plan, or otherwise implemented by the co-managers.

Regulation Implementation

Individual tribes promulgate and enforce regulations for fisheries in their respective 'usual and accustomed' areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the Puget Sound Salmon Management Plan. All fisheries shall be regulated to achieve conservation and sharing objectives based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement, harvest sharing, and fishery impacts. (should exercise of treaty rights be predicated on proof of 'safety', as these four elements hint?)

The fishing regime developed and agreed-to by the co-managers through the PFMC and NOF forums will be documented and distributed to all interested parties, at the conclusion of annual pre-season planning. This document will summarize regulatory guidelines for Treaty Indian and non-Indian fisheries (i.e. species quotas, bag limits, time/area restrictions, and gear requirements) for each marine and freshwater management area on the Washington coast and in Puget Sound. Regulations enacted during the season will implement these guidelines, but may be modified, based on catch and abundance assessment, by agreement between parties. In-season modifications shall be in accordance to the procedures specified in the Puget Sound Salmon Management Plan and subsequent court orders.

Further details on fishery regulations may be found in the respective parties regulation summaries, and other State/Tribal documents. The co-managers maintain a system for transmitting, cross-indexing and storing fishery regulations affecting harvest of salmon. Public notification of fishery regulations is achieved through press releases, regulation pamphlets, and telephone hotlines.

In-season Management

Fisheries schedules and regulations may be adjusted or otherwise changed in-season, by the co-managers or through other operative jurisdictions (e.g. the Fraser Panel, Pacific Fisheries Management Council). Schedules for fisheries governed by quotas, for example, may be shortened so that harvest quotas are not exceeded. Commercial net fishery schedules in Puget Sound may be modified to achieve allocation objectives or in reaction to in-season assessment of the abundance of target stocks, or of stocks harvested incidentally. In each case, the co-managers will assess the effect of proposed in-season changes with regard to their impact on natural chinook management units, and determine whether the management action constrains fishery impacts within the harvest limits stated in this plan. Particular attention will be directed to in-season changes that impact management units or populations in critical status, or where the pre-season plan projections indicated that total impacts were close to ceiling exploitation rates or projected escapement close to the respective escapement goals.

The co-managers will notify the NMFS when in-season actions are expected to increase an exploitation rate to a management unit's ceiling rate or lower the expected escapement level to a management unit's critical abundance threshold. The notification will include a description of the change, an assessment of the anticipated fishing mortality resulting from the change, and an explanation of how impacts of the action maintains consistency with the Puget Sound chinook harvest management plan. This notification process also applies when in-season actions involve impacts to the chinook "stock(s) of concern" identified within the annual pre-season planning process.

Enforcement and Education

The Washington Department of Fish and Wildlife and individual Treaty tribes are responsible for regulation of harvest in fisheries under their authority, consistent with the principles and procedures set forth in the Puget Sound Salmon Management Plan. Fisheries will be regulated to achieve sharing and production objectives based on four fundamental elements: (1) acceptably accurate determination as to the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries to meet objectives for spawning escapement and fishery impact limitations.[1]

The annual Co-managers Fishery Management Plan provides a detailed summary of the fishing regulations for treaty and non-treaty salmon fisheries in each area in Puget Sound. These regulations are based on pre-season expectations and, in some instances, may be modified on the basis of information obtained in-season and by agreement between parties. They reflect agreements reached between WDFW and the tribes during pre-season planning. For some management units, pre-season expectations are recorded in Status as required by the Puget Sound Salmon Management Plan.

Commercial fishery regulations are promulgated by WDFW and each tribe. The co-managers maintain a system for transmitting regulations electronically to all interested parties, in a timely manner, prior to and during specific fisheries. Regulations are stored in paper and electronic format by WDFW, each tribe, and the Northwest Indian Fisheries Commission. Commercial fishery regulations for some fisheries are also available through telephone hotlines maintained by WDFW, the NWIFC, and individual tribes. WDFW publishes regulations for recreational fisheries in a widely distributed pamphlet. Annual recreational salmon fishing regulations are in effect from May through April of the following year. WDFW regulations, and in-season regulation changes, are also published on their website (www.wa.gov/wdfw/)

Non-Indian commercial and recreational fishery regulations are enforced by WDFW. The WDFW Enforcement Program currently employs 163 personnel. Of that number, 156 are fully commissioned Fish and Wildlife staff who ensure compliance with licensing and habitat requirements, and enforce prohibitions against the illegal taking or poaching of fish and wildlife (www.wa.gov/wdfw/enf/enforce.htm). The Fish and Wildlife Enforcement Program is primarily responsible for enforcing the Washington StateFish and Wildlife Code (Title 57). However, officers are also charged with enforcing many other codes as well, and are often called upon to assist their local city/county, and other state law enforcement agencies, and tribal authorities. On an average, officers currently make more than 300,000 public contacts annually (93% of Enforcement FTE's are field deployed). WDFW Enforcement staff also cooperate with the U.S. Fish and Wildlife Service, the NMFS Enforcement branch, and the U.S. Coast Guard.

[1] Exercise of Treaty rights by Indian tribal members is, however, not conditioned by the ability of tribes to achieve these regulatory elements.

Each tribe exercises authority over enforcement of tribal commercial fishing regulations, whether fisheries occur on or off their reservation. In some cases enforcement is coordinated among several tribes by a single agency (e.g. the Point No Point Treaty Council is entrusted with enforcement authority over Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam, tribal fisheries). Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

Participation by Indian and non-tribal fishers participate in pre-season fishery planning, at a local level in meetings conducted by tribal resource managers and WDFW, and through the Pacific Fisheries Management Council hearings and the North of Cape Falcon forum, promotes education about salient conservation concerns that are of particular relevance to planning fisheries. These forums also promote a wide awareness of changes in regulations, well in advance of the onset of most fisheries, directly to fishers and through the news media.

6. Changes from Previous Management Practices

Harvest Objectives Based on Natural Productivity

The harvest objectives for each management unit are stated and measured in terms of impacts and consequences to naturally-produced chinook. Though fisheries in some areas are shaped to harvest surplus hatchery production, the primary and overriding objective is to assure protection and conservation of natural populations. To this end, harvest objectives are defined as ceiling exploitation rates on natural populations or specific natural escapement objectives.

This Plan, then, represents a significant change in fisheries management. Formerly, management of some units was based primarily on harvesting surplus hatchery production, without regard to the consequences of these high harvest rates on natural-origin chinook. These units were designated 'secondary' in the Puget Sound Salmon Management Plan. This Plan superimposes the conservation requirements for all natural populations on harvest in all areas. At this stage in development of the Plan, specific escapement goals have been established for Category II (formerly secondary), to ensure that natural production remains viable. For *all* of these units, in-season assessment of abundance tools, and specific management response when abundance falls short of the forecast level, are in place, or will be developed in the near future.

Reduction in Exploitation Rates

The exploitation rate targets likely under this Plan are substantially lower than rates exerted in the 1980's. Annual exploitation rates for Category 1 management units have declined 42 to 59 percent, based on comparison of the 1983-1987 and 1998-2000 averages estimated from post-season FRAM runs (Table 14). Rates for Category 2 management units have fallen 18 to 52 percent. Exploitation rates in Washington fisheries (ocean and Puget Sound areas combined) have fallen x and y percent for Category 1 and Category 2 units, respectively

Table 12. Percent decline in average total, adult-equivalent exploitation rate, from 1983 – 1987 to 1998-2000, for Category 1 Puget Sound chinook management units.

Mgmt Unit	1983 – 87 average	1996–2000 average	% Decline
Nooksack early	44%	18%	59%
Skagit S/F	67%	29%	56%
Skagit Spring	42%	24%	42%
Stillaguamish	58%	26%	56%
Snohomish	60%	30%	49%
Green	66%	36%	45%
White	42%	24%	42%

Biologically-based Harvest Objectives

Formerly (i.e. prior to 1998), chinook harvest objectives were stated as escapement goals for many Puget Sound management units. The PSSMP stated the preference that escapement goals be based on achieving maximum sustainable harvest, which implied quantification of current natural productivity (i.e. spawner – recruit functions) and productive capacity, to the extent possible. However, the escapement goals that were established by the co-managers for 'primary' management units were not always biologically based, but often consisted of an historical average of escapement during a period of relatively high abundance and survival, (i.e. 1968-1977 for summer fall stocks, 1959-1968 for Skagit River springs). For most units, these goals were not related to the current capacity or quality of spawning or freshwater rearing habitat, or marine survival, particularly as habitat conditions were further degraded through the 1980's and 1990's, and were dictated solely by the fishing levels in the base years. These goals were developed without any age composition or CWT data, and without any productivity assessments, and they were allowed to linger until the ESA listing, with its requirement for development of recovery goals, forced a re-analysis of the old goals. Intentional failure to achieve these objectives, by co-manager consensus, was in part justified by their irrelevance to current conditions.

This Plan commits the co-managers to setting and regularly re-assessing harvest and escapement objectives for all management units to conform with their current or recent productivity. Where biological information is currently unavailable to support this analysis, the co-managers have committed to expanding or re-directing research and sampling programs to collect it.

Accounting for Biological Uncertainty and Variability

The co-managers recognize that there is inherent uncertainty and variability in all productivity estimates, for any given population or management unit. . In order to manage the risk that, due to this uncertainty, objectives will be evaluated and established incorrectly, biologically-based harvest objectives must account and compensate for the uncertainty surrounding current and future productivity (i.e. recruitment and survival).

Methods outlined in section IV.B describe how the current procedure for developing recovery exploitation rates accomplishes this objective. This strategy may be summarized as follows:

- To the extent possible, variability in freshwater and marine survival rates will quantified separately;
- Simulation of population dynamics will incorporate marine and freshwater survivals that have an acceptable probability of exceedance, based on base period estimates;
- Simulation will assume that marine survival will mimic the recent past, though current information indicates marine survival has increased;
- Adaptive management will update objectives as actual exploitation rates, escapements, and rates of survival are monitored closely;

Protection of Individual Populations

This Plan establishes harvest objectives (i.e. ceiling exploitation rates) for management units, but annual fishing planning will give specific attention to the status of individual populations, where a unit consists of more than one population, providing that acceptably accurate data quantify productivity and capacity for those populations. Escapement that is projected for each population, based on unit escapement output from the fishery simulation model, and the recent historical trend in population escapement, will influence the co-managers' annual management targets. Actual exploitation rates, for most units, are likely to fall well below the exploitation rate ceilings, due to concern for weak or critical populations. Specific conditions are established for implementing fisheries that would increase exploitation up to the respective ceiling for any unit. To guard against escapement falling to a level that jeopardizes demographic or genetic integrity, a critical abundance threshold is established, for each population, that triggers more conservative constraint of harvest.

Conservation Requirements of the Endangered Species Act

The conservation standard of the ESA, as expressed in Limit 4 of the salmon 4(d) rule (50 CFR 223 vol 65 p 170 - 188) regarding state / tribal harvest management plans, is that harvest-related mortality must not "appreciably reduce the likelihood of survival and recovery of the ESU". Survival and recovery are further defined as protecting the abundance, distribution, and genetic diversity of the ESU. The objectives of this Plan specifically meet, and exceed, this standard, as they apply to management units and their component chinook populations in Puget Sound, through the following means:

The co-managers have interpreted the 4(d) standard for harvest, by affirming that recovery can not be solely accomplished by constraint of harvest. If harvest mortality is not excessive and spawning escapements are not reduced to the point where depensatory mortality and other ecological factors become significant and threaten genetic integrity, harvest cannot affect productivity (i.e., recruitment rate). Under this circumstance productivity is primarily constrained by the quality and quantity of freshwater and estuarine environment that determines embryonic and juvenile survival, and oceanic conditions that influence survival up to the age of recruitment to fisheries.

The following points demonstrate the conservation objectives of the co-managers' Plan:

1. Exploitation rates have been substantially reduced from past levels. The fisheries constraints in this plan will keep ER's at low rates.

2. Exploitation rate ceilings established for each management unit using the best available biological information, have been shown to achieve a high degree pf probability of stable abundance under current habitat constraints, while not impeding recovery to higher abundance as habitat conditions and marine survival allow.

3. Recovery exploitation rates are ceiling rate, not annual targets for each management unit. Under current conditions most management units are not producing a harvestable surplus, as defined by this plan, so weak stock management procedures that assure meeting conservation needs of the least productive unit(s) forces the annual target rates for most units below the RER ceiling. Projected ER's in 2000 – 2002 for the Skagit, Stillaguamish, and Snohomish management units were substantially below their respective ceiling rates. (Table 13).

Table 13. Annual projected total exploitation rates compared with ceiling ER's for natural chinook management units in Puget Sound.

Management Unit	Ceiling ER	Projected ER		
		2000	2001	2002
Skagit summer/fall	52%	29%	40%	26%
Skagit spring	42%	22%	21%	23%
Stillaguamish summer/fall	25%	15%	17%	14%
Snohomish summer/fall	35% (2000); 32% (2001-02)	26%	23%	19%

4. If a harvestable surplus is available for any management unit, that surplus will only be harvested if a fishing regime can be devised that is expected to exert an appropriately low incidental impact on weaker commingled populations, so that their conservation needs are fully addressed.

5. Exploitation rate objectives must be met for each MU.

6. Furthermore, if annual abundance is forecast to result in escapement at or below the critical abundance threshold, the ceiling rate will be further reduced to the Critical Abundance ER. In this case, fisheries will be constrained to the new ER ceiling. The critical abundance thresholds are intentionally set at levels substantially higher than the actual point of biological instability, so that fisheries conservation measures are implemented to prevent abundance falling to that point.

7. If the annual abundance of any *component population* of an MU is forecast to have an escapement at or below its LAT, fisheries must be further reduced to preserve the viability of that population. As with MU's, the LAT's for populations are set at levels substantially higher than the actual point of biological instability, so that fisheries conservation measures are implemented to prevent abundance falling further to that point.

8. It is not whether high exploitation rates in the past selected against larger, older spawners, thereby changing the age composition or reducing the size of spawning chinook. To the extent that this has occurred, the reduction in exploitation rates required under this plan will increase the proportion of larger, older spawners. The size-, age-, and sex-selective effects of fisheries on spawning chinook are reviewed in Appendix F.

9. While it is not certain that an increase in the number of chinook carcasses on the spawning grounds will increase the productivity of Puget Sound chinook (see Appendix), the reduction in exploitation rates required under this plan will increase the number of chinook carcasses on the spawning grounds. Any increase in productivity that results from this increase in carcasses will accelerate recovery beyond what was assumed when deriving the ceiling ER's. A more detailed discussion of this issue is presented in Chapter 8, and a review of recent literature in Appendix D.

10. Under all conditions of management unit status, whether critical or not, the co-managers maintain the prerogative to implement conservation measures that reduce fisheries-related mortality farther below any ceiling stated in this Plan. Responsible resource management will take into account recent trends in abundance, and freshwater and marine survival, and information on the likelihood of management error for any unit.

Recovery Goals

The co-managers are in the process of quantifying recovery goals for each Puget Sound chinook management unit. Analyses are being done to quantify the productivity, abundance, and capacity of a management unit associated with historical, current, and 'properly functioning' (i.e. recovered) conditions. Productivity goals will be expressed as smolt survival rates and / or adult recruitment rates; abundance and capacity will be expressed in terms of adult escapement; diversity will be expressed as life history variants, spawner age composition, and spatial and temporal run distribution. When completed, these goals will provide a standard to measure progress towards recovery, and to guide recovery efforts

Improving habitat quality and quantity, an essential precursor to increasing stock productivity, will be a long-term process. The quality and quantity of freshwater, estuarine, and nearshore marine habitats are key factors in determining the potential productive capacity of a river system. Until habitat can be restored and estimates of MSY developed consistent with recovered habitat conditions, the ultimate productive capacity for a river system and associated management unit(s) remains unknown. As additional data and experience is gained, adaptive management measures will be applied to refine these recovery goals and associated management efforts. However, given the severe constraints imposed by habitat quality in some basins, the co-managers cannot foresee recovery of all management units. Recovery of the Puget Sound ESU will necessarily be

defined as recovery of a subset of those units, while maintaining natural production for all populations wherever and by whatever means possible.

For the purposes of evaluating the effects of implementing this harvest plan, in the 2003-2004 management year, on the status of Puget Sound management units, reference escapement goals for each unit are presented (Table 14). The co-managers define a viable population as one having a very low probability of extinction, for the foreseeable future.

The critical escapement thresholds defined in this plan represent the lower boundary, and the reference escapement goals an interim upper boundary, of this range of viability. The technical bases for these reference escapement goals varies among management units (see footnotes to Table 14). In some cases they comprise an historical average (1965 – 1976) during a period of relatively high abundance (WDFW 1977). These goals generally do not reflect the current capacity of freshwater habitat or the current productivity of populations. In some cases the goal is based on a qualitative assessment of habitat capacity.

Given two years of Puget Sound management under the 2001 Harvest Management Plan, and three prior years of management under a very similar set of exploitation rate ceilings and escapement goals, the short-term consequences of management under this 2003 Plan may be quantified.

Exploitation rates and spawning escapement objectives in this harvest fishery management plan have been set to facilitate rebuilding toward these recovery levels. Harvest at the ceiling recovery rates, more so for the lower annual target rates anticipated in 2003, will capitalize on favorable environmental conditions, should they occur in the short term, by increasing spawning escapement. In the longer term, the intent is to increase spawners in concert with the recovery of the system's capacity, and the improved productivity of populations resulting from habitat restoration efforts, thereby providing sufficient escapement to enable the management unit to generate higher harvestable surpluses.

Table 14. Interim reference escapement goals[1] and recent escapement for Puget Sound natural chinook management units. Estimates for 2001 are preliminary.

Management Unit	Goal [1]	1996	1997	1998	1999	2000	2001
Nooksack early	**4000** [2]	741	801	523	1124	447 [2]	504 [2]
Skagit spring	**3000** [3]	1051	1041	1086[3a]	471[3a]	906[3a]	1856
Skagit sum / fall	**14900** [4]	10613	4872	14609	4924	16930	13793
Stillaguamish S/F	**2000** [4]	1244	1156	1540	1098	1646	1349
Snohomish S/F	**5250** [4]	4851	4292	6304	4799	6092	8164
Lake Washington Cedar River	**1200** [5]	303	227	432	241	120	810
Green R. Fall	**5800** [4]	6026	9967	7300	9100	6170	7975
White R. spring	**1000** [6]	630	400	316	553	1523	2002
Puyallup fall South Prairie Cr.	**500** [7]	2444	1550	4995	1986	1193	1915
Nisqually fall	**1100** [8]	606	340	834	1399	1253	1079
Skokomish	**3650** [9]	4095	2337	6761	9119	4959	10729
Mid Hood Canal	**750** [10]	24	N/A	287	873	438	322
Dungeness	**925** [11]	183	50	110	75	218	453
Elwha River	**2900** [12]	1608	2517	2358	1602	1851	2208
Western Juan de Fuca Hoko River	**850** [13]	1228	765	1618	1497	612	768

[1] [I]Interim spawning escapement goals are reference points to assess the consequences of this Harvest Plan in 2003.
[2] Nooksack Endangered Species Action Team 2000.
[3] Washington Department of Fisheries 1977. These estimates are generated from redd counts versus earlier estimates which are extrapolated from peak live and dead counts.
[4] Ames and Phinney 1977.
[5] Hage et al. 1994.
[6] WDFW et al. 1996. Natural-origin spawners transported past Mud Mountain Dam.
[7] Puyallup River Fall Chinook Recovery Plan – *in preparation*. Escapement estimates are based on redd counts in even-numbered years and AUC estimations converted to redd-based projections in odd-numbered years due to pink salmon spawning.
[8] Nisqually Chinook Recovery Team. 2001. Nisqually Chinook Recovery Plan.
[9] Ames and Phinney 1977. Composite of 1,650 natural spawners and recently adjusted hatchery escapement t arget of 2000.
[10] U.S. v. Wash. Civil 9213, Ph. I (Proc. 83-8). Order Re: Hood Canal Management Plan (1985).
[11] Smith and Sele 1994.
[12]. Ames and Phinney 1977. This objective is a composite of 500 natural and 2,400 hatchery escapement. Hatchery is listed as essential to recovery.
[13] Ames and Phinney 1977. modified to exclude capture of adults for supplementation program.

7. Plan Review

The performance of the fishery management regime and the effectiveness of its application will be evaluated annually, to assess whether management objectives were achieved, and identify the factors contributing to success of failure of management. This performance assessment will be written into an annual report, by mid-February each year, for reference during the annual fishery management planning process.

While all information used will be preliminary, and it can only point to major events, the annual review is intended to inform the co-managers of any significant reasons for possible deviations from expected outcomes in the immediately preceding season. . To the extent possible, the co-managers will use this information to assess whether these deviations were due to the management system, or to unpredictable variation in the catch distribution of the various management units, migration timing, freshwater entry timing, or other environmental and behavioral factors. Management system inaccuracies might include error or bias in abundance forecasts, inaccuracy or bias in the FRAM fishery simulation, inaccurate in-season abundance assessment tools, or the failure of specific regulations to constrain harvest-related impact in the desired manner.

The co-managers recognize that some degree of inaccuracy and imprecision is inherent in these aspects of the management system. The intent of the annual review is to detect significant and consistent inaccuracies that may become problematic over the short term, and to adjust existing tools or devise new tools, to address them

Monitoring and Evaluation Programs

The Northwest Washington Indian Tribes and the Washington Department of Fish and Wildlife (WDFW), independently and jointly conduct a variety of research and monitoring programs that provide the technical basis for fisheries management. These activities were mandated by the Puget Sound Salmon Management Plan in 1985, though activities related to chinook management have evolved as management tools have improved. Monitoring and assessment essential to the management of Puget Sound chinook is described in detail below, with discussion of how the information is used to validate and improve management regimes. This section is not an exhaustive inventory of chinook research. A wide variety of other studies are underway to identify factors that limit chinook production in freshwater, and to monitor the effectiveness of habitat restoration.

Monitoring catch and fishing effort

Chinook harvest in all fisheries, including incidental catch, and fishing effort are monitored and compared against pre-season expectations. Commercial catch in Washington waters is recorded on sales receipts ('tickets'), copies of which are sent to WDFW and tribal agencies and recorded in a jointly-maintained database. A preliminary

summary of catch and effort is available four months after the season, though a final, error-checked record may require a year or more to develop.
Catch and effort are estimated in-season for certain chinook fisheries that are limited by catch quotas, such as the ocean troll and recreational fisheries that are managed under the purview of the Pacific Fisheries Management Council. Recreational catch in Areas 1 – 6 is estimated in-season by creel surveys. Creel sampling regimes have been developed to meet acceptable standards of variance for weekly catch.

For other Puget Sound fishing areas, recreational harvest is estimated from a sample of catch record cards obtained from all anglers. The recreational fishery baseline sampling program provides auxiliary estimates of species composition, effort, and CPUE to the Salmon Catch Record Card System. The baseline sampling program is geographically stratified among Areas 5-13 in Puget Sound. For this program, the objectives are to sample 120 fish per stratum for estimation of species composition, and 100 boats per stratum for the estimation of CPUE.

Catch and effort summaries allow an assessment of the performance of fishery regulations in constraining catch to the desired levels. Time and area constraints, and gear limitations, are imposed by regulations, but with some uncertainty regarding their exact effect on harvest. For many fisheries, catch is often projected preseason based on the presumed effect of specific regulations. Post-season comparison to actual catch assesses the true effect of those regulations, and guides their future application or modification.

Incidental mortality in fisheries directed at other species has comprised an increasingly significant part of the total harvest mortality of Puget Sound chinook. For many commercial net fisheries in Puget Sound, incidental mortality is projected by averaging a recent period, either as total chinook landed or as a proportion of the target species catch. Recent-year data are the basis for continually updating these projections.

Non-landed mortality of chinook is significant for commercial troll, recreational hook-and-line, and certain net fisheries, regulations for which may mandate release of sub-adult chinook, or all chinook, during certain periods. Studies are periodically undertaken to estimate encounter rates and hooking mortality for these fisheries. Findings from these studies are required to validate the encounter rates and release mortality rates used in fishery simulation models.

Higher priority has been assigned to sampling the catch from certain terminal-area fisheries, to collect biological information about mature chinook. Collection of scales, otoliths, and sex and length data will characterize the age and size composition of the local population, and distinguish hatchery- and natural-origin fish.

Spawning escapement estimation

Chinook escapement is estimated from surveys in each river system. A variety of sampling and computational methods are used to calculate escapement, including

cumulative redd counts, peak counts of live adults, cumulative carcass counts, and integration under escapement curves drawn from a series of live fish or redd counts. A detailed description of methods used for Puget Sound systems is included in Appendix E.

Escapement surveys also provide the opportunity to collect biological data from adults to determine their age, length, and weight, and to recover coded-wire tags. Tissue or otolith samples are also used to determine whether they are of hatchery or wild origin, and coded wire tags or otoliths may be used to identify strays from other systems. Depending on the accuracy required of such estimates, more sampling effort will be directed to gathering basic biological data to determine age and sex composition. State and tribal technical staff are currently focusing attention on the design and implementation of these studies.

Escapement surveys also describe the annual variation in the return timing of chinook populations. Given that terminal-area fisheries for chinook have been highly restricted or eliminated throughout Puget Sound, escapement surveys are increasingly relied on to monitor run timing, as well as age composition.

Reconstructing Abundance and Estimating Exploitation Rates

Estimates of escapement and fishery exploitation rates enable reconstruction of the abundance of annual chinook returns, and given the age composition of annual returns, estimation of the abundance of all cohorts produced from a given brood year escapement. After adjustment to account for non-landed and natural mortality, these estimates of recruitment define the productivity of specific populations. The principal intent of the current chinook harvest management regime is to set management unit objectives based on the current productivity of their component populations. These objectives will change over time, therefore, in response to change in productivity.

Indicator stocks, using local hatchery production, have been developed for many Puget Sound populations, as part of a coastwide program established by the Pacific Salmon Commission. These include Nooksack River early, Skagit River spring, Stillaguamish River summer, Green River fall, Nisqually River fall, Skokomish River fall, and Hoko River fall stocks. Additional indicator stocks are being developed for Skagit River summer and fall, and Snohomish summer stocks. To the extent possible, indicator stocks have the same genetic and life history characteristics as the wild stocks that they represent. Indicator stock programs, in general, release 200,000 tagged juveniles annually, so that tag recoveries will be sufficient for accurate estimation of harvest distribution and fishery exploitation rates.

Commercial and recreational catch in all marine fishing areas in Washington are sampled to recover coded-wire tagged chinook. For commercial fisheries, the objective is to sample at least 20% of the catch in each area, in each statistical week, throughout the fishing season. For recreational fisheries, the objective is to sample 10% of the catch in each month / area stratum. Mass-marking of hatchery-produced chinook, by clipping the adipose fin, has necessitated electronic sampling of catch and escapement to detect coded-wire tags.

Coded-wire tag recovery data enables the calculation of total, age-specific fishing mortality in specific fisheries. These estimates of fishery mortality may be compared with those made by the fishery simulation model (FRAM) to check model accuracy. The FRAM may incorporate forecast or actual abundance and catch, which are scaled against base-year abundance and fisheries. It is recognized that the model cannot perfectly simulate the outcome of the coast-wide chinook fishing regime, so, periodically, the bias in simulation modeling will be assessed. The migration routes of chinook populations may vary annually, and the effect of changing fisheries regulations cannot be perfectly predicted in terms of landed or non-landed mortality. Tag recoveries from a given year provide an independent basis for estimating harvest mortality of particular stocks.

Estimation of Smolt Production

Smolt production from several Puget Sound management units is estimated to provide additional information on the productivity of populations, and to quantify the annual variation in freshwater (i.e. egg-to-smolt) survival. Methods and locations of smolt trapping studies are described in detail elsewhere, but in general, traps are operated through the outmigration period of chinook (January – August). By sampling a known proportion of the channel cross-section, with experimental determination of trapping efficiency, estimates of the total production of smolts are obtained. These estimates are essential to understanding and predicting the annual recruitment, particularly in large river systems where freshwater survival has been shown to vary greatly. Abundance forecasts may incorporate any indications of abnormal freshwater survival.

Survival of juvenile chinook is highly dependent on favorable conditions in the estuarine and near-shore marine zones. For many Puget Sound basins, degraded estuarine and near-shore marine habitat is believed to limit chinook production. Studies are underway to describe estuarine and early marine life history, and to quantify survival through the critical transition period as smolts adapt to the marine environment (Beattie 2002).

Annual Chinook Management Report

The co-managers will write an annual report on chinook fisheries management. Post-season review is part of the annual pre-season planning process, and is necessary to permit an assessment of the parties' annual management performance in achieving spawning escapement, harvest, and allocation objectives. The co-managers review stock status annually and where needed, identify actions required to improve estimation procedures, and correct bias. Such improvements provide greater assurance that objectives will be achieved in future seasons. Annual review builds a remedial response into the pre-season planning process to prevent excessive fishing mortality levels relative to the conservation of a management unit. The annual report will include:

Fisheries Summary
The chronology and conduct of all fisheries within the co-managers' jurisdiction will be summarized, comparing expected and actual fishing schedules, and landed chinook catch. Significant deviations from the pre-season plan will be highlighted, with a summary of in-season abundance assessments and changes in fishing schedules or regulations.

Catch
Landed catch of chinook in all fisheries during the management year (May – April) will be compared with pre-season expectations of catch, including revised estimates of landed catch for the previous management year. For the most recent management year, preliminary estimates of commercial catch from all fisheries will be reported. Creel survey-based estimates of recreational catch in Areas 1 – 6 will also be available. The causes of significant discrepancies between expected and actual catch will be examined, with a view to improving the accuracy of the pre-season projections.

Non-landed Mortality:
Recreational and troll fisheries typically allow retention of chinook above a minimum size, or prohibit retention of chinook during some periods. The ocean troll fishery has been monitored since 1999, using on-board observers and fishers to collect data on encounters with sub-legal chinook. These studies enable comparison of encounters, and consequent mortality, with pre-season expectations.

Spawning Escapement
Spawning escapement for all management units will be compared to pre-season projections, with detail on individual populations reported as possible. Escapements will be compared to escapement goals and critical escapement thresholds. Final and detailed estimates of escapement for the previous year will also be tabulated.

Sampling Summary: The annual review will also include summary of CWT sampling rates achieved in the previous year, and describe biological sampling (i.e., collection of scales, otoliths, and sex and size data) of catch and escapement.

Exploitation Rate Assessment
Annual, adult equivalent exploitation rates for each management unit will be estimated periodically, using the FRAM, incorporating actual chinook catch from all fisheries, and estimates of the actual annual abundance of all chinook units, based on spawning escapement or terminal abundance. These rates will be compared to the preseason expected ER's and ceiling ER's. The 2002 annual report will include post-season FRAM estimates through 2000. Methods are also being developed for assessing annual exploitation rates, for management units with representative indicator stocks, based on coded-wire tag data.

ISBM Index Rates: The annual report will summarize the Chinook Technical Committee's assessment of whether non-ceiling fishery exploitation rates for indicator management units achieved the PST benchmarks (either 60% of the 1979-1982 mean

non-ceiling rate or the 1991-1996 average reduction compared with that base period), for units failing to achieve agreed escapement goals for two consecutive years.

The following assessments will be done every 5 years:

Cohort Reconstruction and Exploitation Rate (from CWT data)
Coded-wire tag data will be used to reconstruct brood year AEQ recruitment and exploitation rates for management units with representative indicator stocks, for the five most recently-completed broods with complete data. Because coded-wire tag recoveries require at least one year to process and record, estimates for a given brood year will be made six years later, (i.e. after the brood is completely matured).

Comparison to FRAM
The AEQ fishing year and brood year exploitation rates generated from coded-wire tag data will be compared to the corresponding rates estimated annually from post-season runs of the assessment model. Biases will be examined and either accounted for or corrected in future management.

Spawner-Recruit Parameters
The spawner-recruit parameters used to generate the ceiling ER's, thresholds, and recovery goals will be re-examined by including the most recent data on escapement, juvenile production, habitat productivity, marine survival, and recruitment. As appropriate, the ceiling ER's, thresholds, and recovery goals will be updated to account for changes in productivity.

Spawning Salmon as Source of Marine-derived Nutrients

Mature adult salmon provide essential marine-derived nutrients to freshwater ecosystems, as a direct food source for juvenile or resident salmonids and invertebrates, and as their decomposition supplies basic nutrients to the base of the food chain. A body of scientific literature, reviewed in Appendix D, is developing to support the contention that the nutrient re-cycling role played by salmon is particularly important in nutrient-limited, lotic systems in the Northwest. Many studies assert that declining salmon abundance and escapement currently exacerbate nutrient limitation in many systems. However, this research has not advanced to the point of quantifying threshold nutrient loading levels, associated with adult salmon, necessary to support ecosystem function and improve the survival of post-emergent juvenile salmon. The specific role of adult chinook in this regard must be examined in the context of their abundance (i.e. escapement) compared to much larger escapement of coho, pink, and chum salmon in the large river systems that support chinook populations. Furthermore, chinook populations in Puget Sound exhibit, primarily, an 'ocean-type' life history, with relatively short freshwater residence. Freshwater survival, through the egg-to-smolt phases, is undoubtedly constrained by other biotic and physical factors. It has not been demonstrated that nutrient limitation (i.e. secondary production of prey species) actually creates a limit on chinook survival. There is not correlation between brood year escapement and subsequent 0+ chinook

smolt production in the Skagit River over the past ten years. (R. Hayman, memorandum to Skagit Chinook Workgroup, August 17, 1999)

Answers to some of these key question could emerge as research proceeds, but at this juncture the co-managers do not have information that would support changing management objectives for chinook Implementation of this Plan will, by imposing 'weak stock management' and fixed exploitation rates, result in significantly increased chinook escapement for many populations. These principles have been in effect since 1998, and the effect on escapement is already clear in some systems. As previously noted, however, the nutrient-loading effect of increased chinook escapement will be difficult to distinguish from that associated with relatively high escapements of other species in many systems. Nonetheless, the co-managers will, in future, adjust chinook management objectives, if the escapements that result from the implementation of this plan are shown to impede recovery of the Puget Sound ESU.

Age- and Size-Selective Effects of Fishing

Commercial and recreational salmon fisheries exert some selective effect on the age, size, and sex composition of mature adults that escape to spawn (Appendix F). When and where fisheries operate, the catchability of size and age classes of fish associated with different gear types, and the intensity of harvest determine the magnitude of this selective effect. In general, hook-and-line and gillnet fisheries are thought to selectively remove older and larger fish. To a certain extent related to the degree to which age at maturity and growth rate are genetically determined, subsequent generations may composed of fewer older-maturing or faster growing fish. Fishery-related selectivity has been cited as contributing to long-term declines in the average size of harvested fish, and the number of age-5 and age-6 spawners. Older, larger female spawners are believed to produce larger eggs, and dig deeper redds, which improve survival of embryos and fry. .

There is no evidence of long-term or continuing trends in declining size or age at maturity for Puget Sound chinook.. Available data suggest that the fecundity of mature Skagit River summer chinook has not declined from 1973 to the present. (Orrell 1976; SSC 2002). The age composition of Skagit summer / fall chinook harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of three and four year-old fish, but there is no declining trend in the contribution of five year-olds, which has averaged 15 percent (Henderson and Hayman 2002; R. Hayman, SSC December 9, 2002, pers comm.)

Amendment of the Harvest Management Plan

The co-managers view the chinook harvest management plan as dynamic; harvest objectives will change in response to change in the status and productivity of chinook populations. It is likely that the assessment tools will evolve to improve estimation of spawning escapement and cohort abundance. The most pressing data gaps are identified for each management unit in their profiles (Appendix A). As these new data accumulate, the co-managers will periodically re-assess harvest objectives for all management units.

In general this will occur on a five-year cycle, unless information suggests that rapidly changing status demands more frequent attention.

8. Glossary

Abundance - Abundance is the measure of the size of the population or a component of the population. For habitat of constant quality, abundance is positively correlated with the quantity of the habitat. Abundance goals are expressed as numeric life stage targets reflective of the capacity of the associated ecosystem. In general, abundance may be expressed in terms of brood year (the offspring of parents that spawned during a single year) or return year (the individuals maturing and returning to spawn in a single year).

Adult Equivalents (AEQ) - The potential contribution of fish of a given age to the spawning escapement, in the absence of fishing. Because not all unharvested fish will survive to contribute to spawning escapement, a two-year-old chinook has a lower probability of surviving to spawn, in the absence of fishing, than does a five-year-old. Fishery mortality from these two age classes have different "adult equivalents".

Adult Fish - a salmonid that would spawn in the current year absent fishing or natural mortality.

Affected Party - A party who believes its interests will be affected by a proposed action under this plan. [see **Parties**]

Allocation Unit - A management unit or aggregated group of management units for which harvest shares are calculated. [see also **Management Unit**]

Base Period - A set of years used as an information basis to assess present or proposed actions. For example, exploitation rates on specific chinook stocks may be required to be z% lower than those achieved in a **xx-yy** base period.

Catch Ceiling - A fishery catch limitation expressed in numbers of fish. A ceiling fishery is managed so as not to exceed the ceiling. A ceiling is not an entitlement. [see also **catch quota**]

Catch Quota - A fishery catch allocation expressed in numbers of fish. A quota fishery is managed to catch the quota; actual catch may be slightly above or below the quota. Usually a quota is treated as an entitlement in that deviations may result in adjustments in subsequent years. [see also **catch ceiling**]

Cohort Analysis -. Estimation of the abundance of a population or management unit prior to the occurrence of any fishing mortality. The calculation sums spawning escapement, fisheries-related mortality, and adult natural mortality.

Cohort Size (initial) - The total number of fish of a given age and stock at the beginning of a particular year of life.

Coded-Wire Tag (CWT) - Coded microtags that are implanted in juvenile salmon prior to release. Fisheries and escapements are sampled for tagged fish. When recovered, the

binary code on the tag provides specific information about the location, timing of release, and rearing strategy of the tag group.

Conservation – This term is used in the general sense such as to foster or maintain and not in the legal context within this document.

Critical Abundance Threshold - A spawning escapement level below which the co-managers will exercise maximum regulatory effect to minimize fishery related impacts and maximize spawning escapement.

Diversity - Diversity is the measure of the heterogeneity of the population, in terms of the life history, size, timing, and age structure. It is positively correlated with the complexity and connectivity of the habitat. Diversity goals are expressed as desirable population characteristics.

Dropoff Mortality - The fraction of salmon encountered by a particular gear type that "drop-off" before they are landed, and die from their injuries prior to harvest or spawning.

Escapement - The portion of a run that returns to natural or artificial spawning areas.

Evaluation Fishery - A fishery scheduled specifically to obtain technical or management information, e.g. run timing, abundance, age composition.

Exploitation Rate (ER) - Total mortality in a fishery or aggregate of fisheries expressed as the proportion of the un-fished cohort removed by fishing.

Extreme Terminal Fishery – A fishery in freshwater, or one that harvests primarily fish from a single management unit.

Fishery – The harvest of salmon by a specified gear type in a specified geographical area during a specified period of time.

FRAM - The Fishery Regulation Assessment Model is a simulation model developed for use in estimating the impacts of Pacific Coast fisheries on chinook and coho stocks.

Gamma Distribution - The gamma distribution is member of the exponential family of distributions. Values of the gamma distribution are positive, ranging from zero to infinity, a property which makes it attractive for modeling or simulating variances. Two parameters describe the distribution, one parameter describes the shape and one parameter describes the scale. A special case of the gamma distribution is the Chi-Square distribution.

Harvest Rate (HR) - Total fishing mortality in a fishery expressed as a proportion of the total fish abundance available (standing stock) in a given fishing area at the start of a time period.

Landed Catch – Harvested fish that are taken aboard vessels or shore and retained by fishers. [see also **Nonlanded Catch**]

Management Period - The time interval during which regulatory actions are directly based on the management objectives for a management unit or allocation requirement for an allocation unit, taking into account catches (actual or expected) of the unit(s) outside its management period. Management periods are specific to each combination of management unit and fishery. [see also **Management Unit**]

Management Unit - A stock or group of stocks which are aggregated for the purpose of achieving a management objective.

Maximum Sustainable Harvest (MSH) - The maximum number of fish of a management unit that can be harvested on a sustained basis, measured as adult equivalents. In the Puget Sound Salmon Management Plan, MSH is defined as maximum sustainable harvest to Washington fisheries. [see **Adult Equivalent**]

MSY Exploitation Rate – The Maximum Sustainable Yield (MSY) exploitation rate is the proportion of the stock (computed as the sum of all fishing mortality, measured in adult equivalent terms and escapement) that could be harvested if long-term yield was to be maximized. The MSY exploitation rate is typically computed assuming stable stock productivity, although annual variability may occur.

Natural Spawning Area - An area which is or may be utilized by spawning salmon and in which egg deposition, fertilization, and rearing occur naturally.

Non-landed Catch - This category of fishery-related mortality includes drop-off mortality, and all other sources of fishery-related mortality that are not included in landed catch. Also referenced to as non-landed mortality. [see **Landed Catch**]

Non-treaty Fisheries - All fisheries that are not treaty Indian fisheries. [see **Treaty Fisheries**]

North of Cape Falcon – A regional, pre-season, management planning forum for fisheries in Washington and Oregon. This process is a series of public meetings, usually two, which occur between the March and April Pacific Fishery Management Council meetings. Due to the migratory nature of chinook and coho salmon, these meetings provide for an opportunity for discussion, analysis and negotiation among management entities with authority over southern US fisheries.

Parties - The State of Washington and 17 Puget Sound tribes comprise the parties to this plan.

Point of instability - that level of populations abundance (i.e., spawning escapement) which incurs substantial risk to genetic integrity, or expose the stock to depensatory mortality factors.

Pre-terminal Fishery- A fishery that harvests significant numbers of fish from more than one region of origin.

Productivity - Productivity is the measure of the survival rate of the population from one life stage to another is measured after taking into consideration mortality occurring during that period, e.g. smolts produced per spawning adult.

Recruitment – The abundance of the unfished cohort produced from a single brood year.

Run - A stock or group of stocks identified for fishery management purposes.

Run Size - The number of fish in an allocation unit, management unit, stock or any aggregation thereof.

Salmon - the following anadromous species of the family Salmonidae are native to the United States v. Washington Case Area:

Oncorhynchus tshawytscha (chinook, king, spring, tyee, blackmouth salmon)
Oncorhynchus kisutch (coho, silver, silverside, hooknose salmon)
Oncorhynchus nerka (sockeye, red, blueback salmon)
Oncorhynchus keta (chum, calico, dog, keta salmon)
Oncorhynchus gorbuscha (pink, humpback, humpy salmon)
Oncorhynchus mykiss (Steelhead)

Shaker Mortality - Nonlanded fishing mortality that results from releasing sub-legal fish, or non-target species. [see **Nonlanded Mortality**]

Southern US Non-Ceiling Index – The index compares the expected AEQ mortalities (assuming base period exploitation rates and current abundance) with the observed AEQ mortalities, by calendar year, over all non-ceiling fisheries in southern US. This index originates from the pass through provision of the Pacific Salmon Treaty.

Spawners – Equivalent to **escapement**.

State - The State of Washington and all the agencies of its government.

Stock - - a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season.

Terminal Fishery - A fishery harvesting primarily fish from a single region of origin, but may include more than one management unit.

Test Fishery – Same as Evaluation Fishery - A fishery conducted for the purpose of acquiring technical or management information. Fish caught in test fisheries may not be sold for personal profit.

Treaty Fisheries - Fisheries authorized by tribes possessing rights to do so under the Stevens treaties. [see also **Nontreaty Fisheries**]

Tribes - All Puget Sound treaty tribes: Lummi, Nooksack, Suquamish, Swinomish, Upper Skagit, Sauk-Suiattle, Tulalip, Stillaguamish, Muckleshoot, Puyallup, Nisqually, Squaxin Island, Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha Klallam, and Makah.

Viable - Adescriptor of a salmon population that has a negligible risk of extinction over a 100-year time frame due to threats from demographic variation , local environmental variation, or threats to genetic diversity .

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APPENDICES

Appendix A: Management Unit Status Profiles

Appendix B: Non-landed Mortality Rates

Appendix C: Minimum Fisheries Regime

Appendix D: Role of Salmon in Nutrient Enrichment of Fluvial Systems

Appendix E: Puget Sound Chinook Escapement Estimates: Description and Assessment

Appendix F: Fishery Selectivity on Biological Characteristics of Salmon

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